

## **Continuous Mortality Investigation**

### **Working Paper 56**

#### **CMI Life Office Mortality ‘Per Policy’ Results: the Initial Methodology and Format**

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## Executive Summary

The CMI Life Office Mortality investigation has, until recently, collected what is termed ‘scheduled’ data. That is, the data provided by contributing offices has been in a census format containing the total numbers of policies (in force and deaths) split by age and duration. No policy specific details were requested from contributors which means that the level of analysis that could be carried out on the data has been limited.

In recent years the CMI has been switching to ‘Per Policy’ data collection for life office mortality data. The aim is to capture more detailed information which will allow analyses that would previously have been impossible as well as improving the accuracy of the analysis.

A significant number of offices have now supplied Per Policy data and considerable progress has been made in verifying and processing this data. However, the additional time and effort required by offices and the CMI to validate Per Policy data means that it has not yet been possible to issue results based only on Per Policy data. Some of the areas within the Per Policy data requirements that are causing difficulty are discussed in section 2 to provide context for the remainder of this paper. The remainder of the paper sets out the methodology to be used initially for Per Policy mortality investigations and the format of the initial results.

The CMI Life Office Mortality Committee’s proposed methodology was set out in [CMI Working Paper 45](#) which proposed analysing actual incidences of death compared with expected deaths calculated using forces of mortality applied to the central exposure, derived on a day-count basis. This is similar to the approach now used for the CMI SAPS Mortality investigation.

The areas that attracted significant feedback were the proposal to analyse actual deaths against expected deaths based on incidence – even though data on deaths are collected by year of settlement – and the allowance for late settled deaths. The Committee has considered the feedback and decided to report under two different approaches:

- An initial analysis using only deaths that occur and are settled in an investigation year and then a single re-statement adding the deaths submitted in the following year; plus
- An analysis including an estimate of the deaths that have been incurred but not yet submitted to the CMI.

The changes to the proposed methodology and the initial methodology itself are set out in this paper.

The paper then describes the content and format of the initial results using Per Policy data. These are essentially similar to the results that the CMI has previously issued and do not use much of the additional data that is available in Per Policy data. The possible development of the results in the future is discussed in Working Paper 57, published simultaneously with this paper. Key features of the initial results, which will be issued in spreadsheet form, are:

- The results will contain exposed to risk, expected and actual deaths, on both a lives and an amounts basis.
- The results will be sub-divided by age, duration, gender, smoker status and what we refer to as the “Product Category”.
- The results will be issued in a similar form for a single year’s data and for quadrennial data, and at both an Individual Office level and for All Offices.

A template spreadsheet of initial Per Policy results is available from the website.

# Continuous Mortality Investigation

## Working Paper 56

### The Initial Methodology and Format of Results based on CMI 'Per Policy' Data

#### 1. Introduction

##### 1.1 Background

The CMI Life Office Mortality investigation has, until recently, collected what is termed 'scheduled' data. That is, the data provided by contributing offices has been in a census format containing the total numbers of policies (in force and deaths) split by age and duration. No policy specific details were requested from contributors which means that the level of analysis that could be carried out on the data has been limited.

In recent years the CMI has been switching to 'Per Policy' data collection for life office mortality data. The aim of this is to capture more detailed information which will allow analyses that would previously have been impossible as well as improving the accuracy of the analysis.

Under the Per Policy submission requirements, offices are asked to submit a separate record for each benefit of each life insured on each policy for each period that this benefit is in force with unchanged details within a calendar year. This means that more than one record per year is required for many policies. For example, an additional record is required if a policy is taken out of force during the year and brought back into force as is the case with an alteration. Each record should occupy one "row" in the medium of submission (e.g. one row in a spreadsheet, one database record or one text line). The information requested in each record is set out in the [Coding Guide](#).

A significant number of offices have now supplied Per Policy data and considerable progress has been made in verifying and processing this data. However, the additional time and effort required by offices and the CMI to validate Per Policy data means that it has not yet been possible to issue results based only on Per Policy data. As an interim measure, validated Per Policy data has been converted into the old, scheduled format to produce Individual Office results (and combined with scheduled data for the 2006 All Office results). Some of the areas within the Per Policy data requirements that are causing difficulty are discussed in section 2 to provide context for the remainder of this paper.

The CMI Life Office Mortality Committee has now decided on the methodology and format of results to be used initially using Per Policy mortality data. These are set out in this paper.

With the level of detail included in the Per Policy submissions, the Committee has the opportunity to extend these analyses greatly. However the initial results will not use much of the additional data that is available in Per Policy data and the possible development of the results in the future is discussed in Working Paper 57, published simultaneously with this paper.

## **1.2 Methodology**

[CMI Working Paper 45](#), published in May 2010, set out the Life Office Mortality Committee's proposed methodology to be used for Per Policy mortality data. This included the allowance for delays in validating deaths, estimation of missing dates of death, exposure calculations and comparisons of actual and expected deaths.

The Committee has considered the responses to this consultation and made some relatively minor alterations to the methodology. These changes and the initial methodology itself are set out in section 3 of this paper.

## **1.3 The Format of Results**

The results issued by the CMI in recent years comprise the results for each Individual Office, which are sent to that data contributor only, and the All Office results which are sent to all member offices. These are produced for each single year's results and for four years' results combined (quadrennial results).

The initial format of these regular results, based on Per Policy data, is described in this paper.

The CMI has also published a summary of the experience of each successive quadrennium in CMI Reports or Working Papers. These publications are not considered within this paper.

## **1.4 Terminology**

For simplicity, we generally refer only to deaths (and the date of death) in this paper; however for assurances with a terminal illness benefit, claim incidences include diagnoses of terminal illness (in which case we request that the date of claim incidence will be the date of diagnosis of terminal illness).

