“A jewel in our crown”

The first 100 years of the CMI

compiled by

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The quotation that forms the title of this book is taken from Stewart Ritchie's Presidential Address (as the incoming President of the Faculty of Actuaries) in 2006; available in the British Actuarial Journal (2007). It is extracted from:

> "I believe that there is an excellent future for actuaries as quantitative risk professionals. We do not have a monopoly in risk measurement or risk management, but we do have great core strengths on which to build. For example, in mortality we are unrivalled in our expertise, and the Continuous Mortality Investigation is a jewel in our crown."

Contents

Overview of this book

This book documents the history of the Continuous Mortality Investigation (the CMI) over its first 100 years and sets out some thoughts regarding its future.

Structure and content of this book

After this overview, the book is in four parts:

- Part A describes (approximately) the first 50 years of the CMI. This part of the book relies on existing sources but includes a few of my own observations, in particular on how the CMI evolved, both during this period and subsequently.
- Parts B and C describe subsequent developments. Part B covers the years to 1999; few of those involved during those years were able to contribute directly to this book so, inevitably, this also relies mainly on published material. Part C[1] is more extensive; in particular:
    a. I was personally involved during almost all of this period and can therefore reflect my own memories;
    b. A number of key individuals from that period have shared their recollections; and
    c. I was granted access to CMI committee papers[2] and some IFoA[3] papers from this period.
- Part D is much briefer, setting out some thoughts on the current position and the future of the CMI. It was largely written by current members of the CMI committees but, as with Part A, includes a few of my own observations.

The time-segregation between parts A, B and C is not precise and some commentary relevant to each period can be found in the other sections, but I felt it was helpful to divide the book into these periods to distinguish between the different source materials available to me.

Why now?

2024 arguably marks the centenary of the CMI. The exact date that the CMI was formed is uncertain – my understanding is that the first Chairman was in place from 1923 however 1924 marks the first full year of the CMI. What is indisputable is that the CMI chose 1999 for the 'CMI 75' anniversary event and that 2024 is the 25th anniversary of that event!

Why me?

My involvement with the CMI was divided into two phases:

- I was involved in instigating the critical illness investigation in the mid-1990s. Through that, I became a member of the Mortality Committee and also of both the Management and Executive Committees.
- In 2005, I joined Barnett Waddingham LLP which provided the Secretariat function to the CMI. As a result I stepped back from my volunteer roles before becoming CMI Secretary in 2006; a position I held through to 2021. In that role, I was involved in key developments within all of CMI's committees.

As CMI Secretary, I was very aware of the CMI's history and that this had been documented for earlier periods. I felt it would be appropriate to bring the history up to date for the centenary year … and no-one else seemed to be about to volunteer!

[1] Part C covers the period until 31 December 2023 but I have mentioned some events during 2024.
[2] Papers from prior years were all held in paper form – not electronically – and only published documents, such as CMI Reports, have been retained.
[3] The Institute and Faculty of Actuaries.

Thanks to…

I quote extensively from CMI Reports, working papers and other documents in this book; consequently, many people have unknowingly contributed to this book! Unfortunately, from my perspective, the vast majority of the CMI's work is unattributed meaning that many people who made substantial contribution are unnamed in this book. I have included a list of Chairs of the various CMI committees, in Appendix 1, but even this only scrapes the surface of all those who have contributed.

I would like to express particular thanks to the following people, who have knowingly assisted me in producing this book:

- The CMI and specifically:
    a. Matthew Edwards and Jonathan Hughes, then Chair and Deputy Chair of the Executive Committee, who permitted access to CMI committee papers;
    b. Jonathan and Stuart McDonald, the current Chair and Deputy Chair of the Executive Committee, who supported this initiative and reviewed various draft sections;
    c. The CMI committees, who documented their thoughts on the future of the CMI that forms much of Part D and reviewed their sections of earlier parts of the book; and
    d. Viv Maclure, my successor as CMI Secretary, and her team for providing the CMI papers I requested.
- David Raymont, Librarian at the IFoA, and his colleagues in the Library Service who provided access both to the papers that I asked for, and sourced others that I didn't know existed!
- All of the individuals who knowingly provided input: Steve Bale, Matthew Edwards, Tim Gordon, R. Dale Hall, Dave Heeney, Colin Kirkwood, Tony Leandro, Angus Macdonald, Anne Moore, Jon Palin, Brian Ridsdale, Neil Robjohns, Gordon Sharp, Caroline Twomey, Howard Waters and Richard Willets, many of whom I have quoted in this book. A particular pleasure for me, in undertaking this project, was to reconnect with some former 'CMI colleagues' who I had not been in touch with for some years. Particular thanks are due to those who contributed significant segments of text:
    - Matthew Edwards, whose recollections of his period as Chair during the COVID-19 pandemic are contained in Appendix 10;
    - Neil Robjohns and Richard Willets who contributed their recollections of the early development of the CMI Mortality Projections Model (in Section C7); and
    - Howard Waters, whose memories of the start of the PHI investigation make Section B4 much more colourful!
- Finally, but certainly not least!, Kevin Armstrong who reviewed all of the sections of this book and made countless suggestions for improvement.

Needless to say, any errors in the final text are mine (unless they are inside quote marks!)

Important notes

I have quoted extensively from CMI Reports, working papers and other material. Any reader considering using any of the findings documented in this book should consult the original document and not rely on this book, which reflects my interpretation of the findings.

Part A: The early years of the CMI, 1924 to 1973

A1. Introduction to Part A

The first CMI Report[4] was issued in 1973 and it included a section entitled 'HISTORY AND DEVELOPMENT'. This details the history of the CMI to that date[5] and the core content is reproduced in full in Section A2.

That section of CMIR 1 includes three appendices:

- The first two contain the CMI's constitution and its consolidated rules (effectively, the data requirements); as these are still of interest, I have included these below.
- The formation of the CMI did not mark the start of actuarial investigations into mortality rates in the UK. Appendix 3 of CMIR 1 contains a bibliography of previous papers relating to insured mortality, including papers published in the Journal of the Institute of Actuaries (J.I.A.), the English professional body, and/or the Transactions of the Faculty of Actuaries (T.F.A.), the Scottish body[6] and some published elsewhere. Note that this list includes papers published prior to the existence of the CMI and those published in J.I.A. and T.F.A. in 1924-1968, after the founding of the CMI. (I assume there were no new papers between 1968 and CMIR 1 being issued.) As CMIR 1 remains available[7], I chose not to reproduce that appendix here.

Following this extract, I have included a few observations in Section A3; these are intended to highlight key aspects of CMI's history and, where applicable, how these differ from recent practice.

There are a number of other sources of information on the formation and early years of the CMI that I have included as appendices:

- Appendix 2 is a section titled 'MORTALITY AND OTHER INVESTIGATIONS' in the book 'The Institute of Actuaries 1848-1948: An Account of The Institute of Actuaries during its First One Hundred Years' by R. C Simmonds, published in 1948. Much of this describes work prior to the formation of the CMI but it is of considerable interest, so I have included it in this book.
- Another paper providing insight into the CMI's early work is 'A note on the history of the computerization of the work of the Bureau and the development of improved services to contributing offices', which was originally published in CMIR 8 in 1986. This is reproduced in Appendix 3. Although, in part, it describes developments after the period covered by this part of the book, it provides valuable insight into how data was processed prior to the developments this paper describes.
- Finally, Appendix 4 contains the text of a booklet given out to attendees at the CMI's 75th anniversary event, in 1999.

Note that:

- To distinguish the historical material from my comments, I have tried to reproduce each item of the source material it in its original font (including some idiosyncratic aspects). I have also retained the original terminology and spelling, even where a different form might now be used.
- The historical material has been copied from pdf documents. In some cases, this process introduced errors that I have sought to correct but I may have missed some such errors.

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[4] See Section B6 for more information on CMI Reports; throughout this book, references to a specific CMI Report are abbreviated to 'CMIR *x*'.

[5] The report is dated 1973, and the membership of the CMI Executive Committee is as at 15 June 1973, but the content may have been written earlier. A supplement, covering the years to 1983, is included in CMIR 6 and is reproduced in Appendix 7 of this book.

[6] These bodies were separate until the formation of the Institute and Faculty of Actuaries in 2010.

[7] At the time of writing, all CMI Reports remain public-available at:https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-reports.

A2. CMI History and Development to 1973 (extract from CMIR 1)

HISTORY AND DEVELOPMENT

The first standard table prepared in Great Britain based upon an assured lives experience was the *Seventeen Offices' Table*, which was published in 1843 and based on the combined experience of the group of offices up to 1837. Further standard tables were prepared in the nineteenth century, and an investigation into the mortality of immediate annuitants was made over the period 1900-20, but during the whole of this time the work was in the hands of *ad hoc* Committees. A file of papers left by the late Colonel H. J. P. Oakley, now in the Institute Library, indicates that separate investigations were placed in the hands of different Committees, which disbanded as each experience was concluded, and the 1900-20 annuity experience appears to have been in the hands of the last of these Committees.

The establishment of what was referred to in the Minutes of the Councils of the Institute and Faculty as a Permanent Research Bureau was first considered long before the Bureau was in fact set up, and the Life Offices were circularized in February 1913. The draft of a further letter was approved by the Institute Council in January 1914, and indicated that most of the offices had expressed their approval in principle to the proposal. The distribution of the letter was, however, deferred until the Faculty had decided upon the draft to be sent to the Scottish offices, and the First World War had broken out before the details were concluded. It seems that the matter was left in abeyance until, in 1923, a new investigation into the mortality of assured lives was referred to the *ad hoc* Committee dealing with annuity investigation. The continuous collection of data started from the beginning of 1924 and this can be taken as the time when the evolution of the Bureau resulted in its emergence in its present form.[8]

The first Chairman of the Committee was Mr W. P. (later Sir William) Elderton.[9]

The Joint Committee in its present form was not set up until some years later. In 1931 the two Councils accepted in principle that a working Committee be set up consisting of three representatives of the Institute and three of the Faculty with the two Presidents as members *ex officio*.

No formal minutes were retained of the Committee's transactions up to the end of the Second World War, although its work had been summarized in a note prepared by F. L. Bradshaw in 1949. The last meeting of the Committee at which Sir William Elderton took the chair was held on 14 June 1946, and the next meeting does not appear to have been held until 22 April 1949, with Mr R. Ll. Gwilt in the chair, and at which reference is made to 'the newly constituted Committee'. Mr Gwilt, although a Fellow of both the Institute and the Faculty, was on the Committee as a Faculty representative, and he remained Chairman until the middle of 1961 when he was succeeded by Mr F. M. Redington.

[8] Further support for 1924 being considered the first year of the CMI is the report to Council, regarding an Assurances investigation, dated 1 May 1924 and contained in Appendix 6.
[9] A full list of CMI Chairs is included in Appendix 1.

The unwritten law under which Institute and Faculty representatives alternate in filling the office of Chairman was continued in 1968 when Mr J. M. Denholm succeeded Mr. Redington.

The first appointment of a Secretary to the Committee was that of Mr R. D. Clarke with effect from 1 July 1950, a position he held until 30 September 1972, when he was succeeded by Mr H. A. R. Barnett.

When the collection of data started on a continuous basis in 1924 the offices submitted statistics for three main investigations, viz. Assured Lives, Children's Deferred Assurances, and Immediate Annuities.

Statistics are submitted in a form suitable for the use of the 'Census Method', that is to say the offices submit particulars of policies in force on 1 January each year (a different date can be substituted if more convenient to the office[10]) and of policies becoming claims by death notified in the year. Statistics are usually submitted according to age nearest birthday, but for some offices a different age classification is more convenient, and in these cases the Bureau makes appropriate adjustments to the figures to approximate to an age nearest birthday classification. There are also subdivisions according to curtate duration of policy, durations 0 to 4 inclusive each being shown separately, durations 5 and over being combined. Data are received from about sixty offices. Female lives are generally excluded, but initially offices were permitted to include them if exclusion was difficult and if they were only a small proportion of the total, and a few offices still include a few females in their data. The proportion is believed to be well under 1%.

Mention has been made of 'policies' and this word was used deliberately. The investigations have generally been on the basis of policies rather than of lives, although in the assured lives' experience 'concurrent duplicates' have been excluded, so that a batch of policies effected at the same time on the same life would only be counted as one. Where possible all duplicates in the assured lives over age 80 have also been excluded.

The effect of duplicate policies was investigated by the Committee who invited the contributing offices to analyse the death claims in 1954 showing the numbers of lives at each age having 1, 2, 3, … policies. The returns were of duplicates within offices, no attempt being made to trace duplicates on the same life in several offices. The purpose of this investigation was to ascertain whether it would be possible to improve the estimates of the standard deviations needed to test the differences between actual and expected deaths; it was based on statistics for durations 3 and over.

The assured lives' experience was originally sub-divided into eight sections according to whether the policies were whole life or endowment assurance, whether they were with or without profits, and whether they were effected with, or without medical examination. (Policies on lives effected at higher than normal rates were excluded.) However, when standard tables were prepared, based on the experiences of 1924-29 and 1949-52[11], it was found that the Whole Life section was insufficient to give reliable results at young ages and the Endowment Assurance section was insufficient at the older ages. Furthermore, the Non-Profit Whole Life section was insufficient at the older ages. Variations between individual offices were found to be more significant than variations between the different types of policy and consequently the

[10] I am aware that Standard Life exercised this option; their year-end was 15 November.
[11] I think these tables were published in 1936 and 1956, respectively.

A1924-29 and A1949-52 tables were constructed from the whole of the data. After the publication of the A1924-29 table, the experience was subdivided into offices exhibiting the lightest and heaviest mortality and 'Light' and 'Heavy' tables were constructed from the data of a selection of these offices[12]. 'Light' and 'Heavy' tables were not prepared from the 1949-52 experience[13].

Despite the knowledge that variations between types of policy were of little significance, the subdivision of the data in this way continued up to and including 1958, after which the only division (apart from age and duration) has been between medical business and business accepted without medical examination.

For convenience, the 1924-29 tables were based on a three-year select period even though data had been collected on a five-year select basis. Similarly, the 1949-52 tables were based on a two-year select period. Details of the graduation methods employed are described fully in the official publications.

Apart from the standard tables, periodical reports have appeared in the *Journal of the Institute* and in the *Transactions of the Faculty*. From 1948 these included comparisons of trends with those of the national mortality – originally as separate reports but now incorporated with the main reports on assured lives.

Although comparisons with national mortality can show overall differences, they cannot analyse these differences in detail, and accordingly from 1964 a subsidiary investigation of the main assured lives' data has been undertaken according to cause of death. A first report was published in the *Journals* based on years 1964-66.

From 1924 there was a separate investigation into mortality under Children's Deferred Assurances. A report was made on the experience of the years 1924-36 inclusive. After the First World War interest in the experience under this class of policy declined and the investigation closed with the year 1960, a final note being prepared for the *Journals*.

The other investigation which has been continuing ever since the Bureau was set up is that on immediate annuitants. Data for males and females are kept separate and there has generally been a five-year select period; however, periodical scrutiny of the results in the preparation of reports indicated that from 1957 onwards there appeared to be some change in the class of lives effecting immediate annuities, possibly arising from the effects of the 1956 Finance Act, and accordingly, from 1963 onwards, the select period was extended by one year every year up to and including 1968. The select period has now reverted to five years, but pre-1957 business is kept separate from post-1956.