## **1.5 The Critical Illness investigation**

This paper focuses on mortality data, where the previous data format was particularly restrictive. Many of the considerations are also relevant to Per Policy data for the Critical Illness investigation; however the change in data format is less radical for the Critical Illness investigation which was already collecting individual data records containing life- and policy-specific details.

Consequently, the Critical Illness Committee has yet to consider in detail how it will adapt its methodology and results for Per Policy data. As far as practicable, it will seek consistency with the Life Office Mortality investigation. This has benefits both to the CMI, in terms of systems and processes, but more importantly to practitioners seeking to understand CMI results. However, particular features of the two datasets may lead the Critical Illness Committee to take a different approach in some areas.

## **1.6 Feedback**

The Committee is not specifically consulting on the initial format of results; however any feedback on this paper should be sent via e-mail to [mortality@cmib.org.uk](mailto:mortality@cmib.org.uk) or in writing to: Rachel Cox, CMI, Cheapside House, 138 Cheapside, London, EC2V 6BW.

## **2. An update on Per Policy data processing**

Since 2005, the CMI has been collecting “Per Policy” data for both the Life Office Mortality and Critical Illness investigations. The Life Office Mortality Committee now has two tasks to complete regarding Per Policy data: the short-term task of producing results akin to the scheduled results that have previously been produced and the longer-term task of producing analyses that benefit from linking Per Policy data across years and/or using the greater amount of information available.

Long delays have arisen in the processing of Per Policy data due to the number of issues arising and the resulting back and forth communication between the CMI and contributing offices. The Committee would like to take this opportunity to thank offices for their patience and perseverance.

This section sets out a summary of the issues arising and the actions undertaken by the Life Office Mortality Committee to speed up processing.

### **2.1 Data Issues**

There are numerous issues that are each specific to one office. Some issues are easily remedied and some have resulted in clarifications which have already been incorporated in the Coding Guide.

In addition to the office specific issues, others are common to a number of offices. In particular, many of these are identified during the processing of the second submission, not the first, and relate to the tracking of policies across years. These cause problems in relation to the CMI’s desire to assemble an accurate history of each person/policy/benefit across multiple years. Some examples of these common issues are set out below.

#### ***Inconsistent identifiers***

Inconsistent identifiers make it difficult, if not impossible, to check an individual data record against its corresponding record in the preceding year’s data. Some offices are unable to create unique identifiers and as a result the CMI system can attempt to join unrelated records. A similar issue arises when identifiers are not consistently applied between records, e.g. when benefit identifiers change upon the alteration of a benefit. In this case the CMI system is unable to find a related record when it expects there to be one.

#### ***Alterations***

For policies that have been altered (other than contractual changes to the benefit amounts) the CMI seek pre- and post-alteration records. Numerous issues arise in respect of alterations; these include overlaps or gaps in the period covered by the pre- and post-alteration records and in some cases offices are unable supply the date of alteration.

Another common issue arising from alterations is the inclusion of post-alteration records without matching pre-alteration records. This situation may arise under two scenarios; the pre-alteration was simply not included in the data submission, or the pre- and post-alteration records have inconsistent identifiers and hence the CMI is unable to correctly join the two records.

### ***Policy amounts***

The CMI seeks to use the type of increment/decrement and the rate of benefit increase/decrease to check that the start- and end-year amounts are consistent for individual records. Various inconsistencies arise when the CMI attempts to reconcile amounts due to the presence of minimum guarantees and the provision of non-annual increments. In addition to these inconsistencies, the CMI has discovered that some offices do not hold the rate of benefit increase/decrease on their systems.

## **2.2 Actions considered by the Committee**

The Committee has taken stock of the issues arising in the processing of Per Policy data and has considered a number of actions to enable processing to move forward more quickly in the future.

### ***Review of the data requirements***

The Committee has reviewed the data requirements and decided to make the rate of benefit increase/decrease a non-mandatory field. This has been incorporated in version 1.7 of the Coding Guide.

No other fields appear to be creating significant difficulties for a number of offices.

### ***Review of the coding guide***

During the period that data has been submitted, the Coding Guide and the processes for validating the data have evolved. This means there are likely to be small differences in the treatment of the data submitted earlier and that submitted more recently.

The Committee has reviewed the latest version of the Per Policy Coding Guide and has identified some areas for improvement. Although the Coding Guide will not undergo a major revision, the Committee will clarify some areas in the next version.

### ***Processing Per Policy data***

The Committee is aware that offices have their own internal quality controls on data and that the Per Policy data they submit is within the tolerances deemed acceptable for other purposes.

The Committee is now looking to make reasonable assumptions, where possible, and state these solutions to offices for confirmation, rather than simply posing questions. In some cases, this may result in the exclusion of problematic records, as an alternative to finding a solution for each individual record; however this practice will be managed carefully to avoid introducing any bias into the results. The Committee is keen to establish tolerance thresholds in the data processing to ensure that large submissions are not being delayed for a small number of records that are unlikely to materially affect the results.

To aid the Committee in understanding the issues in Per Policy data, and especially the residual issues that remain after processing, the Secretariat is now providing the Committee with a regular document summarising the assumptions and updates made to Per Policy submissions (whilst ensuring anonymity of offices). The purpose of the document is to allow the Committee to gauge whether the Secretariat is making sensible, consistent assumptions and approximations that do not undermine the accuracy of the final results.

### ***Contact with data contributors***

Many of the issues outlined above have resulted in extended communication between the CMI Secretariat and contributing offices to date, adding to the slow progress of processing.

The Committee would like to encourage data contributors to contact the CMI at an early stage in preparing their data submissions, if that would help to clarify any areas of doubt. Meeting to discuss the issues specific to a particular office might help to jointly identify how any issues can best be resolved and speed up future processing.

### **2.3 Conclusion**

The Committee is mindful of offices' competing claims on resources (e.g. Solvency II), and keen that Per Policy submission to the CMI should be as painless as possible. With this in mind the Committee has reviewed the Per Policy submission requirements and the data processing to relax the data validation without undermining the accuracy of the final results.

It is therefore hoped that these practical steps will speed up the submission and review of data and the production of results.

Many of the issues highlighted above are only apparent because of the move to Per Policy and may have been present in scheduled data, but would not have been visible to the CMI from the scheduled data.

### **3. The initial methodology for analysing Per Policy data**

The Committee issued a consultation on the methodology to be adopted for the initial analyses using Per Policy data in [CMI Working Paper 45](#). There was relatively little feedback to this consultation and only minor amendments are being made to the methodology set out in that paper.

This section summarises those amendments and also notes other areas where the methodology has been clarified. The methodology itself is set out in Appendix 1; this will also be added to the website as a separate document. Any future amendments to the methodology will be included in updated versions of that document; any material changes may be subject to prior consultation.

#### ***Age definition***

Working Paper 45 highlighted two age definitions that could be used to calculate exposure; age last and age nearest. Exposure using an age last definition is intuitive, and different approaches can be considered using age nearest, so the Committee has decided to use an age last definition in the initial methodology.

#### ***Missing dates of death***

The issue regarding missing dates of death was discussed in Working Paper 45. For a policy with a missing date of death, the Committee proposed to use a single point-estimate of the date of death to allocate the death to a particular investigation year and to determine the age and duration at death.

The Committee has decided to initially adopt the same approach used in the CMI Critical Illness investigation, based on deaths within CMI accelerated critical illness data, for estimating missing dates of death in the initial Per Policy results. Full details of this approach are included in the updated methodology in Appendix 1.

As stated in Working Paper 45, this approach will be reviewed when data volumes permit. This will be given higher priority if estimates are required in more cases; particularly for annuity data given that the initial estimates are based on assurances data.

#### ***Analysis of incurred deaths or settled deaths?***

Given that the CMI analyses should only include validated deaths, it is inevitable that some deaths that occur during a particular investigation year will only be settled by the office in a subsequent calendar year, and hence reported to the CMI in that future investigation year. Working Paper 45 set out three options for analyses to reflect these delays:

- a) Analyse actual settled deaths against expected incurred deaths;
- b) Analyse actual settled deaths against expected settled deaths; or
- c) Analyse actual incurred deaths against expected incurred deaths.

The paper stated that the Committee's preference was for option c). This attracted mixed views in the consultation and is discussed further in the following section.



### ***Allowance for late reported deaths***

Working Paper 45 set out three options for dealing with the late reporting of deaths to the CMI under option c), above. The Committee expressed an intention to initially carry out analyses with no allowance for late-reporting and then to provide a single re-statement when offices submit further data on these deaths in the subsequent investigation year.

This area, and the question of whether to analyse deaths by incidence or by settlement, received feedback from all respondents. In particular, concerns were expressed over the significant understatement of mortality in the first year if no allowance was made for late-reporting (initially).

The Committee has considered the feedback and decided to report under two different approaches:

- 1) An analysis of actual incurred deaths against expected incurred deaths, i.e. approach c), above. As proposed in Working Paper 45, initially this will include only the deaths with a date of death in the current calendar year (and with no allowance for late-reporting); the results will then be re-issued to include the additional deaths reported in the subsequent investigation year.
- 2) An analysis including an estimate of the deaths that have been incurred but not yet submitted to the CMI. Once data volumes warrant detailed analysis, a more accurate process for estimating these deaths will be introduced but, in the interim, all actual settled deaths (including those with dates of death in prior investigation years) will be compared with expected deaths i.e. approach a), above. The allowance for late-reporting implicit in this approach assumes that the incurred deaths that are not submitted to the CMI in that particular investigation year are offset by those occurring in prior years but submitted to the CMI in that year.

Working Paper 45 also considered the possible re-calculation of exposure when data on late-reported deaths are received. Initially, the re-statement of results under 1), above, will only reflect the additional deaths and not extend to the re-calculation of exposure. The Committee will review the impact of also re-calculating exposure and consider whether to revise this approach in future.

### ***Multiple Benefits***

Working Paper 45 noted that the "lives" analysis is at an individual record level but did not highlight that this will result in exposure (and actual deaths) being generated at the same age and duration if there are two near-identical benefits under a single policy as can arise under multiple-benefit policies.

The Committee does not intend to make any allowance for this issue in the initial methodology, and both the issue and the Committee's intentions are now noted in the updated methodology in Appendix 1.

#### 4. Initial results from Per Policy data

Initially, the analyses that are undertaken and the results that are issued using Per Policy data will be similar to the results that the CMI has previously issued (a high-level view of the current results is contained in Appendix 3. This is especially relevant given the issues that have been encountered by offices in producing Per Policy data and by the CMI Secretariat in processing the data, discussed in section 2.

As noted above, the initial results will be similar to the results that have previously been issued. In particular:

- The results will contain a summary of exposed to risk, expected and actual deaths for various categories of the overall dataset, on both a lives and an amounts basis.
- The categories into which the results are divided will include gender, smoker status and what we refer to as the “Product Category”. The latter are analogous to, but differ from, the “investigations” used previously.
- The results will use age bands and grouping of durations selected by the Committee.
- The expected deaths will be calculated on a single basis for each category, selected by the Committee. It is expected that these will be changed infrequently over time, with results on both the old and new bases when such changes do occur.
- The results will be issued in a similar form for a single year’s data and for quadrennial data, and at both an Individual Office level and for All Offices.