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[12] A section on 'Inter-office comparisons' in CMIR 13 adds a little detail here "They therefore devised supplementary tables from the experience of the seven lightest and five heaviest offices respectively, which were published in 1937."

[13] CMIR 13 also comments on the A1949-52 tables "The individual calculations were carried out and 'it was again found that wide divergences existed among the mortality experiences of different offices'. Offices were allocated to a light or heavy group and the experience of the two groups published in *JIA* **85**,57 and *TFA* **26**,122. It was considered that very little use had in fact been made of the A1924-29 (Heavy) Table and that there was therefore little justification for deriving a new one. However, it was thought useful to derive a set of rates of mortality from the experience of the light offices. No monetary functions were produced for these and it was recommended that, in practice, light offices use the standard A1949-52 Table with a rating down in age."

From 1960 the offices have been asked (in the case of their immediate annuity returns only) to submit lists of deaths notified in the first half of a year which took place in the previous year. This enables the 'in force' figures to be adjusted, and cuts down systematic distortion which can otherwise be quite serious at the advanced ages which figure prominently in this class of business.

A standard table was prepared on the basis of the 1947-48 experience, projected to give rates which might be expected to apply to lives purchasing annuities in 1955[14]. A 'forecast' generation table was also prepared on a projection based on expected improvements in mortality which, in the event, have not materialized.

In 1948 an investigation was started into the experience of annuities payable for a term certain and for life thereafter. This was concluded in 1957.

Also in 1948, collection of data was started for pensioners under life office pension schemes. Originally this investigation was based on lives, but since 1958 particulars based on amounts have also been submitted, and these two sets of data are still being collected. Also, since 1965, separate data have been submitted by five offices[15] based on 'Works' pension schemes, these being also included in the main pensioners' data.

Retirement annuities effected under the 1956 Finance Act have been the subject of an *ab initio* investigation, and will therefore form the basis of the only investigation into which all possible data will have been collected, apart from the fact that there are some offices who write this business but do not submit data.

A special investigation based on seven offices and three years only (1958-60) was undertaken into mortality under group life assurance schemes. This was carried out on a 'policy year' basis, and the results were presented according to both lives and amounts. The returns of policies in force were by age nearest birthday on the scheme anniversary which occurred in the calendar year for which the return was being made. Deaths and withdrawals were tabulated by age nearest birthday on the scheme anniversary prior to death or withdrawal no matter what calendar year the exit took place in. New entrants and increments, where they took place at dates other than the scheme anniversary, were tabulated by age nearest birthday on the scheme anniversary prior to entry.

In 1968 it was decided to investigate the mortality of lives assured under policies written in the Republic of Ireland[16]; twelve offices are contributing data, the first returns being for the year 1970.

Current investigations include one into the mortality under certain temporary assurances, which was started in 1970, and one into the mortality of female assured lives, starting with the year 1973.

A sub-committee has been set up to plan and conduct an investigation into sickness rates under permanent health insurance policies.

Generally it may be stated that wherever appropriate the statistics for medically examined lives are kept separate from those relating to non-medical data.

[14] I think these tables were published in 1951.

[15] This is shown – inaccurately in my opinion – as "officers" in CMIR 1.

[16] In 1968, I suspect most of the offices contributing data were branches or subsidiaries of UK offices – so were existing contributors to CMI investigations. The CMI's relationship with Ireland is considered further under 'The CMI and Ireland' in Section C9.

It should be mentioned that strict anonymity of offices is preserved in all data and statistics. Each contributing office is allocated a number, and the name of the office does not appear on any data sheets.

Appended to this note are (1) a copy of the Constitution and Rules of the Bureau; (2) a copy of the Consolidated Rules issued to the contributing offices as a guide to the preparation of data, incorporating all amendments to date but not including the recent instructions concerning the permanent health insurance investigation; and (3) a bibliography of all publications and papers prepared by, or under the auspices of the Committee or any of the earlier *ad hoc* Committees[17].

APPENDIX 1

CONSTITUTION AND RULES OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU

1. The Bureau shall be called 'THE CONTINUOUS MORTALITY INVESTIGATION BUREAU' and is herein referred to as 'the Bureau'.

2. The objects of the Bureau shall be:

   (a) To collect statistics relating to the mortality of various classes of insured lives, annuitants and pensioners.
   (b) To analyse such statistics and prepare reports for publication.
   (c) To construct tables of mortality and morbidity functions and of actuarial functions dependent thereon to be published primarily for use by assurance companies.
   (d) To make estimates of future developments in mortality and morbidity rates and to carry out other statistical investigations such as may be useful to the conduct of long-term assurance, annuity and pension business and of sickness insurance.

3. The organization and administration of the Bureau shall be in the hands of an Executive Committee consisting of not less than 6 or more than 10 members of whom not less than 3 or more than 5 shall be appointed by the Council of the Institute of Actuaries and not less than 3 or more than 5 shall be appointed by the Council of the Faculty of Actuaries in Scotland. The said Institute of Actuaries is hereinafter referred to as 'the Institute' and the said Faculty of Actuaries in Scotland is hereinafter referred to as 'the Faculty'.

4. The Chairman of the Executive Committee shall be appointed from the members of the Executive Committee by agreement between the Councils of the Institute and the Faculty.

5. The Executive Committee shall appoint a Secretary of the Bureau on such terms as to service and remuneration as it shall think fit but such appointment shall be subject to the prior approval in writing of the Councils of the Institute and the Faculty.

6. The Treasurer for the time being of the Institute shall be the Treasurer of the Bureau and all property of the Bureau shall be vested in the Institute on behalf of the Bureau. The financial year of the Bureau shall run from 1 April to 31 March and once in every year the audited accounts of the Bureau shall be presented to the Councils of the Institute and Faculty.

[17] As noted earlier, this appendix is not included in this document – see CMIR 1.

7. A member of the Executive Committee shall hold office either until he is requested by the Institute or the Faculty responsible for his appointment to resign or until he shall tender his resignation in writing to the Institute or Faculty responsible for his appointment.

8. The Executive Committee may within its absolute discretion set up sub-committees and may appoint persons to serve on such sub-committees who are not members of the Executive Committee; provided always that responsibility for the conduct of all the activities of the Bureau shall remain with the Executive Committee.

9. The Councils of the Institute and Faculty shall be entitled to invite subscriptions from persons or Corporations making use of the facilities afforded by the Bureau of such amounts and calculated in such a manner as the Executive Committee of the Bureau may in its absolute discretion recommend.

10. The Executive Committee shall have power to apply the funds of the Bureau in promoting, furthering or protecting the objects for which the Bureau has been established and without prejudice to the generality of the foregoing:

(a) In acquiring whether by letting or otherwise premises for use as offices or otherwise for the use of members of the Executive Committee or for any purposes of the Bureau.
(b) In maintaining an official library.
(c) In paying remuneration to officers and servants of the Bureau or pensions or gratuities to former officers and servants or to their dependants or in making other provision for the payment of pensions or gratuities to former officers and servants or their dependants provided that rates of remuneration, pension or gratuity shall be subject to the approval in writing of the Councils of the Institute and Faculty.
(d) In paying such reasonable sums for the expenses of officers of the Bureau or members of the Executive Committee as may from time to time be thought desirable or for the expenses reasonably incurred by any persons who may have rendered special services to the Bureau and for meeting all other expenses incurred in the running of the Bureau.
(e) In making grants to research establishments or other organizations where the Executive Committee is of the opinion that such grants will promote or further the objects for which the Bureau has been established.
(f) In obtaining or distributing or causing to be published or distributed any book, pamphlet or journal relating to the affairs of the Bureau or promoting or furthering the usefulness or efficiency of the Bureau.

11. No person or corporation making use of the facilities afforded by the Bureau shall be entitled to any direct or indirect payment or transfer of all or any part of the income or property of the Bureau whether by way of dividend, gift, division, bonus or otherwise howsoever by way of profit.

12. The Executive Committee may at any time with the prior approval in writing of the Councils of the Institute and of the Faculty rescind, vary, amend or add to any of these Rules.

28th July 1970

APPENDIX 2

CONSOLIDATED RULES OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU (AS ISSUED TO THE CONTRIBUTING OFFICES, BUT INCLUDING CHANGES IN PROCEDURE UP TO OCTOBER 1973)

INTRODUCTION

During the fifty years' existence of the Continuous Mortality Investigation Bureau many circulars have been issued setting forth rules to be followed by the contributing offices when compiling their returns of data for the various investigations. It has been suggested that a consolidated set of rules would be helpful to the offices and the present memorandum has accordingly been prepared. It is divided into sections corresponding to the various investigations at present being undertaken by the Bureau. These are as follows:

(1) Assured lives.
(2) Immediate annuitants.
(3) Lives covered by retirement annuity contracts.
(4) Pensioners under life office pension schemes (including subsidiary investigation into ‘works’ schemes).
(5) Causes of death among assured lives.

ASSURED LIVES

The assured lives investigation was originally restricted to policies on male lives issued in the United Kingdom at standard rates of premium without surcharge. It is divided into two sections, *viz.* Medical and Non-Medical. The Medical section relates to lives which have been medically examined at entry and the Non-Medical section relates to lives accepted under a standard type of Non-Medical proposal form.

A separate investigation started in 1970 on policies issued on male lives in the Republic of Ireland, another started in 1973 on policies issued on female lives in the U.K. Both these are on similar lines to the male U.K. investigation.

The investigation is carried out in select form, the period of selection being five years. The census method is employed and offices are asked to submit annually returns of the 'in force' on 1 January and of the deaths during the preceding year.

Various classes of policy are excluded from the investigation and these are listed below. An essential principle to be borne in mind is consistency. The obvious application of this principle lies in the exact matching of the ‘in force’ data with the deaths. No policy should be included in the return of deaths unless at the time of death it would have qualified for inclusion in the ‘in force’. Equally, no policy becoming a death claim should be omitted from the deaths if at the time of death it was qualified for inclusion in the ‘in force’ – unless it should belong to one of the excluded categories of death claim noted hereunder.

As the census method is employed in the investigation it can happen that a policy appearing as a death claim has never been included as ‘in force’. Thus if the policy is effected in April and becomes a death claim in the following August, it should (if it is not disqualified by falling into one of the excepted

classes) be included in the return of deaths at duration 0 even though it will never appear in the 'in force'.

Printed forms are supplied to the offices for making the annual returns and there are separate forms for Medical and Non-Medical business[18]. Individual columns are provided on the forms for durations 0 to 4 and there is a final column for durations '5 and over'. For the 'in force' the duration at 1 January of year N is given by:

Duration = $N - 1$ – year of issue

The ages at which the policies in force are tabulated are intended to be the nearest ages on 1 January. However, various approximations are used in practice. A common approximation is:

Nearest age on 1 January = Age next birthday at entry plus curtate duration.

The form of approximation employed by a particular office will obviously depend on its internal system of records.

Deaths are recorded according to nearest age and curtate duration of death. While, as with the 'in force', some method of approximation may be employed in arriving at the nearest age at death, the method of determining the duration should be exact. For purposes of calculating both age and duration at death it is permissible to regard the date of notification of death as the actual date of death.

There are certain categories of death claim which should be excluded from the return of deaths. These are:

1. Deaths from suicide when the sum assured is not paid.
2. Deaths from any cause excluded from cover by the terms of the policy, where the sum assured is not paid.
3. Death claims repudiated by reason of non-disclosure of essential information on the proposal form.
4. Deaths occurring after the policy has been removed from the 'in force' register as a lapse – whether a claim payment is made or not.

The various classes of policy to be excluded from the investigation are listed below. In applying the rules it is intended that offices should be guided by commonsense. For example, it is hoped that an office which transacts a substantial amount of overseas business will adhere to the rule excluding all policies issued outside the U.K. But an office which issues only an occasional policy outside the U.K. may find that the exclusion of these policies creates a major inconvenience. Consequently the office may decide to include its small number of overseas policies, knowing that the effect on the combined experience of all offices[19] will be negligible. As emphasized earlier, however, it is essential that in the preparation of data the principle of consistency should be observed at all stages.

The classes of policy which are excluded from the assured lives' investigation are as follows:

1. Policies on female lives (apart from those offices making separate returns for the female investigation.)

[18] An example of one of these forms is included in Appendix 5.

[19] This is the first use I have found of the term 'all offices'. It has subsequently been used extensively but it is important to recognise that 'all' refers only to those contributing data to the CMI, not the whole industry.

2. Policies on which any form of surcharge has been imposed, whether by way of extra premium, rating-up in age, or deduction from the sum assured.
3. Policies issued outside the U.K. (apart from those offices making separate returns for the Republic of Ireland.)
4. Policies issued under schemes granting cover with minimum evidence of health. (Note: Since 1964, policies issued under the Federated Superannuation Scheme for Universities fall into this category and are therefore excluded.)
5. Policies issued without medical examination in conjunction with an immediate annuity.
6. Temporary assurances (including convertible term assurances and income benefit policies *where there is no basic lump sum benefit*) (but see next section.)
7. Pure endowments.
8. Deferred assurances.
9. Joint life policies of all kinds.
10. Contingent assurances.
11. Double endowments.
12. Increment policies under staff superannuation schemes. (Note: many such policies will already be excluded under item 4. For the rest, only the initial policy should be included and all subsequent policies should be excluded.)
13. Reassurances received from other offices.
14. Policies under which the office is no longer in regular contact with the life assured. These, in general, will be non-participating policies under which premiums have ceased to be payable and may include policies which are maintained in force for a prolonged period under non-forfeiture regulations.
15. Simultaneous duplicates, *i.e.* where more than one policy is issued on one life at the same time, only one policy should be included in the investigations.[20]
16. Duplicate policies on lives aged 80 and over. This means, in effect, examining the records for policy holders attaining age 80 in a given year and excluding all policies in excess of one for each policy holder.
17. Unit-linked policies.

TEMPORARY ASSURANCES

A new investigation started in 1970 into the mortality experienced under the following classes of temporary assurance:

1. Level temporary assurances for terms of not less than one year, including convertible term assurances.
2. Decreasing temporary assurances under which there is no terminal endowment benefit and no permanent life assurance.

[20] Note: This has been relaxed in recent years in response to representations from a number of offices. It is now permissible to include simultaneous duplicates, but it is hoped that where an office avails itself of this relaxation it will take special steps to eliminate simultaneous duplicates in all cases where five or more policies are issued on one life at the same time.
[NB: Unlike the other footnotes in this section, this was included in the original text.]

Within each of the two classes defined above the investigation is subdivided into Medical and Non-Medical sections, in select form with a five year period of selection. In general, the rules applicable to the main investigation for Assured Lives also apply to the Temporary Assurance investigation. If an assurance is extended, it may be removed from the investigation at the end of the original term or may remain for the extended term, whichever the office finds more convenient but the duration must continue to be measured from the original date of entry.

IMMEDIATE ANNUITANTS

The immediate annuitants' investigation embraces both male and female lives in receipt of purchased single-life immediate annuities. The following classes are excluded from the investigation:

1. All joint life annuities of whatever types.
2. Annuities guaranteed for a term certain and for life thereafter.
3. Annuities under which there is a return of part of the purchase money on death.
4. Annuities purchased in connection with pension schemes.
5. Annuities issued in conjunction with life assurance (usually to elderly lives in connection with Estate Duty avoidance).
6. Annuities issued on special terms on account of health impairment.
7. Annuities which were originally issued as deferred annuities.
8. Annuities secured out of the proceeds of an endowment assurance without the option to take cash.
9. Temporary annuities.