The structure of each subset of results will therefore be as follows:

Results for Category A (Product Category, Gender, Smoker Status, etc)								
Age Band	Duration a				Duration b			
	Exposure (Years)	Actual	Expected	100 A/E	Exposure (Years)	Actual	Expected	100 A/E
X1-X2								
X3-X4								
X51X6								
X7-X8								
X9-X10								
<b>Total</b>								

Initial results in this format will be familiar to users and will contain the information that the Committee believes to be most valuable. The default medium for the results will be an Excel spreadsheet with the results for each Product Category in a single tab; supplementary tabs will contain the same results using individual ages, rather than age bands, and individual durations (up to 25 with a 25+ category) to provide additional flexibility to users. [This is similar to the provision of a “grouped” tab and an “all” tab in SAPS results; for example, see the spreadsheets available alongside [CMI Working Paper 51](#).]

The initial results are described in more detail in the remainder of this section.

#### **4.1 Categories for Summary Results**

The Committee will keep the categories for the initial results to a manageable level, as follows:

- Age (last birthday)
- Duration (curtate)
- Gender
- Smoker status (where relevant)
- Retirement type (where relevant)
- Product category (see below)

Once sufficient volumes of Per Policy data have been received, the Committee will analyse and report on the impact of other factors on mortality experience. It may be appropriate to consult on changes to the initial categories.

The scope of the initial results will be restricted, in line with existing results, to:

- UK only, and
- Non-rated.

Non-underwritten (“guaranteed acceptance”) business will also be excluded initially. Only a small volume of such data has so far been submitted in Per Policy format and it is not (yet) sufficient to produce separate results. The Committee therefore decided to exclude such business from the initial results rather than including it with underwritten business to avoid distorting the experience of underwritten business.

#### **4.2 Product Categories**

Within Per Policy data requested by the CMI, “product type” is a free-format field and is generally unique to an individual data contributor. The CMI can therefore make available Individual Office results based directly on product type. However, in some cases it can identify an office and therefore it is not suitable for use in All Office results as its use could breach office confidentiality.

The CMI is therefore using the product type and other fields, such as the ABI New Business Code, to assign data to “Product Categories”. The initial hierarchy for Product Categories for All Office results is set out in Appendix 2. To decide the levels at which initial results are produced, the Committee will need to assess the data volumes for each category, with regard to both credibility and confidentiality.

It is anticipated that initially results would use the Level 2 product categories for Assurances and the Level 4 product categories for Annuities, i.e.:

- The Level 2 product categories for assurances might be –
  - Endowment,
  - Whole Life,
  - Level Term,
  - Increasing Term,
  - Decreasing Term,
  - Family Income Benefit,
  - Pensions Term, and
  - Other/unknown.

- The Level 4 product categories for annuities might be –
  - Life Annuities in Payment,
  - Pension Annuities in Payment split between Occupational (Direct or Bulk) and Private (Individual or Bulk),
  - Pension Annuities in Deferment split between S226 and Personal Pension, and
  - Other/unknown.

As discussed in Appendix 2, the proposed Product Categories do not easily translate to the “investigations” traditionally used for Life Office Mortality. The Committee is keen that – as far as possible – results will be made available comparable with those issued for earlier years. It envisages that this will be a temporary measure, to allow mortality experience to be tracked across years, although the period may vary between the investigations, dependent on data volumes and the perceived value of such continuity.

### 4.3 Expected Deaths

The expected deaths will be calculated in the results on a single basis, selected by the Committee, for each category. The initial bases are set out below, based on the expected Product Categories.

#### *Assurances*

<b>Product Category</b>	<b>Gender</b>	<b>Smoker Status</b>	<b>Comparator table</b>
Endowment and Whole Life	M	N	AMN00 Sel
		Y	AMS00 Sel
		Combined	AMC00 Sel
	F	N	AFN00 Sel
		Y	AFS00 Sel
		Combined	AFC00 Sel
Term	M	N	TMN00 Sel
		Y	TMS00 Sel
		Combined	TMC00 Sel
	F	N	TFN00 Sel
		Y	TFS00 Sel
		Combined	TFC00 Sel

#### *Annuities*

<b>Product Category</b>	<b>Gender</b>	<b>Comparator table</b>	
Life Annuities in Payment	M	IFL00Base Sel	
	F	IML00Base Sel	
Pension Annuities In Payment (Occupational; at or after NRD)	M	PNML00Base Ult	*
	F	PNFL00Base Ult	*
Pension Annuities In Payment (Occupational; Early retirement)	M	PEML00Base Ult	*
	F	PEFL00Base Ult	*
Pension Annuities In Payment (Private)	M	PPMV00Base Ult	
	F	PPFV00Base Ult	
Pension Annuities In Deferment (S226)	M	RMD00Base Ult	
	F	RFD00Base Ult	
Pension Annuities In Deferment (Personal Pension)	M	PPMD00Base Ult	
	F	PPFD00Base Ult	

Note that the “lives” tables will also be used for amounts results, except where the corresponding amounts table already exists (marked with a \*).

#### **4.4 Age bands**

Scheduled mortality results have used 5-year age bands for results of 21-25, 26-30, etc. Although the Committee will retain 5-year age bands for Per Policy results in the summary tab, it has decided to adopt the bands 20-24, 25-29, etc. These are consistent with the CMI SAPS results and, for annuity business, the Committee considers it more logical to combine the experience at age 65 last with that at ages 66-69, rather than with that at ages 61-64.

#### **4.5 Grouping of durations**

Scheduled mortality results have used different groupings of duration by investigation, for example: Permanent assurances have used 0, 1, 2+ and Temporary assurances have used 0, 1, 2-4, 5+ whilst Personal Pensions have just used “All”. For Per Policy results, the Committee has decided to adopt a single grouping for all products of 0, 1-4, 5+ in the summary tab. This is clearly simpler and the consistency will allow users to easily aggregate results across categories.