Separate returns are required for male and female annuitants. The investigation is carried out in select form and (subject to the qualification noted hereunder) the select period is five years. The contracts in force on 1 January are tabulated according to nearest age and curtate duration on that date; and the deaths are tabulated according to nearest age and curtate duration at the date of death. (Note: The actual date of death must be employed for calculating age and duration and not the date of notification.)

Data for annuities which entered the experience before 1957 are now kept separate from those which entered after 1956; the pre-1957 data are required in aggregate form.

When deaths are notified too late for inclusion in the return of data for the year in which they occurred, they must be included in the data for the year in which they were notified, but at the age and duration appropriate to the correct year of death. Every year, as soon as possible after 30 June, offices are asked to send a supplementary return (for which a printed form is provided) of annuity deaths occurring in the preceding year but notified too late for inclusion in that year's returns. This is to enable the Bureau to add these deaths into the correct year's data and to adjust the 'in force'. The same 'late-notified' deaths will be included by the offices in their standard returns for the year following the year of death and the Bureau will be responsible for subtracting them.

When notification of death is delayed longer than 30 June following the year of death, no adjustment will be made but offices are asked to send a note of such cases to the Bureau.

RETIREMENT ANNUITIES

Since 1958 an investigation has been conducted into the mortality experienced by lives holding retirement annuities, *i.e.* contracts providing pensions for the self-employed under the terms of the 1956 Finance Act. There are eight sections of the investigation, the sub-divisions being:

male or female
medical or non-medical
during deferment or after retirement.

The investigation is conducted on an aggregate basis, so that there is no sub-division by duration. The census method is employed and policies in force are scheduled according to nearest ages on 1 January and deaths according to nearest ages at death.

This investigation is based on 'lives' as opposed to 'policies'. Consequently all duplicate policies within the same office must be excluded. (Note: it is recognized that, since a life may effect policies with two or more offices, it is impracticable to exclude duplicates completely and such a life will accordingly be enumerated separately by each office with which a contract is effected.)

Retirement annuities payable for term certain and for life thereafter should be included in the investigation. Retirement annuities with a reversionary benefit to widow should be included only in respect of the principal life. Wives and widows of the holders of retirement annuities should not be included in the experience.

If, during the period of deferment, the holder of a retirement annuity leaves the U.K. to reside overseas, the annuity should be removed from the investigation as there is a danger of loss of contact with the annuitant.

PENSIONERS

An investigation is carried out into the mortality after retirement of pensioners under life office pension schemes. This is divided into 'early retirements' (*i.e.* retirements taking place before the normal retirement date) and 'normal and late retirements'. Male and female lives are investigated separately.

Schemes qualify for inclusion in the data if they are written under a group contract providing deferred annuities for employees. It is recognized that there is a wide variety of such schemes and precise rules have deliberately not been laid down to define which schemes do or do not qualify for inclusion. The fact that pensions may be guaranteed for a certain number of years is no bar to inclusion and joint pensions are included until the death of the pensioner life.

It is not always possible in this investigation to exclude duplicates. Not only may one person be a member of several schemes (whether with the same life office or different life offices), but even within one scheme he may draw several slices of pension (*e.g.* one for past service as at date of entry into the scheme, another in respect of his own contributions and yet another in respect of supplementary contributions). As pension business is usually administered in bulk, the sorting out and elimination of duplicates is sometimes impracticable.

The investigation is conducted on an aggregate basis, so that there is no analysis by duration. The census method is employed, the 'in force' being

scheduled according to nearest age (or some approximation thereto) on 1 January and the deaths according to nearest age at death.

A special feature of this investigation is that the experience is examined not only according to the number of 'lives' (strictly speaking, the number of individual slices of pension), but also according to 'amounts'. For this reason, the total amount of pension per annum must be entered at each age on the returns for both 'in force' and deaths.

A few offices are making separate returns in respect of pensioners under schemes covering 'works' personnel only. The same principles apply as in the main return (in which, of course, these special 'works' schemes are also included).

CAUSE OF DEATH INVESTIGATION

Since 1964 the Bureau has conducted an investigation into causes of death among assured lives. The data are provided by the policies included in the return of deaths for the main investigation into assured lives' mortality. Thus, there should be an exact correspondence between the returns of deaths for the main investigation and the cards completed for the cause of death investigation.

One card is to be completed for each policyholder in respect of whom there is at least one policy included as a death in the main investigation. Provision is made on each card to record data for any number of policies up to six. (If there are more than six policies on the same life, a supplementary card must be used and attached to the principal card.) For each policy the nearest age and the curtate duration of death, as calculated for the main investigation, are to be recorded. Where approximate methods are used for calculating the age at death, this can mean that the same life may be recorded at different ages on different policies. Special care must be taken to exclude any policies which are not in the main investigation.

On the card there is a space for recording the cause of death. This must be copied precisely, and in full, from the death certificate, including any code numbers that may appear against the stated causes of death (*e.g.* 1 (a), 2 (b), etc.). The completed cards should be sent to the C.M.I. Bureau, where the cause of death will be coded. It is helpful if they are sent in batches at intervals during the year, care being taken not to mix cards for different years. For this purpose the year is not necessarily the year when death occurred, but the year for which the policy is recorded as a death. When the cards for a year's claims have all been completed, each office is asked to reconcile the data with its return of deaths in the main investigation.

In addition to the deaths which are recorded as death claims in the main investigation, there are other deaths under which the sum assured is not paid (*e.g.* suicide within a certain period from the issue of the policy or claims repudiated because of non-disclosure of material information on the proposal form). When the cause of death investigation was instituted offices were not asked to return cards for these policies which did not qualify for inclusion as deaths in the main investigation. However, it has since been decided that information about these excluded cases would be of interest and offices are asked to complete cards for them. These cards should be plainly marked 'excluded from deaths in main investigation' and it is possible, therefore, that there may be two cards for one life: one card being for 'included deaths' and the other for 'excluded deaths'. All 'excluded deaths' must relate to policies which qualify for inclusion in the 'in

force’; there is no intention of extending the investigation to classes of policy which are at present excluded altogether.

CHANGES OF METHOD IN PREPARING DATA

From time to time it happens that an office changes its internal rules for preparing data for the Bureau. This may affect the calculation of ages at which data are recorded or it may be concerned with the inclusion or exclusion of a class of policy or with some other variation of practice. Whatever the nature of the change, offices are asked to notify the Bureau fully of what has been done so that, if necessary, suitable adjustments may be made in the Bureau's calculations of exposed-to-risk, etc.

A3. Observations

Here, I set out a few of my own observations on aspects of the CMI's history, as described in the various sources included above:

1. The focus is firmly on mortality, although there is mention of the nascent permanent health insurance[21] investigation at the end of the extract from CMIR 1.

2. Moreover, the focus is on base mortality; the only mention of mortality projections is the reference in CMIR 1 to projecting the 1947-1948 annuitant experience to apply to lives purchasing annuities in 1955.

3. In particular, there are numerous references to 'standard tables'. To my knowledge, this term was not defined until many years later, as described under ''Adoption' and 'Standard tables'' in Section C9.

4. Considerable collaboration was needed between the (English) Institute of Actuaries and the (Scottish) Faculty of Actuaries to form, and then to oversee, the CMI. My understanding is that the CMI was the first long-term 'joint venture' between the Institute and the Faculty, pre-dating (for example) collaboration on examinations.

5. The Presidents of the Institute and the Faculty were both members of the CMI Executive Committee, a situation that continued until 2010[22]; the subsequent position is described under 'Structure and operations: 2000 to 2013' in Section C9.

6. The extract from CMIR 1 refers to "The unwritten law under which Institute and Faculty representatives alternate in filling the office of Chairman…". I think this continued to apply until 2008, when Gordon Sharp succeeded Brian Ridsdale as Chairman; both were Faculty members.

7. Under the Constitution, the two Councils had high-level responsibilities – for example in appointing members of the Executive Committee – but most of the operational aspects were delegated to the Executive Committee, including inviting subscriptions and running the investigations. This situation largely persisted until 2013, when substantive changes took effect, as described under 'Review of the CMI' in Section C9.

8. The 'objects' of the Bureau – set out in section 2 of the Constitution – remain broadly unchanged as the 'Areas of Research' defined in the CMI's current Terms and Conditions.

9. Although its core function, of collecting data and constructing mortality and morbidity tables, has remained unchanged, the CMI was innovative and there are a number of developments noted in CMIR 1, such as the investigation into Group Life mortality.

10. The data requirements, set out in the Consolidated Rules, were potentially onerous on life insurers; for example, if their internal practices on defining a 'death' differed from those specified by the CMI. Another example is the exclusion of duplicates in the assured lives data over age 80 where CMIR 1 notes "This means, in effect, examining the records for policy holders attaining age 80 in a given year and excluding all policies in excess of one for each policy holder."

11. As noted in the Consolidated Rules, printed forms were supplied to the offices for making the annual returns at the time CMIR 1 was published (an example is included in Appendix 5). These forms were certainly still in use in 1983[23]. My understanding is that these forms were designed by PICS[24] when the work was computerised; these replaced earlier forms that had been designed for clerical input and were judged unsuitable for punch operators.

12. The extract from CMIR 8 notes that "It is the hope of the Committee that participation by offices in the work of the Bureau can now be regarded in terms of a partnership rather than merely as a tiresome duty undertaken for the benefit of the profession and the insurance and pensions industry as a whole." Whilst that may have been true at that time, data submission may now have reverted to a

[21] Now usually called 'income protection insurance'.
[22] With the exception of a short break, in 1991-1992, noted under 'Structure and operations' in Section B6.
[23] As an actuarial student for a small insurer, I was given the responsibility for submitting the data from that firm around 1983 and I recall delivering the returns by hand to the offices of Rodney Barnett & Co, which were accessed through a gentleman's outfitters!
[24] Pension and Insurance Computing Services, the 'computer bureau' referred to in Appendix 3.

'tiresome' activity for larger insurers, as their substantial data volumes may limit the incremental value they derive from aggregated results. It is now also unlikely to be regarded as a 'duty' – whilst most insurers remain highly supportive of the CMI's work, there is now a greater obligation to consider the commercial value embedded in their data.

13. The list of Contributing offices in 1924-1929 included in the 75th anniversary booklet is fascinating, and much longer than similar lists in recent CMI working papers!

14. The 1949-1952 dataset used in the A1949-52 tables appears to be the first example of the CMI using data for a quadrennium, which has subsequently become something of a norm in the CMI's work. There is nothing sacrosanct, in my opinion, in the use of four years' data but it is sensible to use data for a period (to increase data volumes and to average out years' experience) and to keep that period as short as possible (to avoid using out-of-date data).

15. It is interesting to note the formality of members' titles in CMIR 1; for example, referencing each actuary as 'Mr' (with the exception of **Sir** William Elderton!). Such formality still existed when I first became involved in CMI committees (in the late 1990s) with minutes of meetings referring to me as 'Mr D. L. Grimshaw'. It is also noticeable that all of the individuals mentioned are male, although this was, I suspect, reflective of the membership of both the Institute and the Faculty during those years.

16. CMIR 1 notes that "The first appointment of a Secretary to the Committee was that of Mr R. D. Clarke with effect from 1 July 1950, a position he held until 30 September 1972, when he was succeeded by Mr H. A. R. Barnett." My understanding is this statement masks a material shift in the operation of the CMI – whereas Roland Clarke (pictured below) was employed by the Prudential, which therefore effectively sponsored his role as the CMI Secretary, Rodney Barnett was a self-employed consultant who could not devote all of the significant time required by the role without remuneration so the CMI engaged Rodney as a paid consultant (although he continued to undertake some research as a volunteer)[25]. This change is evident in the 'Constitution and Rules' (in Appendix 1 of CMIR 1) where 5 states that "The Executive Committee shall appoint a Secretary of the Bureau on such terms as to service and remuneration as it shall think fit…"

Roland Clarke, pictured receiving the Institute of Actuaries' Silver medal in 1980:

[25] My understanding is that the appointment of Rodney was on a personal basis and not, at that stage, an appointment of his firm, Rodney Barnett & Co (a predecessor of Barnett Waddingham LLP). This is supported by Rodney's comment, quoted in note 17, that "…the Bureau … has been accommodated in the offices of the Secretary's firm."

17. There are several references in Appendix 2 and Appendix 3 to the (small) staff of the Bureau. An article entitled 'CMI Reminiscences' by Rodney Barnett in *The Actuary* in January 1991, following his retirement as CMI Secretary, provides some additional background:

> "When I first came on the scene the staff in the CMI room at Staple Inn consisted of H L Trachtenberg and P S Smith. Two taciturn individuals who worked very hard. Trachtenberg died in harness at the age of 85 and it may have been his presence which caused the Bureau to become known as *"The Immortals"*. Smith's comparatively premature death occurred some years later, by which time Kitty Hicks, a pensioner from a certain life office[26], had joined. For many years she ran the CMI room under my guidance (which was superfluous in view of her efficiency) until she retired at the age of 73; she started her 90th year in December. During her employment, Una Archer joined the Bureau from the same office, and has just retired at an even riper age than 73 – how much riper I will not disclose. The third of these personalities, Joyce Tallboy, is still employed by the Bureau, whose transactions have been greatly enhanced by these redoubtable ladies. During Miss Hicks' years the Bureau moved to Barnard's Inn and, since her retirement, it has been accommodated in the offices of the Secretary's firm."

[26] The Prudential.

Part B: The CMI's third quarticentennium, 1973 to 1999

B1. Introduction to Part B

This part of the book describes developments in the CMI in the years 1973 to 1999.

In 1973, the CMI was a very similar beast to that established fifty years previously:

- The CMI Bureau was funded solely by life insurers.
- The first CMI Report shows a single committee – the Executive Committee – on its inside front cover, its members included the Presidents of both the Institute and Faculty.
- That committee was focused on (base) mortality and, presumably, did much of the leg-work in terms of producing CMIR 1 and technical work such as graduations.

The principal difference was that the Permanent Health Insurance (PHI) investigation had been initiated, under the auspices of a separate sub-committee, although no results had yet been issued.

By 1999 the structure of the CMI looked very different, with the Executive Committee now having four sub-committees – Management, Mortality, PHI and Critical Illness.

This part of the book describes work on the main mortality investigations in Section B2, then on impaired lives (Section B3), Permanent Health Insurance (Section B4) and a short section on critical illness, in Section B5.

Finally, Section B6 covers a number of miscellaneous topics, including:

- A fuller overview of the changes in structure of the CMI over this period.
- A description of CMI Reports; this is particularly aimed at readers who did not experience these for themselves. As noted previously, Section A2, documenting the CMI's early years, is reproduced from CMIR 1 and CMI Reports also provide much of the foundation for this part of the book.
- 'CMI 75', an event to mark the CMI's 75th anniversary.

The early years of this period are documented in another 'History and Development' section, in CMIR 6. This is reproduced in Appendix 7; inevitably, this overlaps with some of the other content of this section.

B2. Mortality

Mortality was the sole focus of the CMI's work in its early years and it is important to reiterate that, at the start of the period covered in this section, 1973, this means the mortality of insured lives, based on data received from life insurers, and base mortality, not projections of future mortality.

Mortality experience in 1967 to 1970

The bulk of CMIR 1 describes mortality experience in 1967 to 1970. This was segmented into the main investigations:

- Assured lives[27];
- Immediate annuitants;
- Pensioners under life office pension schemes;
- Purchasers of retirement annuities under the provisions of the Finance Act, 1956; and
- Assured lives, according to cause of death.

Note that there were no results yet for unit-linked assurances, term assurances or Irish business, although data was being collected for each of these by the time CMIR 1 was published.

The results for each investigation are presented mainly as values of actual deaths / expected deaths ('A/Es') compared with the latest CMI table, for example A1949-52 for assured lives. This form of results continues to be prevalent today!

It is interesting to observe, with the benefit of hindsight, that there was no clearly-stated conclusion that the previous tables were inappropriate and that the 1967-1970 assured lives experience should be graduated, although that did then happen.

Noteworthy points from the commentary on immediate annuitant experience in this report are:

- It states that "It is desirable now to consider whether a new standard table should be prepared; the last such table was based on an experience which ended 19 years before the beginning of the quadrennium upon which this present report is based, with a projection to make it applicable to purchases 18 years ago. The forecast rates of improvement have not been realized."
- However it concludes that it would be premature to produce new tables for annuitants. The reason this was not yet appropriate was explained as "…the Committee recommended a further lapse of time of at least four, and possibly eight, years to enable longer experience to be gained of the apparently new class of lives who have been purchasing annuities since 1956."[28]
- It also says "It is the intention in future to prepare for the contributing offices an annual summary of the experience of all offices combined, similar to those already prepared in respect of life office pensioners." This reiterates the comment in the 'History of the computerization of the CMI', extracted from CMIR 8 and reproduced in Appendix 3, that, previously, offices only received quadrennial 'all offices' results.

CMIR 1 also includes an interesting description of the processes underlying the analysis of the mortality of assured lives by cause of death, as well as the results for 1967-1970. Individual cards were submitted for each policy[29] – a total of 95,132 policies – and these were coded manually by the team at the CMI. CMIR 1 states that "As the experience was to be compared with the national experience it was essential to ensure that, as far as possible, each case was coded to the same

[27] This was not actually defined in this section of CMIR 1, but should be read as whole life and endowment assurances, both with profits and non-profit, issued on standard terms.
[28] This quote is from the paper in JIA 101, referred to below.
[29] Once reliable photocopiers became widely available, the cards were replaced by copies of death certificates sent to the Secretariat.

underlying cause as would have been allotted to it by the Office of Population and Census Surveys[30] at Titchfield; for this purpose coders have completed a course at Titchfield to learn, in particular, the correct selection of the underlying cause when more than one cause of death is stated on a certificate…". It continues: "A large sample of nearly 10,000 cards, on which the offices supplied sufficient data to enable the cases to be identified at Titchfield, were sent there for comparison with the national coding…". This represents a significant collaborative effort between the CMI and the OPCS.

Following CMIR 1, the next publication of note appears to have been a paper entitled 'Considerations affecting the preparation of standard tables of mortality', setting out the graduation of the assured lives data, to produce the proposed A1967-70 table, and of pensioners under life office pension schemes. This paper was submitted to the Institute (and can be found in JIA 101, 133) and the Faculty (TFA 34, 135).

Readers may find it curious that the CMI had begun producing CMI Reports but submitted this paper to both JIA and TFA. This is explained in the introduction to the paper, which notes: "The Committee's latest reports have been published under the new arrangement whereby its factual reports are printed in a separate volume (and distributed, inter alios, to members of both the Institute and the Faculty) instead of appearing in both J.I.A. and T.F.A."; i.e. the CMI's intention at that time appears to have been that factual papers were issued in CMIRs but papers warranting discussion should be submitted to the Institute and Faculty, for discussion at sessional meetings.

The graduation of the assured lives data for 1967 to 1970

An interesting aspect of the paper in JIA 101 is the consideration as to whether the standard table should reflect decreasing mortality with increasing age up to the late twenties (such an 'accident hump' had been smoothed out in the A1949-52 tables) and, if so, how. This issue was explored using data on cause of death – the corresponding data had not been available for the earlier tables – and comparing this to data for the general population. The report observes "…in the new experience it is even more clear than it was in the 1949–52 experience that as the age reduces from the late twenties to the late teens so q_x increases… This is the case for every duration, and it is the case also for population mortality in Britain and in many other countries." It concludes that "It therefore seemed essential that the graduation of the data should reproduce the facts, even though this clearly may pose problems for life offices using the table to calculate premium rates." This was allowed for by using Barnett's formula, as set out in his sessional paper[31].

Consideration was also given to the suitability of the data at the oldest ages "…where the crude rates of mortality exhibited by the data were somewhat irregular, and ludicrously low above age 99." The report states that "…the exposed to risk are seriously overstated by maintaining policies on the books after an office has lost touch with the life assured. Even though these cases are eventually written off the exposed in the intervening years remain unadjusted and overstated…". The Committee again considered the cause of death cards; specifically, "…deaths at nearest ages 85 and over where the year of death had been recorded as well as the year of notification." These revealed one death notified 33 years after death, and another 27 years after! The Committee commented: "At first sight it might be thought that the numbers involved are insignificant; but it must be remembered (a) that there are probably others on the books who are already dead but who will not be notified for 10, 27 or 33 years (or whatever); (b) that there are others who will never be notified, but will stay as apparently 'exposed to risk' until they are written off by the office and taken out of the experience…". Here, "The only practicable course was to ignore the data from age 90½ upwards…".

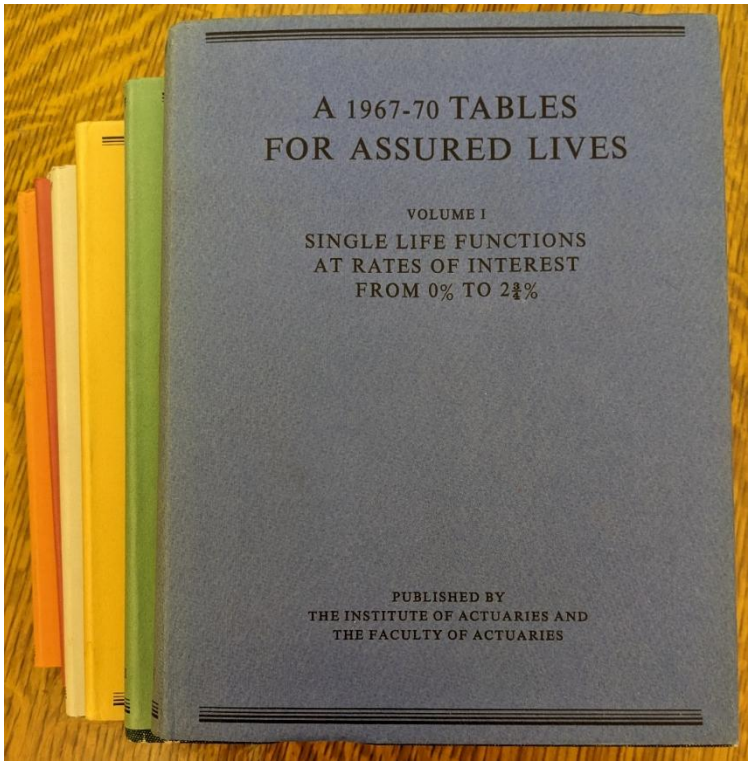
In considering the select period, the data identified individual durations up to 4 years but the predecessor A1949-52 tables had used a select period of 2 years. The data for 1967-1970 indicated higher experience at durations 2 to 4 than at duration 1, but lower than for durations 5+. The Committee noted that "…whole life or endowment assurance functions might not differ substantially

[30] Its correct name was the Office of Population, Censuses and Surveys (OPCS); a fore-runner of the Office for National Statistics (ONS).
[31] The paper refer to "Barnett's modification of Thiele's formula, with which he graduated the assured lives' data for 1953–58 (J.I.A. 87)…" but the formula was initially set out in 'The Components of Mortality' (J.I.A. 81).

whether a two-year or a five-year table was used, it might well be thought inappropriate to use a two-year select table for the calculation of short-term temporary assurance rates." As a result, the Committee produced graduated tables on both a two-year and a five-year select period – named A1967-70(2) and A1967-70(5) – but sought views on which is more suitable for monetary functions, which, as described below, involved extensive computation.

The A1967-70 tables were something of a magnum opus. Given the form of publication for these and previous CMI standard tables, I have detailed this as it will be unfamiliar – and probably unexpected – to actuaries who have only worked in the era of computers! The A1967-70(2) tables were published in six volumes (see photo below) with the A1967-70(5) tables in a separate volume.

The six volumes of the A1967-70(2) tables:



Each volume contained a foreword (in the names of the two Presidents), the list of contributing offices and a four-page introduction, summarising how the rates were derived. These were identical in all six volumes. The list of offices included 45 life insurers – lower than the 58 contributing offices in 1924-1929 (included in the 75th anniversary booklet, reproduced in Appendix 4), but much higher than in recent years.

Each volume also contained:

- Basic mortality functions: $l_{[x]}$, $l_{[x]+1}$ (both for ages 0 to 80) and l_{x+2} (for ages 0 to 109) and similarly for $d_{[x]}$, $q_{[x]}$ and $\mu_{[x]}$.
- A number of basic monetary values, such as d and v for each interest rate (see below).
- Further monetary values, such as $(1+i)^n$ and v^n, for each interest rate and each term (n) from 1 to 100.

Volumes I to V each contained a series of mortality functions that were dependent on the interest rate: $D_{[x]}$, $D_{[x]+1}$ and D_{x+2} and similarly for $N_{[x]}$, $C_{[x]}$, $M_{[x]}$, $S_{[x]}$ and $R_{[x]}$ for the age ranges noted above. They also contained annuity and assurance factors. Volume I used interest rates of 0%, ½%, 1%, 1½%, 2%, 2¼%, 2½% and 2¾%; volumes II to V used higher interest rates, up to 15%. Volume VI contained a selection of mortality and monetary functions for joint lives, including some values on three and four lives.

The picture does not capture the thickness of each book – Volumes I to V each comprised 256 numbered pages (i.e. those containing mortality and monetary functions but excluding the introductory sections) and volume VI comprised 229 numbered pages. I have been told (but been unable to verify) that prior to distribution, these volumes were initially stored on the top floor of Staple Inn, alongside the team processing the data, but had to be moved to the basement due to fears that the floor might collapse!

The graduation of pensioners (and annuitants) data for 1967 to 1970

The paper in JIA 101 also considers the graduation of pensioners (under life office pension schemes) for 1967-1970. This section of the paper opens by noting the heterogeneity of the data, combining all types of pension scheme, having no regard for duration since retirement and with different 'normal' retirement ages between schemes. Such heterogeneity is a consequence of historic data submission processes and the Committee observes that:

> "If [we] had been allowed to suppose that most offices would be able to submit data suitable for processing by an electronic computer, then the plans which were drawn up before the investigation commenced in 1955 would have made provision for all these variables to be considered, but it was not then possible to make plans which called for the data to be submitted on returns other than the simplest of hand-written schedules."

The report showed that generally:

- lives who retired before the normal age experienced heavier mortality than those who retired at or after the normal age;
- mortality rates by 'lives' were heavier than those by 'amounts';
- the mortality of females was lighter than that of males; and
- the difference in mortality as between early retirements and other retirements was less marked for females than for males.

It also showed that "…none of the existing standard tables is a really good fit and it appears that the time has come when a standard table of pensioners' mortality must be prepared…". Before doing so, the Committee sought discussion of:

(1) "Ought the new table to be constructed from the experience of 'lives', from the experience of 'amounts', or from some combination of the two?

(2) What allowance ought to be made for improving mortality?

(3) What use should be made of the experience of early retirements?

(4) Can we actually produce a table or set of tables which will be a useful tool for individual offices?"

The report then presents evidence to facilitate consideration of these questions. It concludes:

> "…the Committee recommends that two graduated tables of mortality be constructed, one for males and the other for females to exhibit faithfully the experience in 1967–70 of 'lives' who retired at or after the normal age and that the tables be used by the Committee to supply to each office a comparison of its own mortality with the experience of all offices in 1967–70."

It notes that:

- "No attempt at forecasting future mortality rates would be made because to do so might lead those who will use the resulting tables to attribute to them an authority which they do not possess." and
- "It might be thought by some that the tables which it is proposed to construct will be only a small reward for the many years of data collecting…"

The next publication, in CMIR 2 in 1976, was 'The graduation of pensioners and of annuitants mortality experience 1967-70'. Interesting points are:

- It notes that the Institute and Faculty discussions did not lead the Committee to produce standard tables for pensioners and annuitants, but there did appear to be a desire for "further guidance" and the Committee therefore produced graduated tables.[32]
- The lower status of these tables is stressed, for example for the pensioners tables: "The Committee cannot stress too strongly that the present tables of graduated rates have been produced solely as a standard of comparison for offices. They do not purport to provide a suitable tool for the calculation of premiums or reserves without adjustment being made for one or more of a number of possible reasons."
- Despite not being 'Standard tables', both were given names: "Peg…" for Pensioners experience graduated and "aeg…" for annuitants experience graduated.
- The report refers to a comment by Professor R. E. Beard who, in the Institute discussion, "…had criticized the formula used on the grounds that it did not readily allow comparison of its parameters with those of other tables at different times (such as A1949-52) or in other countries." Such practice would be uncommon today but was suggested to be desirable in an era where computational facilities were limited.
- Paragraph 3.1 notes that, for the pensioners data, "The statistics for ages up to nearest age 50 and for ages from 101 onwards are not available for single years of age, and they have therefore been ignored." and that "The statistics for each single year up to age 107 will be collected from offices from 1975 onwards." These statements illustrate the rigidities inherent in the data collection process at that time. It would clearly be many years before this change, to extend the age range of single years' data, would generate meaningful data volumes.
- Eight sets of data were graduated for pensioners – males and females, separated by retirements at or after normal retiring age and retirements before the normal age and by both lives and amounts.
- A particular feature of the annuitants data is noted: "Comparisons of annuitants' mortality in recent years have been confused by the break in the class of person effecting annuities after the Finance Act, 1956. All the pre-1957 contracts were at least 10 years old by the beginning of 1967; the post-1956 contracts are no more than 14 years old by the end of 1970." The Committee chose to graduate the post-1956 data only, despite its relative immaturity.
- The effort in data preparation – by both the CMI and the offices – is illustrated by an example in Paragraph 4.10: "It was clear that some unusual feature was present at age 94 in the year 1970[33], and it was not accounted for by errors of transcription of the data. Offices who had contributed to these deaths were asked if they could identify the annuitants by name. Many offices could do so, and it transpired that of 54 identified deaths in the combined pre-1957 and post-1956 data some 41 were of a Mr A and 3 of a Mr B, so there were only 12 separate lives for the 54 policies." The Committee applied an ad hoc adjustment to the number of deaths in that cell prior to graduating the data.
- The graduated rates are given to eight decimal places "…whereas any rates based on arbitrary adjustments are quoted to only six decimal places." but the report then notes "In neither case are more than about the first three figures of any significance."
- This section of the report concludes with the Committee's priorities for future work: "The Committee considers that it should pursue with urgency its search for a suitable way to prepare standard tables with full monetary functions broadly corresponding to the present a(55) tables, particularly since there is no simple way of making use of the existing tables

[32] The terms 'standard tables' and 'graduated tables' were not defined in the paper but I assume the graduated tables were considered factual, and hence not presented for discussion, whereas standard tables would have been. At that time, standard tables might also imply publication of monetary values. The concept of 'standard tables' is discussed under ''Adoption' and 'Standard tables'' in Section C9.
[33] There were 94 deaths in this cell; the next largest at a similar age being 34 deaths at age 93 in 1969.