#### **4.6 Medium for results**

The default medium for initial results will be an Excel spreadsheet with the summarised results for each Product Category in a single tab. This will allow the user to gain easy access to the results and the format will be familiar and accessible to all users. Users will also be able to aggregate across Product Categories (for example to “All Term Assurances”), if required.

Supplementary tabs will contain the same results using individual ages, rather than age bands, and individual durations. Whilst the data at individual ages and durations might lack credibility, the detailed version will allow users to:

- Apply different age bands or an alternative grouping of durations, and
- Create results with a different basis for expected deaths from that used by the CMI.

Additional fields, such as Distribution Channel, can also be included in the second tab, without unnecessarily complicating the summarised results. Users can then choose to produce consistent results by distribution channel, rather than for all channels combined.

An example spreadsheet to illustrate the proposed format is available alongside this paper on the CMI website.

The CMI will consider requests for alternative formats (such as PDF).

#### **4.7 Statistical Tests**

No statistical tests will be included in results initially.

#### **4.8 Data Security**

The results will be encrypted and distributed via e-mail. The CMI Secretariat will provide the user with a password to access the spreadsheet. In order to avoid any security breaches in transmission, the Secretariat will telephone the nominated recipient with the password.

The Secretariat will also distribute results on CD upon request, in which case the password may be supplied via e-mail or telephone.

## References

CMIR 8 (January 1986)

CMI Working Paper 14 : Methodology underlying the 1999-2002 CMI critical illness experience investigation (May 2005)

CMI Working Paper 34 : Methodology and assumptions used for CMI self-administered pension schemes mortality experience analyses (October 2008)

CMI Working Paper 36 : The mortality of impaired assured lives: Report on 1995-2006 experience and consultation on the future of the investigation (January 2009)

CMI Working Paper 45 : Consultation on the Proposed Methodology for the Analysis of CMI 'Per Policy' mortality data (May 2010)

CMI Working Paper 51 : Report on the preliminary results of an analysis into the mortality experience of pensioners of self-administered pension schemes for the period 2002-2009 based on data collected by 30 June 2010 (May 2011)

CMI Working Paper 57 : CMI Life Office Mortality 'Per Policy' Results: Consultation on the Future Format of results (September 2011)

Per Policy Coding Guide; version 1.7 (September 2011)

Template spreadsheet of Per Policy results (September 2011)

All of the above can be found at: <http://www.actuaries.org.uk/research-and-resources/pages/continuous-mortality-investigation>

## Appendix 1 – Initial Methodology for Analysing Per Policy Data

This paper sets out the CMI Life Office Mortality Committee’s initial methodology for Per Policy mortality investigations, including the allowance for delays in validating deaths, the estimation of missing dates of death, the exposure calculations and comparisons of actual and expected deaths. This follows the consultation on the methodology undertaken in [CMI Working Paper 45](#).

The methodology for analysing Per Policy data compares **actual incidences of death** with expected deaths, calculated using **forces of mortality** applied to the **central** exposure, derived on a **day-count basis**. This methodology removes the need for many of the assumptions implicit in previous CMI analyses, which are detailed in [CMI Working Paper 45](#). At this level, this is consistent with the approach used recently by the CMI SAPS Mortality Committee as described in [CMI Working Paper 34](#).

Note that for simplicity we generally refer only to deaths (and the date of death) in the remainder of this paper; however for assurances with a terminal illness benefit, claim incidences include diagnoses of terminal illness (in which case we request that the date of claim incidence will be the date of diagnosis of terminal illness).

The following sections set out the methodology used in calculating the central exposure by age and duration for each Per Policy data record. This is described at a high level for the lives analysis, in section A1.1, followed by amounts analysis, in section A1.2. Section A1.3 then contains further detail on a number of areas, for example the allowance for late reported deaths.

The methodology assumes that analyses are only carried out for investigation periods that correspond to calendar years; in particular, information on actual deaths is only captured on a calendar year basis.

### A1.1 Lives analysis

#### *Calculation of exposure*

Exposure is calculated as age last birthday, e.g. a life attaining age  $x$  on 1<sup>st</sup> July in a year is regarded as age  $x-1$  in that year up to and including 30<sup>th</sup> June and age  $x$  in that year from 1<sup>st</sup> July, and curtate duration in years is used.

For each Per Policy data record, the contribution to the exposure cell for age  $x$  and duration  $t$  in a given investigation year equals the number of days the life insured is at risk in the observation period and is age  $x$  and duration  $t$  (according to the age and duration definitions) divided by the number of days in the year (i.e. 365 days or 366 days in a leap year).

For a life exposed to risk throughout a year, this would result in total exposure of 1 year (split between age and duration cells). This means that the expected number of incurred deaths may be slightly underestimated in leap years as the actual length of exposure in leap years is higher by a day (in theory, we would see slightly higher actual incurred deaths in leap years).

#### *Calculation of expected deaths*

Expected deaths are calculated by multiplying the central exposure ( $E_x^c$ ) by an appropriate force of mortality. Exposure will be calculated for age  $x$  last birthday, i.e. from  $x$  to  $x+1$ , on

average  $x+1/2$ . Given that  $\mu_x$  applies to age exact where an ultimate duration mortality comparison basis is used:

$$\text{Expected deaths at age } x = E_x^c \times \mu_{x+1/2}$$

The value of  $\mu_{x+1/2}$  will be approximated by averaging between  $\mu_x$  and  $\mu_{x+1}$ .

Where a select duration mortality comparison basis is used, interpolation is required by both age and duration and the following approximation will be applied:

$$\text{Expected deaths at age } x, \text{ duration } t = E_{x,t}^c \times (\mu_{[x-t]+t} + \mu_{[x+1-t]+t} + \mu_{[x-t]+r+1} + \mu_{[x-t]+t+1}) / 4$$

### ***Allocating actual deaths by age and duration***

Deaths are allocated according to the age and duration on the date of death, based on the age and duration definitions used to calculate exposure.

Actual deaths are then compared with Expected deaths.

## **A1.2 Amounts analysis**

In many cases benefit amounts change during an investigation period.

Where benefit amounts change regularly as a policy condition (without new underwriting), the Per Policy data requirements request the benefit amounts applicable at the start and end of the year as well as the date the benefit amount is reviewed during the investigation year. Using this information, the benefit amount applicable to each day during the investigation year is estimated by assuming that the amount only changes once, on the relevant date. Note that if benefit amounts change more frequently (e.g. on some mortgage decreasing policies the benefit amount reduces monthly) then the review date is taken as 1 July which, on average, gives an appropriate total amount of exposure, although the allocation by age and duration will not be entirely accurate.

Where benefit amounts alter on an irregular basis (whether or not this is contractual), the data requirements depend on whether new underwriting was carried out:

- For increases without new underwriting (and for reductions in benefit), offices are asked to submit two records, one before and one after, each with the relevant benefit amount. This allows exposure to be weighted by the correct benefit amount, for the correct proportion of the investigation period, without affecting the duration of the policy.
- For increases with new underwriting, offices are again asked to submit two records, the original record being unchanged and the increase in benefit submitted as a separate record with the benefit commencement date set to the date of the increase. This allows exposure to be allocated to curtail duration zero for the increase in benefit, without affecting the duration and benefit amount of the original policy.

### ***Calculation of exposure***

For each Per Policy data record the exposure to a particular age and duration cell is calculated in a similar way to the exposure for the lives analysis but weighted by amounts. Therefore the amounts exposure to risk on a given date will be their lives exposure for that date multiplied by the amount applying to that date. If the amount were £1 throughout the investigation period, the lives and amounts exposure would be identical.

### ***Calculation of expected deaths***

For amounts analyses, expected deaths are calculated in a similar manner to the lives analyses.



### ***Allocating actual deaths by age and duration***

The amount of benefit applicable on the date of death is allocated to the relevant age and duration in a similar way to the lives analysis.

Note that where the benefit amount changes more frequently than annually, this amount may not equal the assumed amount of exposure on that date.

Actual deaths are then compared with Expected deaths.

### **A1.3 Areas of detail**

#### ***First day of exposure***

For each Per Policy data record, the first day of exposure to a given age  $x$  and duration  $r$  cell is the last of the following dates during the investigation period:

- a) The first day of the investigation period;
- b) The date the record was brought into force;
- c) The benefit commencement date; and
- d) The first date on which the life is aged  $x$  and the curtate duration is  $t$ .

#### ***Last day of exposure***

For each Per Policy data record, the last day of exposure to a given age  $x$  and duration  $r$  cell is the first of the following dates during the investigation period:

- a) The last day of the investigation period;
- b) The date of death. (The approach where this date is not available is discussed below);
- c) The day before the record is taken out of force during the investigation period for a reason other than death, e.g. due to surrender, benefit alteration or maturity (see below for further discussion); and
- d) The day before the life reaches age  $x+1$  **or** the day before the benefit reaches curtate duration  $t+1$ , whichever happens first.

#### ***Leap years***

Birthdays or policy anniversaries falling on 29<sup>th</sup> February are assumed to occur on 1<sup>st</sup> March in non-leap years. This ensures that any exposure on both 28<sup>th</sup> February and 1<sup>st</sup> March in non-leap years is allocated to the correct age and duration cell.

#### ***Definition of the Maturity date***

We assume that the maturity date provided by offices is the first day on which cover no longer applies.

#### ***Defining a “death”***

- a) Assurances.  
Offices are asked to submit data on deaths (or terminal illness claims) that are valid under the policy terms in the year they are admitted **OR** in the year they are settled.

Even if an office has been notified of a death within the calendar year of death, unless the death is admitted or settled there is a possibility that it may be declined. As the investigation is only concerned with valid claims under the policy conditions, we would wish to exclude any deaths where the claim is declined.

Therefore claims only become valid either when they are admitted or when they are settled and offices need to decide which of these two events they wish to use to define “valid claims” for the purpose of submitting data.

Whichever event is used, all the claims settled (or admitted) in the year should be submitted even if the policy had previously been treated as lapsed. This means that all settled claims should eventually be collected.

Where offices use admission as the key event, the CMI expects that all admitted claims are eventually settled. (In the rest of this paper, unless otherwise stated, references to settled claims include admitted claims where these are used by offices to define valid claims.)

b) Annuities.

Offices are asked to submit data on annuities where the benefit payments have ceased after the office has been notified of the death of a policyholder (in a form acceptable to the office).

Further details and guidance on the definitions and treatment of deaths are given in the [Per Policy Coding Guide](#).

***Missing dates of death***

As well as identifying the last day of exposure, the date of death is used to calculate the age and duration at death and to assign each death to a particular investigation year.

For assurances, offices are asked to provide at least one of four dates relating to each claim event (dates of death (or confirmed diagnosis of a terminal illness), notification, admission and settlement) with the date of death being preferred and offices being encouraged to provide all four dates of claim.

For annuities, dates of admission and settlement have little meaning so these dates are not required – offices are requested to provide at least one of the dates of death and notification for such business. Again, the date of death is preferred.

However the date of death may not be clear, particularly for terminal illness claims and suspended annuities and hence the precise date of death may not be known by offices. Alternatively it may be known but not recorded in a suitable form for inclusion in the data submitted to the CMI.

For these policies, the date of death is estimated from whichever of the dates of notification, admission and/or settlement are provided by the office. In these cases, we use a single point-estimate of the date of death to allocate deaths to particular investigation years and to determine the age and duration at death. Note that this issue has already been encountered in the CMI critical illness investigation; this is discussed in [CMI Working Paper 14](#).