> while allowing for changes in mortality since they were produced. As soon as the Committee has some proposals to put to the profession they will be exposed to scrutiny."

CMIR 3 (published in 1978) duly contains the proposed tables for life office pensioners and annuitants, alongside a number of reports on mortality experience in 1971-1974.

CMIR 3 appears to represent an evolution in the status of CMI Reports. As noted earlier, the CMI's intention when CMIR 1 was issued appears to have been that factual papers were issued in CMIRs but papers warranting discussion should be submitted to sessional meetings of the Institute and Faculty. In the case of CMIR 3, the proposed tables were issued in the form of a CMI Report, but this was discussed at meetings of the Institute and Faculty (on 23 January 1978 and 10 April 1978, respectively).

The proposed tables used the graduated tables published in CMIR 2 – Peg 1967-70 and *aeg* 1967-70 – but with mortality improvements applied. The approach to allowing for improvements was a radical one at that time but will be familiar to actuaries today – a two-way table of mortality rates at each age in each calendar year – with the graduated rates for age *x* considered to apply to a life attaining age *x* during 1968.

In assessing suitable improvements, the report notes that the a(55) tables were constructed based on reduction factors from the experience of annuitants over more than 60 years from 1880 to 1945. However "Such an approach is neither possible nor appropriate on this occasion. Both for pensioners and for annuitants consistent data are available for too short a period for any trend to be measured satisfactorily. It is, therefore necessary to look primarily at the experience of other groups, e.g. the whole population and assured lives." It also cautions that "…a simple projection of past trends may not be appropriate: the steady and rapid improvement that took place in the first half of the twentieth century may not continue; indeed there is some evidence that the rate of improvement in mortality has slackened in recent years."

After considering various datasets, the Committee concluded that:

- "…there is no strong reason for using factors that vary by age";
- "…the same improvement factor should be used for male and female rates"; and
- "… the same improvement factor should be used for pensioners' lives and amounts data, and annuitants' ultimate and select rates."

These conclusions led to "…the tentative conclusion that the projected mortality rates for all the tables under consideration should incorporate a 20-year improvement factor of about .9." In practice, the Committee chose to express the improvements differently: "…a reduction of k years in the age for each year ahead we are forecasting, or of 1 year in the age for each 1/k years ahead." As a result, "…the projected double-entry tables would all be based on the assumption that the mortality table for calendar year T is the same as the table for the base year with a deduction of T/20 from the age, i.e.:

$$q_{x,\,T} = q_{x-T/20,\,0}$$"

The Committee appeared to favour the use of the double-entry table; in particular, noting that an office could vary the rate of mortality improvement by altering the factor 1/k. However, it recognised that this may be impractical for some offices and that there was therefore also a need for a single-entry table. The method favoured by the Committee "…is to choose the table for a particular calendar year, which will be broadly appropriate to the mix of business in force over the medium-term future." It continued "The year 1990 would seem an appropriate year for use during the 1980s" noting that "…in due course a later year will become appropriate".

The formal PA(90) and a(90) tables were both published in 1979. The style was similar to that of the A1967-70 tables detailed earlier but each set of tables comprised only two volumes, albeit these were thicker than the assured lives tables! Both sets of tables also indicated that "A more extensive set of functions is available on microfiche, each containing a range of functions at a single rate of interest". They added "It is possible to obtain microfiches for any rate of interest in the range –5% to +20% at steps of 0.00001%." Sadly, details of the prices of the microfiches were available on request, so are not shown in the printed volumes.

An interesting aspect of the PA(90) and a(90) tables is that the published volumes were the first, I think, to include formal caveats as to the use of the tables; they concluded "The Committee cannot stress too strongly that it is the responsibility of any life office or actuary using these tables to ensure that they are appropriate for the particular purpose to which they are put." A similar caveat has been included in every subsequent table issued by the CMI.

It is also interesting to note that the PA(90) tables used interest rates in the range –5% to +16%, noting "Functions at negative rates of interest are included to allow for possible escalation of benefits at a compound rate greater than the valuation rate of interest."

Mortality experience in 1971 to 1974

Much of CMIR 3 comprises reports on mortality experience in 1971 to 1974 for the various investigations. Many of these were ongoing studies:

- For the main assurances investigation, the A1967-70 tables provided a good fit to the more recent experience, albeit mortality was at a lower level.
- For the annuitant and pensioner investigations, the change in experience from the graduated tables based on 1967-1970 experience was less clear, with lower mortality in some subsets of the data but higher mortality in others. For example, the commentary on immediate annuitants concludes "…the practice [of assuming continuing improvement in the mortality of annuitants], although no doubt still justified on grounds of prudence, no longer seems supported by the immediate past."
- There was also an update to the Cause of death analysis.

In addition, CMIR 3 contained the first results from several new investigations:

- The experience of males under whole life and endowment policies in the Republic of Ireland[34]. This was based on data from 12 offices. It was a much smaller dataset than the corresponding UK study but suggested Irish mortality experience was around 15% higher than in the UK.
- The experience of females under whole life and endowment policies in the UK. This was based on data for 1973 and 1974 only and, for some offices, included only data for new policies. Any conclusions were therefore tentative but the report suggested ultimate female mortality experience could be approximated by a 6-year age reduction from the (male) A1967-70 tables. The report concludes that "…the male table is the wrong shape and is not suitable to be used for female mortality" and indicates that the Committee "…intend that, after data have been collected for a further 4 years, it will endeavour to construct a table based directly on the experience of female assured lives."
- The experience of males under term assurances in the U.K. This was based on data from 26 offices, sub-divided between level and decreasing policies. The conclusion was that the overall mortality experience of term assurances was a little lighter than the A1967-70 tables.

Mortality experience in 1975 to 1978

CMIR 5 (published in 1981) contained the next set of reports on mortality experience, in 1975 to 1978. The only new analysis was of linked assurances; as this had only started in 1976, data volumes were limited but the experience appeared to be higher at durations 0 and 1, but lower at durations 2+, than the corresponding non-linked business for both males and females.

For the ongoing studies, there were few findings of historical note, with the features noted for 1971 to 1974 generally continuing. One such point worth noting is for Whole life and Endowment assurances effected on female lives where "The main conclusion is that none of the bases of comparison [E.L.T.

[34] The changing nature of the CMI's involvement in Ireland is considered under 'The CMI and Ireland' in Section C9.

Nos. 12 and 13[35] and A1967-70] is really suitable", which led into the subsequent graduations of this dataset.

The final mortality-related paper in CMIR 5 is a short note entitled 'a(55) Tables: q_x at High Ages' that arose "…from a query received from an actuary who wished, for the purpose of a computer program, to know what formula could be fed to the computer in order to produce the values of q_x at ages above 103 as shown in the preface to the a(55) tables." The tables were published in 1951 and the note acknowledges that "…no record had been kept of the method" and notes that "Several of the then Committee are now deceased". Attempts to reproduce the rates exactly proved fruitless and the note concludes that the rates were probably "…obtained graphically with efficient hand-polishing."

The first graduations of female data and a possible graduation of Irish data

CMIR 6 (published in 1983) contained the graduations of female assured lives, as promised in CMIR 5; these were named the FA1975-78 tables. The rationale for producing these tables was repeated:

> "For female lives many offices simply rate down the age (e.g. by 3 or 5 years). However … the shape of the q_x curve for females is somewhat different from that of the corresponding curve for males. This means that a constant age deduction is not really appropriate. For this reason it may be desirable to have a separate table for female assured lives."

The graduations were undertaken for medical and non-medical data combined and for durations 0, 1 and 2+. One interesting aspect of the tables was that the select rates were obtained by optimising the value of the age deduction to be applied to the ultimate rates, rather than by direct graduation of the underlying data.

The FA1975-78 tables were also published in a separate volume in 1983, but this was far less extensive than the A1967-70 tables described earlier. In particular, as noted in the Foreword, "In view of the extensive availability of computers to those likely to be using the tables, the Committee is not including any monetary functions in the present publication."

CMIR 6 also contained a paper titled "On a possible graduation of the Irish assured lives mortality experience". The paper concluded "…that the A1967-70 table is, for all durations, a satisfactory representation of the Irish assured lives experience 1975-78. There appears to be no case for preparing and publishing any other standard table."; noting that "…the Irish experience applies to a period eight years later than that on which the U.K. A1967-70 table was based."

Mortality experience in 1979 to 1982 and the "80" Series tables

CMIR 8 (published in 1986) contained the reports on mortality experience in 1979 to 1982. It also noted that

- The statistics for the one year were too scanty to justify reporting on the investigations into whole-life and endowment assurances issued in the Republic of Ireland on female lives and linked life assurances issued in Ireland, which started in 1982; and
- Two more investigations had started in 1983: joint-life-first-death policies and whole-life and endowment assurances accepted with no selection (or with limited selection) and issued in connection with mortgages.

For the ongoing studies, there was a clear statement that "The Committee has under consideration the preparation of graduated tables of the experiences where the volume of data justifies it and will present the results to the profession in due course." For example, for UK whole life and endowment assurances, overall ultimate male experience was 82% of A1967-70 ultimate, but the improvements were lower at shorter durations and for younger lives; consequently, the A1967-70 tables were no longer a good fit to the most recent experience.

[35] The English Life Tables (ELT) are graduated mortality tables for the population of England & Wales that are normally produced once every ten years. ELT12 used data for 1960-1962 and ELT13 used data for 1970-1972. These tables were produced by the Government Actuary's Department (GAD) but they are now published by the Office for National Statistics (ONS).

The final mortality-related paper in CMIR 8 is a note describing an investigation into the distribution of policies per life. The note opens with a reminder of why the subject is important:

> "The continuous investigation into the mortality of assured lives is based on policies and not lives. Consequently the death of a policyholder carrying *n* policies appears as *n* deaths in the data. In order to estimate the standard deviations needed to test differences between actual and expected deaths. information is required about the distribution of policies per life assured."

Unlike the previous analysis, based on deaths in 1954 that identified duplicate policies within offices, the latest analysis used information submitted to the cause of death investigation, based on copy death certificates, allowing the Committee to also identify duplicate policies between offices. Perhaps because of the difference in methodology, the prevalence of duplicates was observed to be much higher – for each of the two years, 1981 and 1982, there were around 21,000 policies for 16,000 deaths.

The graduations of mortality experience in 1979 to 1982 duly followed in CMIR 9 (published in 1988). CMIR 9 also included analysis of mortality by cause in 1979 to 1982 including, for the first time, for females. This indicated that insured females were significantly more likely to die from cancer, but less likely to die from ischaemic heart disease than the general population, for example.

The introduction to CMIR 9 notes that "[The report on the graduation for 1979-1982] has to be read in conjunction with a paper prepared by three members of the Committee, entitled 'On Graduation by Mathematical Formula', by D. O. Forfar, J. J. McCutcheon and A. D. Wilkie, which is being published in *J.I.A.* and in *T.F.A.*"[36]

The paper by Forfar, McCutcheon and Wilkie is described in CMIR 9 as "…a comprehensive paper on the mathematical methods suitable for graduation in modem conditions, i.e. taking into account both modern statistical ideas and modern computing facilities." It also notes that "The authors of that paper were able to use the C.M.I. experiences as examples of the methodology."

The introduction to the paper by Forfar, McCutcheon and Wilkie notes that "In the course of work … [on the new tables] … we have had occasion to make use of and develop a number of statistical techniques with which actuaries may not be familiar … We therefore felt that it would be useful to the profession if we were to present these methods comprehensively in one paper." The paper laid the foundations for CMI's work on new tables for many years to come, with the next significant review of methodology that by the Graduation and Modelling Working Party, published in 2015 (see Section C8).

As with previous tables, the graduated rates were set out in CMIR 9 for discussion by the profession before they were extended to a full age range and, where appropriate, projected to future years. The Committee set out a number of questions on which it sought views. One of particular interest is whether it was appropriate to produce tables using 1979-1982 data given the threat of AIDS, asking: "If mortality rates at adult ages are likely to rise because of AIDS, will a new standard table be of any practical use? If not, will it nevertheless be useful as a historical record of mortality rates before the arrival of AIDS?"

CMIR 9 states that "The Committee is aware of the work of the AIDS (Acquired Immune Deficiency Syndrome) Working Party of the Institute of Actuaries, and the profession has been informed of this work through the Bulletins issued recently by that Working Party, and through some common membership." Although there was common membership (Chris Daykin was a member of the CMI Executive Committee and Chairman of the Working Party, whilst David Wilkie was Chairman of the Executive Committee and a member of the Working Party!), the AIDS Working Party was an Institute initiative and the CMI was not directly involved at this stage. As noted in Section B6, the Working Party became part of the CMI in 1993, as the AIDS Sub-Committee.

CMIR 9 notes that there were over 100 datasets with sufficient deaths to consider graduations, plus several investigations were available on both lives and amounts bases; consequently there is a

[36] Specifically, this is published in volume 115 of *J.I.A.* and in volume 41 of *T.F.A.*

considerable range of tables in the report. Many of these justified new formal tables, as the experience had diverged from previous tables, but the following points are of interest:

- The graduated rates for term assurances were significantly different from those for permanent assurances; consequently tables were proposed for term policies for the first time. However there were no significant differences between level and decreasing term; these datasets were therefore combined.
- The report notes issues with the data for linked assurances for both genders: "Only a limited number of offices contribute to the investigation; of those that do, some cannot subdivide their data by duration… many cannot subdivide their data by medical type … Some offices find it difficult to differentiate and exclude cases with restricted life cover, and their returns have had to be excluded. The consequence of these defects is that the mortality investigation of a large and important class of business is restricted to being rather a small one." The report concludes "…the experience … is not yet sufficiently reliable for a standard table for this class of policy to be constructed."
- Although tables had been produced recently for female assured lives – the FA1975-78 tables – the Committee proposed producing new tables as it "…inclines towards preparing standard tables for males and females for permanent assurances in parallel …"
- The report compares the Irish experience for male permanent assurances with that in the UK and concludes "It is clear that the Irish experience is significantly higher than the UK experience, by about 25 per cent overall." It appears that the Committee was inclined to produce tables for this dataset but, as noted below, these were not part of the final tables.
- The report notes that the PA(90) tables for females were extended down to age 20 so as to provide a table for widows' pensions. As the Committee proposed graduating the experience of the widows of life office pensioners, it sought views on whether new tables for female pensioners could be produced for only a restricted age range.

Given the increased number of tables, consideration was given to how these should be named. Views were sought via an article by Colin Berman called 'Labels for Tables' in *Fiasco*[37] in October 1989. The article notes that previously the CMI had released single tables whereas here up to 12 tables would be published. It also notes that "…the full title [of each table] is likely to be a bit of a mouthful and it is convenient to have a shorthand version. (When we talk of "A67-70(5)" or "a(55) females" everyone knows what we mean, without our having to quote the name of the table in full.)" The article asked for suggestions, adding that "The CMI Committee will give due recognition (although it has not decided what that means) to the best suggestion received by the end of November."