The number of policies requiring an estimated date of death is currently very low and data volumes do not warrant detailed analysis. Therefore the methodology adopted by the CMI critical illness investigation, based on deaths within CMI accelerated critical illness data, is used for estimating missing dates of death in Per Policy data. The adjustments used to estimate missing dates of death from one of the other three dates of death, based on the duration of the policy, are summarised in the table below:

Duration at relevant date of death in days	Average observed delay in days from date of death		
	Settlement	Admission	Notification
<=91	41	36	8
92 – 183	44	39	14
>=184	103	98	12

Where date of death is unavailable, the adjustment is based on an alternative date that is provided in the order shown (i.e. date of settlement is first choice).

### ***Allowance for delays in validating deaths***

Given that the CMI analyses should only include validated deaths, it is inevitable that some deaths that occur during a particular investigation year will only be settled by the office in a subsequent calendar year, and hence reported to the CMI in that future investigation year. The Committee will initially undertake analyses using two different approaches:

- 1) An analysis of actual incurred deaths against expected incurred deaths. Initially, this will include only the deaths with a date of death in the relevant investigation year (and with no allowance for late-reporting); the results will then be re-issued to include the additional deaths reported in the subsequent investigation year. (NB The exposure will not be re-calculated for these additional deaths.)
- 2) An analysis including an estimate of the deaths that have been incurred but not yet submitted to the CMI. Initially, all actual settled deaths (including those with dates of death in prior investigation years) will be compared with expected deaths. This approach assumes that the deaths that are not submitted to the CMI in a particular investigation year are offset by those occurring in prior years but submitted to the CMI in that year.

### ***Multiple Benefits***

The methodology set out above is applied at a benefit level, i.e. the exposure is calculated for each Per Policy data record and the death of a single individual may be counted under several records. This can arise where two benefits affected by the same individual at the same time differ only in the term of the cover, in whether they are level or escalating, or whether they are Single or Joint Life, for example.

This is an example of the well-known issue of Duplicates in insured experience analysis, for which there is no straightforward solution (even if we assume that we can accurately determine that the two lives are one and the same). If we consider results separately by Single Life/Joint Life (for example), then it is appropriate to treat the two records separately; however for results that do not analyse by this factor, it would be preferable to combine the records.

This issue should not introduce any bias into the mortality rates that are calculated but will affect the variance of these rates. Whilst the Committee does not intend to make any allowance for this issue initially, it will be considered further before any graduations are undertaken.

Note that this issue only affects ‘lives’ analyses, not amounts analyses.

## Appendix 2 – Product Categories

### A2.1 Introduction

For scheduled mortality data, offices were required to submit data segregated between different “investigations”. These sometimes correspond to types of product, as discussed in A2.4 below, but are inflexible and in some cases historic.

Within Per Policy data, the “product type” is free format and the CMI intends to use this and other fields in Per Policy data, such as the ABI New Business Code, to map data to a new hierarchical structure of product categories. The structure is described separately below for assurances and annuities.

It is intended that data will be mapped to the lowest level possible but the Committee will need to assess the data volumes before deciding at which levels results can be produced - both in terms of credibility and to avoid any risk of breaching office confidentiality. Data volumes will also need to be kept under review over time but – unlike the historic need for Life Office Mortality to launch a new investigation or close an existing one – the Committee expects to be able to move to a different level within the hierarchy in future. Where such changes are made, it should be possible to release comparable results over time at the “higher” level.

### A2.2 Product Categories – Assurances

The proposed hierarchy splits assurances into the following categories:

Level 1	Level 2	Level 3
Permanent	Endowment	Non-profit
		Unit-linked
		With-profit
		Hybrid
	Whole Life	Non-profit
		Unit-linked
		With-profit
		Hybrid
Term	Level	Mortgage
		Non-mortgage
	Increasing	
	Decreasing	Mortgage
		Non-mortgage
	FIB	
Pensions Term		

NB At each level there will also be an “Other/unknown” category that is not shown above.

### A2.3 Product Categories – Annuities

The proposed hierarchy for annuities is split into the following categories:

Level 1	Level 2	Level 3	Level 4	Level 5
Life Annuities in Payment				
Pension Annuities	In Payment	Occupational	Direct	
			Bulk	Buy In
		Buy Out		
		Private	Individual	S226
				Personal Pension
			Bulk	Income Drawdown
				S226
		In Deferment	S226	
	Personal Pension			

NB At each level there will again be an “Other/unknown” category that is not shown above.

### A2.4 Mapping Life Office Mortality “investigations” to the new Product Categories

The proposed Product Categories do not easily translate to the “investigations” traditionally used for Life Office Mortality. Consider Permanent Assurances, for example. These are currently separated between investigations 01, 04, 06, 07, 81 and 86 (although 06 also includes Temporary Assurances). As proposed above, these will all be combined in the new Level 1 Product Category; the mapping to the current investigations will use the following fields: Medical type code, Business Type, and Single or Joint Life indicator (provided these are included in the data records).

The Committee is keen that – as far as possible – it will initially make available Summary Results comparable to results issued for earlier years. It envisages that this will be a temporary measure, to allow mortality to be tracked across years, although the period may vary between the investigations, dependent on data volumes and the perceived value of such continuity. Note that even if Per Policy data is mapped to the old investigations, the results will not necessarily be consistent with earlier results because of changes in methodology and, more significantly, changes in data contributors, with a number of offices having submitted data for the first time in Per Policy format.

## Appendix 3 – Current Format of results

### A3.1 Investigations

Scheduled mortality data is collected and analysed by investigation number. These are separate “investigations” into which offices are asked to segregate their data. In some cases these investigations equate to product types but, for others, different product types are combined in one investigation or one product type is split across several investigations. Details of the investigations are contained in Appendix 4.