There was a follow-up article (by Rodney Barnett and Colin Berman) in March 1990. This noted that there were ten responses ("Ten may be only a tiny fraction of the total *Fiasco* readership but it is a good deal more than the number of contributions which we expected") and that all respondents would receive a book token. The article set out the names to be used:

- The assured lives tables would be referred to as AM80 and AF80, for males and females respectively, with (19)80 representing the mid-point of the period.
- Similar labels applied to the other tables with "T" (instead of "A") for term assurances, "I" for immediate annuitants, "P" for pensioners and "W" for widows.
- As the tables for pensioners and widows were produced on both lives and amounts bases, these were distinguished as PML80 and PMA80, for example.
- For the tables for pensioners, widows and annuitants, these names refer to the double-entry tables, by age and calendar year. Single-entry tables should be indicated by "(B=Year)", "(C=Year)" and "(U=Year)" according to whether the tables relate to a year of birth, a calendar year or a year of use.

Similar names are still used for CMI base tables based on insurance data to the current day.

[37] The predecessor to *The Actuary* magazine.

The article finishes by noting "The above abbreviations do not correspond precisely with any of the ten sets of suggestions … The closest was the basis suggested by Graham Teakle and this has been recognised by awarding him a somewhat more valuable book token."

Work on the new tables was concluded when CMIR 10 was published in 1990. There are a number of points of interest from the introduction:

- It notes "this report can be taken as the formal publication of the new tables. However, for the convenience of users, the Committee proposes to publish a printed volume, which will repeat the values of the basic mortality rates, and include values such as those of l_x, μ_x, etc. and values of specimen monetary functions at selected rates of interest, and also to make available a computer package[38] for use on the popular types of personal computer, by means of which a wide range of functions can be calculated at any desired rate of interest."
- Amusingly, it adds: "The Committee believes that this method of making the tables available will be preferred to the previous system of publishing fat volumes with extensive monetary functions, though it recognises that this may disappoint those traditional actuaries who have enjoyed displaying a row of large volumes with variously coloured dust jackets on their bookshelves." A glance back at the picture 'The six volumes of the A1967-70 tables' (under 'The graduation of the assured lives data for 1967 to 1970', above) should explain the context of this comment!
- It adds that a very different process had been used in producing this report in that "…the text of the manuscript was typed on a word processor, the numerical values were calculated by computer, and the whole was transmitted through a series of computer processes into the form of printed proofs."
- Although the report contains extensions to a full age range and projections to future years, the tables were presented as final: "On this occasion, since the graduated rates received extensive discussion at meetings of the Faculty and the Institute during 1988, it is not proposed that special sessional meetings be held to discuss this report."

In terms of the tables, CMIR 10 notes that there was no dissension from the Committee's recommendation not to produce standard tables for linked business and that "…the general view of the meetings seemed to be that … [a new standard table for permanent assurances in the Republic of Ireland] was not required." It also notes that the meetings seemed to agree that a standard table for retirement annuitants was unnecessary given the change in legislation introducing the new style of personal pension.

The graduated rates were unaltered from those proposed in CMIR 9, other than some ad hoc adjustments, for example where "…the rates for one table appeared inconsistent with another…". The remainder of CMIR 10 details the changes to the graduated rates and compares the rates to other CMI tables and to the population ELT 14 tables. It then describes the extensions to younger and older ages and compares the experience with these standard tables. Finally, for the pensioner and annuitant tables, it sets out the projection basis. This differed from that used in previous standard tables; the ratio of mortality at age *x* after *t* years to the corresponding rate at time 0 was assumed to be:

$$\propto(x) + [1 - \propto(x)](0.4)^{t/20}$$

where $\propto(x)$ took values of:

0.5	for $x < 60$
$(x-10)/100$	for $60 \le x \le 110$
1.0	for $x > 110$

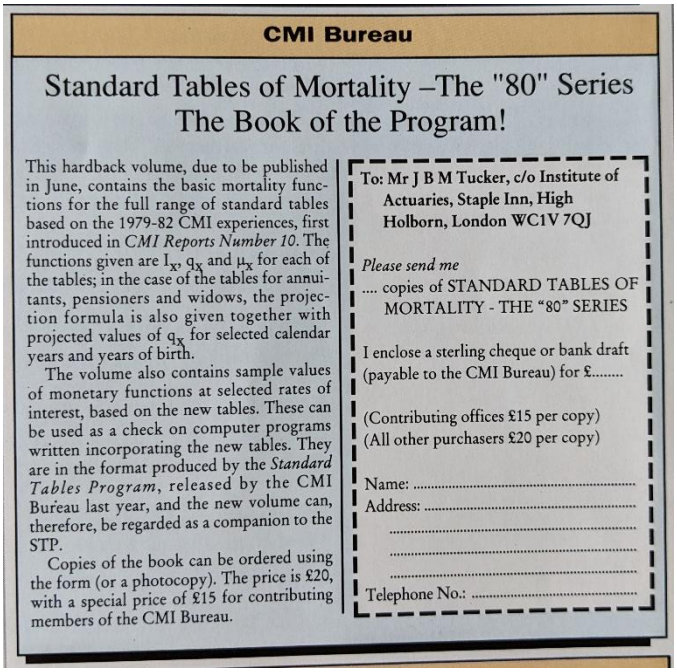
As noted in an article 'Mortality Tables for the 1990s' by Chris Daykin in the September 1990 edition of *The Actuary*: "Thus the rate of improvement varies by age, declining gradually to zero at age 110. Improvement at each age is geometric, with 60% of the ultimate improvement occurring in the first 20 years and a limiting value of 50% of the current rates for ages below age 60."

[38] This would be named the 'Standard Tables Program', or STP, and is discussed below.

The computer package noted above was named the 'Standard Tables Program', or STP, and was the first piece of software issued by the CMI. It was released alongside CMIR 10 in 1990. Describing STP, the article by Chris Daykin notes "This will enable users to generate almost any function in common use at any rate of interest, either as screen output or as hard copy. Facilities will be available to transfer tables or parts of tables into files so that they can be used in spreadsheets where the user wants to access the relevant functions to carry out further calculations." The modern era had truly arrived! The STP formed part of the CMI's offering for many years and is considered further in Section B6.

Collectively, the tables were named 'The "80" Series' and, as proposed in CMIR 10, they were published in a very different form from the A1967-70 tables, described earlier. The printed version of the "80" Series tables was published in 1992 as a single volume containing mortality functions only and comprising only 93 numbered pages.

Advert for the "80" Series tables from the June 1992 edition of *The Actuary*:



CMI Bureau

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The volume also contains sample values of monetary functions at selected rates of interest, based on the new tables. These can be used as a check on computer programs written incorporating the new tables. They are in the format produced by the *Standard Tables Program*, released by the CMI Bureau last year, and the new volume can, therefore, be regarded as a companion to the STP.

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Mortality experience in 1983 to 1986

Mortality experience in 1983 to 1986 was described in two CMI Reports:

- First, the experience was compared with the established tables (e.g. A1967-70) in CMIR 11, published in 1991. As noted in the introduction: "This report has been prepared simultaneously with the report: 'Standard Tables of Mortality based on the 1979-82 Experiences', which appears in C.M.I.R. 10 (1990)." This use of the predecessor tables allowed comparisons to be drawn over a longer period.
- The experience was then compared with that expected using the new standard tables in CMIR 13 (1993); this would then form the basis for comparisons with future quadrennia. This report contains the results only, with the commentary having been provided in CMIR 11.

There were again several additions to the range of products covered under mortality in 1983 to 1986:

- Joint life first death assurances, guaranteed acceptance assurances and minimum evidence assurances, all in the UK;
- Linked contracts in the Republic of Ireland;
- Term assurances (UK) and whole life and endowment assurances (Republic of Ireland) were both extended to female lives; and

- Widowers of life office pensioners (UK).

As a result, the Mortality Sub-Committee was now reporting on 20 investigations for assurances and 12 for pensioners and annuitants, counting males and females separately, plus the cause of death analysis. Inevitably, data volumes were limited for the new areas, some of which had only started during the period, and there were few clear conclusions regarding the experience.

Although guaranteed acceptance assurances was a new investigation, it was already closed to new business. The reason for this was that the investigation was restricted to policies issued in connection with mortgages accepted without any medical evidence. The report notes "Following the perceived adverse selection against offices by holders of these policies they were withdrawn ... This group of assured lives has, therefore, become virtually a closed class, their experience of historical interest only acting as a cautionary tale for actuaries of the future." The high experience was evident in the report, with male experience above A1967-70 ultimate, even at the short durations.

With regard to the ongoing investigations, CMIR 11 included many references to the volume of data and how that compared with previous quadrennia; this had not generally been considered in previous reports on quadrennial experience. For example, the report notes that the exposed to risk for males under whole life and endowment assurances in the UK had fallen by around 10% from the previous quadrennium. The fall was especially pronounced at shorter durations, reflecting a move to other products. By way of contrast, the volume of data for females under such products had increased, largely due to higher volumes of new business in earlier quadrennia. The volume of level term assurance data had also increased – by over 50% from 1979-1982 for males.

The observed mortality experience was generally lower than in 1979-1982, the period used in the "80" Series tables, in many cases falling by around 10%.

This quadrennium was the first in which the Sub-Committee was able to assess whether there was any evidence of additional mortality due to AIDS. Unfortunately, the outcome was inconclusive:

> "The only age group where there appeared to be any additional mortality [for males under whole life and endowment assurances in the UK] was the group 36-40 where the ratio of actual deaths to those expected using the A1967-70 table was 72% in 1984, 78% in 1985 and 83% in 1986 ... However the experience of this age group in 1987, recently available, shows a 100A/E ratio at durations 2 and over using the A1967-70 table of 69 which suggests that more time is needed before any real conclusions can be drawn."

The experience of level and decreasing term were similar to each other; as a result. "The Executive Committee has decided that in future the level and decreasing temporary investigations will be merged. It is believed that the two experiences are not sufficiently different to merit separate investigation, and that it would be beneficial to have a larger body of data with which to work." This was applied to females, as well as males, even though it was the first full quadrennium of female experience.

There is an interesting comment at the very end of the section on mortality experience in 1983 to 1986: "For investigations which have been running for a longer period changes in the level of mortality observed in different quadrennia can be monitored. It is in this area that the real value of the ongoing work carried out in the Bureau lies, providing a solid base from which estimates of future mortality levels in the classes of life studied may be made." This might raise eyebrows amongst actuaries now, as changes in mortality experience might be expected to arise from changes in products, practices and the mix of offices in the dataset, as much as from genuine trends.

Mortality experience in 1979 to 1984 by cause of death

The next section of CMIR 11 considers the mortality of pensioners and annuitants in 1979 to 1984 according to cause of death. CMIR 11 notes that this analysis had its origins in a comment by Frank Redington after a meeting of the CMI Executive Committee in the late 1950s that "he would love to know the causes from which annuitants do not die." The aim of the analysis was ambitious "to be better able to estimate the probable position if a medical breakthrough reduces significantly the risk of death from a particular disease or group of diseases."

However it was to prove a one-off analysis because "…after the initial momentum had worn off some of the contributing offices found the submission of the relevant data was becoming more irksome, the main difficulty being the obtaining of death certificates from pension fund trustees."

The methodology was similar to that used for assured lives, whereby the exposed to risk (adjusted for the proportions of deaths where the cause was unknown) was multiplied by the cause-specific rates of mortality in the national population data of England & Wales. For all bar one cause, the A/E values for pensioners were higher than those for assured lives; the exception being accidental and violent deaths.

Mortality experience in 1983 to 1986

As noted earlier, CMIR 13 (published in 1993) included restated results for each section of the mortality experience in 1983 to 1986 with the experience compared with that expected using the new "80" Series standard tables. It also contained a number of other mortality-related reports:

- Mortality in 1983 to 1986 according to cause of death. This section provided analysis similar to that of 1979 to 1982 in CMIR 9, with broadly similar results.
- Mortality tables based on the combined pensioners experience in 1979 to 1982. The "80" Series tables included separate tables for those who retired at or after their normal retiring age and those who retired earlier; these tables combined the two experiences because "It has been drawn to the attention of the Committee that for some pension schemes the records do not conveniently distinguish between those who retired early and those who retired at or after the normal retiring age … [hence] it may be useful to have available a table based on the combined experience..." These tables used similar methods to the main tables but "It would not be appropriate to give these tables the authority of standard tables."
- Mini-graduations of the mortality experiences of assured lives, pensioners and annuitants in 1983 to 1986. Similar results – effectively updating the latest standard table for the most recent experience – had been presented previously for assured lives only, but this was now extended to most of the other ongoing investigations.
- The mortality of smokers and non-smokers in 1988 and 1989. This is discussed further below.
- Inter-office comparisons. This was the third published analysis of the variation in experience between offices, having previously been considered in relation to the A1924-29 and A1949-52 tables. The analysis considered males under UK permanent assurances at durations 2+. The key finding was that "…there is, indeed, a very wide variation between the mortality experiences of the contributing offices…" leading the Sub-Committee to warn that "…any standard table based on the experience of all offices combined should be regarded as a yardstick only; actuaries should adjust the aggregate experience as appropriate in the light of the experience of their own office."

Mortality by smoking status

The CMI began collecting data differentiated by smoking status from 1 January 1988. In this context a non-smoker is someone who qualified for a premium discount when they took out their policy (typically, this would have been that the proposer had not smoked cigarettes for at least 12 months) and a smoker is someone who did not meet that criterion. CMIR 13 noted "…only a small number of offices have so far actually submitted returns containing split data. It is not unusual for new investigations to take a year or two to get established; the necessary changes to systems providing the data take time to organise and the task has to take its place in the queue for resources." Notwithstanding the limited number of offices, "…the Executive Committee considered that the preliminary results for this investigation were sufficiently interesting to warrant publication at the earliest opportunity."

The analysis considered both permanent and temporary assurances and the conclusions were stark; for example, for permanent assurances "For both males and females, in almost every group and at each duration, the mortality of smokers is heavier than that of non-smokers, in most cases substantially so." Whilst it was rare for the CMI to comment on any commercial implications of its analysis, the report ended "…the evidence is there that, *measured on risk alone*, larger non-smoker discounts than those currently available could be justified."

The results attracted considerable attention, with articles in many national newspapers, several highlighting a quote from David Wilkie[39] at the press conference "There are getting on for twice as many deaths among smokers as among comparable groups of non-smokers and this is equivalent to an age difference of six years." The finding that smoking was correlated with higher mortality was not new – the first clear evidence emerged from a study of British doctors, by Dr Richard Doll and Sir Austin Bradford, published in 1964 – but the CMI analysis was claimed to be the first large-scale study[40], covering more than a million life-years of exposure and 1,888 deaths. As Jillian Evans (the CMI Secretary at that time) noted in an article in *The Actuary*, entitled 'Smoker and Non-Smoker Mortality' in January/February 1993: "It had been expected that some differential would be found, but the fact that the observed mortality rates of smokers were almost twice those of non-smokers was considered surprising enough to be worthy of wider publication."[41]

Mortality experience in 1987 to 1990

CMIR 14, published in 1995, contained a series of reports on mortality experience in 1987 to 1990, compared with the "80" Series tables. The report contained experience for 1983-1986 and 1987-1990 only; as noted earlier, the experience in 1983-1986, set out in CMIR 11, was intended to act as the 'bridge' to earlier quadrennia.

Experience was considered for all of the investigations covered in CMIR 13 and for one new product – personal pensions, which were introduced following the Income and Corporation Taxes Act of 1988. These contracts superseded retirement annuities; those annuitants therefore became a closed class of business.