### A3.2 Data Listing

The data listing that is sent to each data contributor records, for each sex, the numbers of lives (and, where appropriate, amounts) in force at the beginning and end of each year and the number (and, where appropriate, amounts) of deaths occurring during the year by age and duration. The provision of such a data listing originates from the early days of the CMI, when data was submitted in paper form, and was intended to enable offices to check that their data had been input correctly by the CMI. Now that data is submitted electronically, there is less scope for such input errors and as a result the provision of such a detailed and lengthy data listing may be considered less appropriate.

The data listing also contains the results from the following statistical tests:

#### *Consistency Test*

It is expected that, for each calendar year, the number of lives in force at 1 January for age  $x$  and duration  $t$  should be greater than or equal to the number of lives in force at 31 December for age  $x+1$  and duration  $t+1$ . Any exceptions to this test are listed.

#### *Kolmogorov-Smirnov Test*

This test also considers the consistency of the start- and end-in force data, comparing the cumulative distribution of lives aged  $x$  at duration  $t$  to the distribution of lives aged  $x+1$  at duration  $t+1$  at the next year-end to assess whether these are likely to have come from the same underlying distribution. Further details of this test can be found in CMI Report number 8.

### A3.4 Individual Office Results

The results of the scheduled mortality investigations provide a summary of (initial) exposed to risk and actual and expected deaths by five year age bands for various sub-categories of data. In particular, the data is split by investigation number, gender, smoker status (for some investigations) and duration in force (for various pre-specified groupings).

The expected deaths are calculated using comparison bases chosen by the CMI. The current comparison basis for each investigation is also shown in 0.

Two summary statistics are shown to compare the expected and actual deaths: the calculations of  $100 * \text{actual/expected}$  and the Chi-squared statistic; the latter indicates the goodness of fit of the experience to the comparison basis.

Note that if the expected deaths for an age group is less than five then the data for that age group is combined with adjacent age groups until this criterion is met for the purposes of calculating the 100A/E's and the Chi-squared statistic.

### **A3.5 All Office Results**

Once all data has been collected and validated for a particular investigation year, it is combined into an All Office analysis, which is issued to each member office. The All Office results do not include a data schedule and, in order to protect confidentiality, exclude any investigations that comprise an insufficient number of offices. Apart from these differences, the format of the All Office results is identical to that of the Individual Office results.

### **A3.6 Distribution of Results**

The scheduled mortality results are now distributed via e-mail in the form of PDF documents.

#### Appendix 4 – Scheduled Mortality Investigations and Comparison Bases

Investigation Number	Description	Sex	Comparison Basis (Lives only)
<b>Assured lives</b>			
<b>01</b>	Permanent (whole life and endowment) assurances issued after the provision of satisfactory evidence of health	F	AFC00 Sel
		M	AMC00 Sel
<b>02</b>	Temporary assurances (or 02 for level temporary and 03 for decreasing temporary if unable to combine)	F	TFC00 Sel
		M	TMC00 Sel
<b>04</b>	Linked contracts (but not unitised with-profit business which should be included under traditional assurance business classifications)	F	AFC00 Sel
		M	AMC00 Sel
<b>06</b>	Joint-life-first-death issued after the provision of satisfactory evidence of health	F	AFC00 Sel
		M	AMC00 Sel
<b>07</b>	Permanent (whole life and endowment) assurances completed without any medical selection whatever	F	AFC00 Sel
		M	AMC00 Sel
<b>29</b>	Temporary assurances effected under Section 637(1) of ICTA 1988	F	TFC00 Sel
		M	TMC00 Sel
<b>81</b>	Permanent (whole life and endowment) assurances completed on minimum evidence of health	F	AFC00 Sel
		M	AMC00 Sel
<b>86</b>	Joint-life-first-death completed on minimum evidence of health	F	AFC00 Sel
		M	AMC00 Sel



Investigation Number	Description	Sex	Comparison Basis	
			Lives	Amounts
<b>Immediate annuitants</b>				
12	Post 1956	F	IFL00Base Sel	IFL00Base Sel
		M	IML00Base Sel	IML00Base Sel
<b>Retirement annuities and personal pension policies</b>				
21	Retirement annuities in deferment effected under Section 620 of ICTA 1988	F	RFD00Base Ult	-
		M	RMD00Base Ult	-
22	Personal pensions in deferment effected under Chapter IV, Part XIV of ICTA 1988	F	PPFD00Base Ult	-
		M	PPMD00Base Ult	-
23	Retirement annuities in payment effected under Section 620 of ICTA 1988	F	RFV00 Base Ult	-
		M	RMV00Base Ult	-
24	Personal pensions in payment effected under Chapter IV, Part XIV of ICTA 1988	F	PPFV00Base Ult	-
		M	PPMV00Base Ult	-
<b>Pensioners under Life Office pension schemes</b>				
31 & 71	Retirement at or after normal retirement date (31=Durations 0 to 4 years; 71=Durations 5 to 10 years and over)	F	PNFL00Base Ult	PNFA00Base Ult
			PCFL00Base Ult	PCFA00Base Ult
		M	PNML00Base Ult	PNMA00Base Ult
			PCML00Base Ult	PCMA00Base Ult
33 & 73	Early retirements (33=Durations 0 to 4 years; 73=Durations 5 to 10 years and over)	F	PEFL00Base Ult	PEFA00Base Ult
			PCFL00Base Ult	PCFA00Base Ult
		M	PNML00Base Ult	PNMA00Base Ult
			PCML00Base Ult	PCMA00Base Ult
34	Deceased pensioners or members	F	PNFL00Base Ult	PNFA00Base Ult
			PCFL00Base Ult	PCFA00Base Ult
			WL00Base Ult	WA00Base Ult
		M	PNML00Base Ult	PNMA00Base Ult
			PCML00Base Ult	PCMA00Base Ult