As with CMIR 11, this report considered the volume of data, showing the progression over recent quadrennia, 1979-1982, 1983-1986 and 1987-1990. This again showed a fall in the exposed to risk for males under whole life and endowment assurances in the UK, with a trend to limited evidence business. In contrast, the volume of retirement annuitants – both in deferment and in payment – had increased rapidly.

The observed mortality experience was generally lower than in the previous quadrennium, albeit with significant variation by age. There was also variation by duration – for example, for male permanent assurances, ultimate experience in 1987-1990 was 80% of AM80, compared with 90% in 1983-1986, but just over 90% at duration 1 and close to 100% at duration 0.

Unusually, CMIR 14 included some results by individual year to illustrate the impact of AIDS:

> "…the mortality experienced by males up to age 40 has deteriorated in 1989 and 1990 (the pattern in 1989 and 1990 is repeated in 1991 and in 1992, the latest years for which results are available at the time of writing). The suspicion must be that at least some of this deterioration is due to AIDS deaths coming through in the experience…"

There were two other mortality-related reports in CMIR 14:

- The mortality of smokers and non-smokers in 1988 to 1990. Although the volume of data was substantially higher than in the preliminary report on 1988 and 1989, in CMIR 13, the results were "remarkably similar".
- Mortality of retirement annuitants under approved pension arrangements in the Republic of Ireland in 1986 to 1991. This was an extremely unusual report in that it related to the experience of a single office, Irish Life; moreover, many of the calculations were undertaken internally within Irish Life.

[39] A member of both the Executive Committee and the Mortality Sub-Committee at that time.
[40] Although this was claimed at the time, it may only relate to the UK, not globally.
[41] Another example of the media interest was that Angus Macdonald, who would later chair the Mortality Sub-Committee, appeared on Radio 4's 'Money Box'. He noted to me recently that he "…was otherwise very wisely kept behind the scenes."

Mortality experience in 1991 to 1994 and the "92" Series tables

The next series of reports, on mortality experience in 1991 to 1994, was set out in CMIR 16, published in 1998. This had earlier been described in an article in *The Actuary*, entitled 'CMI mortality data 1991-1994' by Colin Kirkwood, then Chairman of the Mortality Sub-Committee, in June 1997. It is an indication of the time taken to produce CMI Reports that the article refers to "…CMI Report no 16, which we intend to produce later this year…" but CMIR 16 actually emerged in December 1998!

The results themselves generally show a continuation of earlier trends, leading to significant divergence from the "80" Series tables, although the need for new tables was assessed differently for the different investigations:

- There was a clear suggestion that new tables would follow for permanent assurances, stating for males, for example: "The differential changes within the three age bands [below 40, 41–65 and over 65] indicate that the shape of the underlying mortality curve has now changed. There is, therefore, a strong case for new standard tables to reflect the changes."
- There was no mention of new tables for temporary assurances, although these were produced in due course.
- The mortality of smokers and non-smokers was again reported separately from the main analyses but there was no mention of separate tables for the different smoking categories.
- There was also no mention of tables for Irish assured lives (none were produced), with the report highlighting the declining volumes of data as much new business was now written on a unit-linked basis, which was not collected by the CMI.
- There was a discussion of new annuitant tables, without any clear conclusion.
- For pensioners, proposed new base tables were presented in CMIR 16 itself[42]. These followed a similar process to the corresponding "80" Series tables initially but, instead of ad hoc adjustments to produce satisfactory results at high and low ages, the graduation formula was adjusted. At younger ages, the AM80 and AF80 tables were used as reference points, even though the intention was to produce new assured lives tables.

Unusually, the section on permanent assurances included an indication of trends over a longer period – for males, starting with the 1959-1962 quadrennium; for females, the first results were for 1975-1978. Similar comparisons were included in subsequent CMIRs and an illustration of the high-level results is shown in Section C2.

The resulting new tables – the "92" Series – were set out in CMIR 17, published in 1999.

The introduction to CMIR 17 refers to two meetings at which the proposed new tables had been discussed ("a special seminar held at Staple Inn in December 1998 and the Current Issues in Life Assurance seminar in April 1999"). Presumably, therefore, a paper was circulated prior to those meetings, but I have not been able to locate this paper. Given these meetings "…it is not proposed that further meetings be held to discuss this report" and the publication of CMIR 17 marked the formal publication of the new tables.

As for the "80" Series, the tables were set out in a "companion hardback volume" and included in an updated version of the STP. In addition, "…the word-processing files that comprise this edition of C.M.I.R. [were placed] onto the Faculty of Actuaries and Institute of Actuaries web site", which presumably enabled the mortality rates to be copied and pasted whereas, historically, users might have had to type in the rates themselves, with an obvious risk of error.

The introduction notes that several new tables are included in the "92" Series: female temporary assurances. amounts tables for immediate annuitants, and tables for retirement annuitants. It adds:

[42] The introduction to CMIR 16 attributes this paper to David Wilkie and John McCutcheon, not the whole Committee, and notes that it "…is an enlarged version of the report sent earlier this year to contributing offices."

"Only the vested section of this last group warrants standard table status[43], but tables based on the deferred and on the combined vested and deferred experience are included in this volume for completeness."

In terms of the tables themselves, similar methods to the proposed new base tables for pensioners, in CMIR 16, were generally used; i.e. a preferred graduation formula was found and the parameters were then adjusted "…so that the resulting mortality rates 'behaved properly', that is, the rates for the select durations rose with increasing duration, the rates for the highest and lowest ages were reasonable, and the rates for the two sexes were not unreasonable in relation to each other." Exceptions to this general approach included for immediate annuitants, where the duration 0 lives rates were calculated as a percentage of the rates for durations 1+ and the male amounts rates were a percentage of the lives rates.

The proposals for pensioners set out in CMIR 16 considered base mortality only, and consideration of future improvements was set out in CMIR 17. It is interesting that the CMI still felt it necessary to make the case for assuming mortality would improve:

> "When publishing the "80" Series of tables, based on the experiences of the 1979-82 quadrennium, the Committee was of the view that it would be imprudent not to incorporate into the new tables for pensioners, annuitants, and widows an allowance for projected improvements in mortality with the passage of time. Analysis of recent trends in the mortality of pensioners confirms that such an allowance is again essential for most practical purposes."

CMIR 17 commenced by considering past improvements in pensioner experience over an extended period and noted "…for the age group 61-65 the crude rate of mortality over the period 1991-94 was 51% of the corresponding crude rate for the period 1959-62."

Further, a pattern was evident in the male data: "Within each age group a more rapid rate of improvement in mortality has occurred in recent years than in the more distant past. Improvements in mortality for amounts are significantly greater than for lives. For both lives and amounts the rate of mortality improvement decreases as age increases." No such pattern existed for females.

CMIR 17 proposed a single set of improvement factors, to apply to all the relevant tables, and to both males and females and lives and amounts, principally on the grounds of simplicity. It recognised that this might overstate future improvements for females but "Given, however, that the female experience has such unusual features, that it is difficult to know how much weight to give to it, and that one should probably err on the side of caution: the Committee feels that the recommended projection factors are reasonable for most practical purposes."

The method used for constructing the factors was similar to that used for the "80" Series tables but incorporated variation in the speed of convergence by age, reflecting the pattern in male data noted above.

[43] It is worth pointing out here that, in common with earlier CMI Reports, CMIR 17 does not spell out what "standard table status" actually means! This point is considered further under ''Adoption' and 'Standard tables'' in Section C9.

B3. The mortality of impaired lives

CMIR 8 (published in 1986) included a short note on the analysis of impaired assured lives, for which a separate sub-committee had been established in 1982. As this had only received data for 1982, no results were included in CMIR 8. Although data had been received from 12 offices, the report notes a potential issue in that "…a substantial proportion of the 1982 statistics were contributed by only one office."

A fuller report followed in CMIR 11 in 1991. This described the protracted birth of the new investigation, which had only begun in earnest when Barry Sherlock, the then Chairman of the CMI, invited contributing offices to "…an exploratory meeting to consider in depth the possibility of collecting the necessary statistics. At the end of that meeting 25 offices indicated their willingness to contribute data…"

Roland Clarke (who had already retired as CMI Secretary at this time) drew up a list of impairments for which he considered there might be sufficient data to be worth investigating. This list was based on his experience within his own office, referred to in CMIR 11 as "the pilot office"[44]. The mortality experience of that office had already been shared with the profession in a series of sessional papers[45]. Unusually, and possibly uniquely, CMIR 11 also included results for that single office, alongside the CMI's results.

The investigation started on 1 January 1982, limited to new policies and to classes of assurance covered by the main investigations. Curiously, in my opinion, the investigation was intended to cover cases where one of the relevant impairments was present, even if the life was not rated.

CMIR 11 includes commentary on the condition groups with significant data volumes – hypertension, ischaemic heart disease (without surgery), ischaemic heart disease (with surgery), nervous disorders, peptic ulcer, diabetes mellitus, respiratory disorders, tumours (for female malignant breast tumours only) and overweight.

As the volume of data for 1982 was limited, that year was not used for this analysis, which covered the years 1983 to 1986 and was based on data from 20 offices. To maximise the volume of data, results were shown for all investigations combined – permanent (both linked and non-linked), temporary and joint life first death. In the main, though, the report was positioned as a call for more offices to submit data, noting:

> "It was realised when the investigation was inaugurated, that it would be several quadrennia before the Committee could obtain full results from a mature set of statistics, and possibly even longer before the durations approach those of the data which formed the basis of the reports by Preston, Clarke and Leighton."

A second paper in CMIR 11 also described the mortality experience of impaired lives in 1983 to 1986 but by cause of death, for which data had been collected since 1983. However:

> "In the event, some offices have been unable to submit any cause of death data for the deaths among impaired lives, and some have submitted the information in respect of only a few cases, with the result that out of 652 deaths (496 male and 156 female) the Bureau has been supplied with cause of death information in only 275 cases, including 7 where the cause was unknown and 4 where the impairment code was not stated, leaving 264 (199 male and 65 female) with full particulars both of the impairment and of the cause of death. This proportion, about 40% for each sex, is too low for reliable exposed to risk and cause-specific expected deaths to be calculated, and an actual and expected comparison will need to wait until a later quadrennium."

Two further reports followed in CMIR 14, in 1995. The first covered the experience in 1983 to 1990 (i.e. including the previous quadrennium, to boost data volumes). The report notes the rationale for

[44] The pilot office was never named in CMI Reports but was probably well known to be the Prudential.
[45] The last being the paper by Leighton on "The Mortality of Impaired Lives 1974-83" (J.I.A. **114**, 19). Colin Kirkwood recalls that Maurice Leighton was a member of the Impaired Lives Sub-Committee, when it was formed.

the choice of a longer analysis period for the main analysis: "This gives a larger body of experience with which to work, in particular a larger number of deaths; at the same time it is believed the period is short enough to preclude secular changes in mortality influencing the results." Again, the analysis provides results for all investigations combined and for the pilot office alongside the CMI results. Although the volume of data was greatly increased – totalling nearly 2,000 deaths for males and females combined – the report notes that it was lower than might have been expected; firstly, because two offices had submitted incomplete years' data and, secondly, because of declining volumes of underwritten policies being written in the market as a whole.

It also notes the difficulty in establishing a base level of mortality for non-impaired lives, with which to compare these results, arising from the very different profiles of the two datasets by duration. An added difficulty arose where there were significant differences between the CMI results and those of the pilot office, for example in respect of hypertension.

For the first time, CMIR 14 shows the mortality of impaired lives by duration, noting that:

> "…for the impairments listed, the additional risk is heavily front loaded, particularly in the case of ischaemic heart disease without surgery. The exception to this is early onset diabetes mellitus (in males) where the additional risk is more evenly spread."

The second report on impaired lives in CMIR 14 set out analysis by cause of death, covering the years 1987 to 1990 only. It notes that the available dataset was much larger than for 1983 to 1986 and also more representative of the overall dataset but "… the numbers of deaths in each impairment group are still too small for a full actual and expected analysis by cause to yield useful results."

Instead, each case was categorised according to whether:

(a) the impairment and the underlying cause of death were identical (or linked);
(b) the impairment could be regarded as associated with the underlying cause;
(c) there was no apparent connection between the impairment and the cause of death; or
(d) the cause of death was not reported.

The distribution of deaths was then shown, separately for males and females, for each impairment group where there were ten or more deaths. This produced contrasting results, for example:

- For hypertension, the impairment was identical with, linked to, or contributory to the cause of death in over 60% of the deaths.
- For urinary disorders, "The deaths were 100% unconnected with the impairment."

The final report on impaired lives in this period, in CMIR 16[46] (published in 1998), considered experience in 1983 to 1994. As with the previous report, this covered an elongated period – adding new data to the existing dataset – and the Sub-Committee noted its intention to retain a rolling 12-year period in future. It also reported that this would probably be the last containing results exclusively from the pilot office, as the Sub-Committee considered the CMI dataset sufficiently credible in their own right, whilst also acknowledging that "For example, amongst the ischaemic heart disease cases with a duration under six years, some 60% of the C.M.I.B.'s data comes from the pilot office."

The overriding conclusion of this analysis was that "…the additional data which have become available have for virtually every impairment served to reinforce tentative conclusions drawn in earlier reports."

The report concluded with the habitual call for more offices to submit data, with the additional justification that "The passing of the Disability Discrimination Act in December 1996 predicates a need for reliable industry data to justify ratings for impairments. A truly comprehensive independent study, such as that provided by the Bureau, could be invaluable in this regard."

[46] It came as a considerable surprise to me to read the list of names of committee members in CMIR 16 and see that I was shown as the Chairman of the Impaired lives Sub-Committee, as I have no recollection of this! My activity in this role may have consisted only of endorsing that the Impaired Lives Sub-Committee be incorporated into the Mortality Sub-Committee…

Curiously, CMIR 16 contained no analysis by cause of death, nor did it give any reason for the absence of such analysis.

The separate sub-committee for impaired lives ended in 1999, when it was incorporated into the Mortality Sub-Committee.

B4. Permanent Health Insurance (PHI)

The birth of the PHI investigation

Much of CMIR 2, published in 1976, describes the birth of the PHI investigation, and the formation of the PHI Sub-Committee. The introduction to that section notes that:

> "In 1970 the Life Offices' Association and the Associated Scottish Life Offices[47] invited the Continuous Mortality Investigation Bureau to undertake an investigation into the sickness rates experienced under Permanent Health Insurance Policies. The Councils of the Institute and Faculty considered the question and on 12 June 1970 they appointed a Sub-Committee to examine the proposal. The constitution of the Bureau was amended so as to extend its activities to the collection of morbidity statistics and to the investigation of permanent health insurance."

CMIR 2 then notes some history of the market before it continues:

> "…there has been a need to collect morbidity statistics to enable the various institutions to calculate rates of premium or contribution but there has not been a great deal of pooling of data. The classic data pools in the United Kingdom were assembled by the Independent Order of Oddfellows Manchester Unity Friendly Society for various investigations in the nineteenth century, reaching a climax in the experience of 1893-97 from which standard tables were constructed. These standard tables are still in use … the consensus of opinion is that none of the material available accurately represents the current morbidity experience of Permanent Health Insurance policyholders in the United Kingdom."

Consequently, the PHI Sub-Committee was formed, with Mr J. Hamilton-Jones as Chairman, leading to a paper being circulated to offices in September 1971. The full text of this paper, incorporating subsequent instructions, is given in Section 5 of CMIR 2. CMIR 2 reports that "The response was both prompt and encouraging. Seventeen offices offered to contribute data…"

A number of further circulars were issued, to amplify the instructions to offices and to give instructions for submitting group business data. The final specification is detailed in CMIR 2 but, in brief:

- Data was collected on punched cards or on magnetic tapes;
- A card with 80 columns was required for each policy in force at the beginning of a record year and another for each claim during the record year; and
- There were also instructions for coding causes of sickness.

One point of note is that data was collected for individual records from the outset – long before these were introduced for the mortality investigations.

The Sub-Committee also considered the computer systems that would be needed. This work was attributed to "Mr G. T. Humphrey, F.I.A., a specialist independent data processing practitioner" whose company, Pensions and Insurance Computer Services (PICS), was at some stage appointed to process the CMI's PHI data. Initially, the system focused on producing results based on the Manchester Unity approach, but they were also intended to allow investigation into claim inception and termination rates, to enable the calculation of disability annuities.

CMIR 2 reports that:

> "The climax of the year was the meeting of 12 December 1973 at which Mr Humphrey reported that he had received data for individual policies from nine offices for in-force at 31 December 1971 and claims in 1972 and from ten offices for in-force at 31 December 1972, and it was decided to run the programs and calculate the experience of these policies in 1972."

The Sub-Committee agreed the exposed to risk formula and, in July 1974, a draft report on the experience of 1972 was discussed. A revised version was circulated to all contributing offices in October 1974 and copies of their own results were sent to the offices which had contributed the data.

[47] I think both can be regarded as fore-runners of the Association of British Insurers (ABI).

During 1974 and 1975 the experience of individual policies in 1973 was calculated, summarised and distributed.

The first results for individual business

The immediate end-result of this work was a report on experience of individual policies in 1972 and 1973 that was also presented in CMIR 2. As noted in that report "Meanwhile work is being continued on the collection of group data…"

Although the investigation was in its infancy, the analysis of claim inception rates in CMIR 2 revealed three important features:

- "…for 1 week deferred benefits up to age group 55-59 the male claim inception rate is surprisingly constant."
- "…there is a high inception rate for the age groups 20-24 for almost all deferred periods."
- "…the overall inception rate for females is higher than for males."

Results for individual policies for the years 1974 and 1975 were included in CMIR 3 (published in 1978), in a similar format to the preceding results.

A fuller report into experience in the four years, 1972-1975, followed in CMIR 4 (1979), including graduated rates for males (only). The paper was submitted to, and discussed at, the Institute of Actuaries[48] prior to its release in a CMI Report. The report highlighted the lack of prior knowledge regarding PHI experience; for example:

> "At this stage it is considered suitable to combine the 4 separate years into a single experience and to publish a graduation. It is the established practice for mortality experience to be grouped in 4-year periods; such data are generally amenable to graduation, and the period is not long enough to include heterogeneous business. Maybe at a later stage reasons may be put forward for treating P.H.I. experience differently, but there is a sense of immaturity in the present state of the experience. It is not yet possible to discern the influences at work. So on this account, and because some graduated table if used with suitable care is a better guide than nothing at all, the present paper is based on 1972-75 and contains a graduated experience table for males."

There was no prior statistical model for PHI (akin to the Makeham formula for mortality) and the attempts to establish one proved fruitless: "The Sub-Committee hoped to see a spectrum, a pattern which could be traced back to a uniform white. Thus we hoped for a well-behaved graduation formula for general use. Much time was spent attempting graduations and reverting to further contemplation of the data. So far, it must be admitted that our expectations are unrealized." In the absence of a suitable model, the Sub-Committee used least squares to produce graduated rates.

The Sub-Committee established a clear need to segment the data by deferred period, and to graduate each subset of data separately, which reduced the data volumes available for each graduation. These were further reduced by the need to segment experience by duration of sickness using the Manchester Unity method.

Despite these challenges, the Sub-Committee produced graduated rates for males, for most deferred periods, based both on expected weeks of sickness (Manchester Unity) and claim inception rates. There were no rates for females or for 52 week deferred, due to the lower data volumes. Termination rates, or disabled life annuities were also out of scope as the dataset was yet too immature.

As well as there being no established statistical model for PHI experience, there was a lack of valid statistical tests; for example, the ongoing nature of a PHI claim meant that claim rates at successive ages and in successive years could not be considered independent. One innovative solution was to

[48] It does not appear to have been discussed at the Faculty. At that time, individual PHI was predominantly written by life insurers based in England; Scottish Mutual is the only exception in the list of data contributors in CMIR 4.

calculate net premiums using both the ungraduated and the graduated experience – as the difference was never greater than 4%, the graduations were adjudged satisfactory.

The Sub-Committee could not be accused of lacking ambition:

- In addition to producing the graduated rates, they sought to illustrate how the experience varied for attributes of the data such as benefit amount that were outside the scope of the mortality investigations at this time.
- CMIR 4 includes a comment that "It will be appreciated that a standard table for sickness business, like one for annuities, needs to make allowance for future trends." It is not obvious to me why this should be the case since – at that time – future trends were not generally considered for assurances. However the Sub-Committee concluded it could not achieve this from the current dataset and settled for only presenting a view of current experience.

The first results for group business

The first results for group policies related to a period one year later than those for individual policies, 1973-1976, and are set out in CMIR 5, published in 1981. The dataset was much smaller than that for individual – around 25% – but growing rapidly. The investigation faced many challenges similar to those for individual business but, additionally:

- Offices could choose whether to submit data on a 'calendar year' basis or a 'scheme year' basis, necessitating, for example, different methods for calculating exposed to risk.
- A large proportion of group schemes were costed in detail less frequently than annually (usually at 3- or 5-year intervals), leading to incomplete data. Typically, unit-costing was used for the largest schemes, so this subset, amounting to around 50% of the total volume of lives, was not included in the results in CMIR 5.
- In some circumstances, the level of benefit may be uncertain for some time. Consequently, "To speed matters up it was, therefore, decided to stop asking for details of the amounts insured."

It is interesting to note:

- The analysis was almost certainly by lives, rather than by policies, as for other CMI investigations, as each individual would only be covered under one scheme at any one time.
- Rated and declined lives would be included in the Group data (the benefit amount for the latter category would have been restricted to the 'free cover' limit for that scheme).

The report sought to compare experience with Manchester Unity and the individual experience for 1972-1975 but for the latter, for example: "It is difficult to draw any conclusions about relative heaviness of experience. On most male tables the group business seems to be the heavier above age 55. but at younger ages there does not seem to be any definite indication."

Results for individual business in 1975 to 1978

The next results for individual policies covered the 1975-1978 quadrennium and were published in CMIR 7 in 1984. The choice of period may appear odd, as it overlapped with the period used in CMIR 4 (1972-1975) but CMIR 7 explained that:

> "One of the features of the experience reported in C.M.I.R. 4 was a possible overall trend of worsening morbidity over the period of the investigation although the evidence for such a trend was not consistent for the separate tables by deferred period and no firm conclusion was drawn."

In fact, as data had been collected and analysed for the subsequent years, it emerged that:

> "…the 1976 crude sickness rates were … not dissimilar to the rates for 1975" and "the rates reported for 1977 and 1978 appeared to be broadly in line with those for 1976… [which] … led the Sub-Committee to decide that it would be best to disregard the data for years prior to 1975 and to base its further work on the experience for the years 1975-78."

To reduce heterogeneity, the main analysis was limited to what the Sub-Committee named the 'Standard' experience. This included "U.K. policies without an occupational rating, without a known exclusion clause for a medical impairment and not providing lump sum or other unusual forms of benefit." This restriction became a regular feature of the CMI's analyses of individual PHI.

CMIR 7 noted the percentage of the total dataset that was included as 'Standard' by deferred period. The percentage tended to increase as the deferred period lengthened, which would be consistent with more conditions requiring an exclusion in the medical underwriting process for a short deferred period. However, the percentage was especially high for 1 week deferred and it noted "The apparently anomalous figure for 1 week deferred may be attributable to the fact that the bulk of the business written under this particular table emanated from one Office specializing in particular professional occupations." This has also been a recurring feature of subsequent CMI work on individual PHI; the office in question has never been named although I assume it would be known to most practitioners!

The report helpfully included 'A brief historical note on the Manchester Unity investigation' and explained why the Manchester Unity approach may be unsuitable for use in CMI analyses:

> "Modern Individual PHI business requires the calculation of guaranteed level annual premium rates and the valuation of existing portfolios of business. The approach used by Watson was designed to value the various sections of the Manchester Unity Society and to assess the contribution rates to be applied to both new and existing members alike. In this approach the sickness rates for the various sickness periods are derived without taking account of the duration that each policy had been in force (once any waiting period is passed) and thus ignores the fact that new policies cannot immediately claim benefit in the later sickness periods… [As a result,] future investigations [may incline] towards the North American system of inception rates and disability annuities…"

Despite the reservations, CMIR 7 included some results on the Manchester Unity basis[49]. It also continued the quest for a mathematical model for inception rates but, as noted in the conclusion, "…the desire of the Sub-Committee to produce a standard table for valuation purposes has not been realized." As for CMIR 4, CMIR 7 also included:

- Graduated claim inception rates; again for males for deferred periods of 1, 4, 13 and 26 weeks only, as (again) there was insufficient data for 52 weeks deferred or for females lives
- Results to show how the experience varied for attributes of the data such as:
  - The Republic of Ireland, which was outside the 'Standard' dataset; and
  - Benefit amount, as the 'Standard' dataset included all amounts combined.

The first results by cause of disability

Cause of disability had been included in the data requirements for claims from the outset of the PHI investigation and the first results were contained in CMIR 8, issued in 1986, for individual policies in 1975-1978. The coding was based on the World Health Organization's 'Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death' and were grouped into 14 sickness categories that were each expected to contain sufficient claims for analysis purposes.

It is interesting that the purpose of analysis by cause of disability was stated as "…to give underwriters some indication of the relative importance of the various conditions giving rise to claims and those concerned with claims control and administration an indication of the average length of claim according to cause" and not, for example, to help actuaries analyse changes in experience over time. This marks another departure from the approach of the mortality investigation, which was focused on the needs of actuaries.

Three sets of results were presented:

- The number of inceptions by sickness category, sex and deferred period, in age groups;

[49] A basis was needed in order to analyse the duration of claims, and not just the number of claims, as measured by incidence rates.

- The total weeks of sickness, again by sickness category, sex and deferred period, in age groups; and
- The average duration in weeks by sickness category subdivided by mode of termination for each deferred period, based on claims that had terminated only.

An example of the findings for the first type of result was the much lower impact of the 'Acute Respiratory' and 'Other Infective' categories for deferred periods of 4 weeks and more, compared with 1 week deferred.

Further results

CMIR 8 included a second report on PHI, covering the experience of group PHI policies in 1975-1978. This investigation period overlapped with that used in CMIR 5 (1973-1976), in order to align with the quadrennium used for individual business. Again, the dataset was growing rapidly – the lives in force at 31 December 1978 were over 2½ times the number at 1 January 1975 – but was still much smaller than for individual business.

The report again compared the experience of group business with the Manchester Unity basis and with individual business, using the graduated individual rates for the same period (from CMIR 7) and focussed on UK, male data, for which:

- Group inceptions appeared to be lower than those for individual business at younger ages but higher at ages over 45.
- "…it was found, perhaps fortuitously, that quite reasonable graduations could be made of the deferred 4, 13 and 26 weeks rates using the same procedure and type of formula as were used to graduate the Individual Standard data".

Some results were also included for the Republic of Ireland and (UK) females; both appeared to exhibit heavier experience than UK males but the findings were caveated due to the low volumes of data.

Results for individual policies in 1979-1982 followed in CMIR 11 in 1991. These were compared with the 1975-1978 graduated rates but no graduation was undertaken on the more recent dataset.

CMIR 11 notes that: "The overall experience in 1979-82 was slightly better than in 1975-78." This is followed by: "There are, however, strong indications from practitioners that the experience has deteriorated since 1982. The rates of sickness set out in this report are likely to be appreciably lower than those now being experienced"; this is an unusual comment for the CMI but suggests strong practitioner representation on the sub-committee.

A CMI statistical model for PHI

CMIR 12, issued in 1991, consists of a single paper, titled 'The analysis of permanent health insurance data'. It was a substantive piece of work that established a model to be used by the sub-committee for many years to come[50].

It is highly unusual amongst CMI Reports, in that four of the sections are attributed to two individuals:

- Phillip Bayliss, a lecturer at the London School of Economics, was named as the author of part B, covering the graduation of death and recovery of claimants.
- Howard Waters, a lecturer at Heriot-Watt University, was the author of three sections – first setting out a multiple state model for PHI (in part A), followed by the graduation of sickness rates (part C) and computational procedures (part D).

There were two further, non-attributed, sections covering the calculation of probabilities and of monetary functions (parts E and F, respectively).

[50] It was so substantial that a reinsurer, Swiss Re (UK), soon issued a booklet entitled ''The 30 minute CMIR12': An overview of its contents and practical implications'!

Howard explained to me that David Wilkie (then CMI Chairman) was keen that Phillip's and Howard's names were attached to parts of CMIR 12 because he understood that, as academics, they were judged by their employers on numbers and quality of publications. Howard added that the two unattributed sections were predominantly David's work, but he was happy not to be individually credited; as a non-academic, publications were not as important to David. Furthermore, Howard acknowledges that "The reality was that David Wilkie co-authored Part D with me."

Howard also described the background to his involvement to me:

> "In 1984 I was a Lecturer in the Department of Actuarial Mathematics and Statistics at Heriot-Watt University, Edinburgh. I recall David Wilkie coming to my office one day, sitting down and asking me:
>
> "What do you know about Permanent Health Insurance?"
>
> "Nothing," I replied, which was true.
>
> "OK, let's start from there," he said.
>
> David was at that time a full time employee of Standard Life Insurance Company in Edinburgh but he was also Chairman of the CMI's Executive Committee. He was a frequent visitor to our Department, mainly to have discussions with my colleague, Professor John McCutcheon, who was a member the CMI's Mortality Sub-Committee. I knew David slightly, but not well, and we had not yet worked together.
>
> David explained to me that he was concerned about the state of the PHI investigation. At that time the analysis was based on the Manchester Unity method which had been developed by Sir Alfred Watson early in the 20th century. This was not to be critical of the Manchester Unity method; it had been developed at a time when statistical analysis was in its infancy and it had lasted for many decades. However, David thought a more up to date method of analysis was required and asked if I could help. I agreed to think about it."

I suspect Howard didn't realise what he had let himself in for … he was invited to become a member of the PHI Sub-Committee in 1986, also joined the Critical Illness Committee in 1999 – remaining a member of both until 2011 – and was the first Chairman of the CMI Technical Committee!

CMIR 12 sets out three requirements of a model for PHI:

(i) "It should be sufficiently realistic. Any model incorporates some simplifications but these should not be so severe as to make it difficult to accept as a model for the purposes being considered. For example, a model for PHI which has recovery rates depending only on the policyholder's attained age and not on the duration of his sickness may be considered too unrealistic to be of any use.

(ii) It should be possible to use the data which is available, or which could easily be made available, to estimate the parameters which determine the model, and, more importantly, to estimate them in such a way that the statistical properties of the estimators are known.

(iii) It should be possible to derive from the model numerical values of some functions which can conveniently be used to set premium rates for, and carry out valuations of, PHI business."

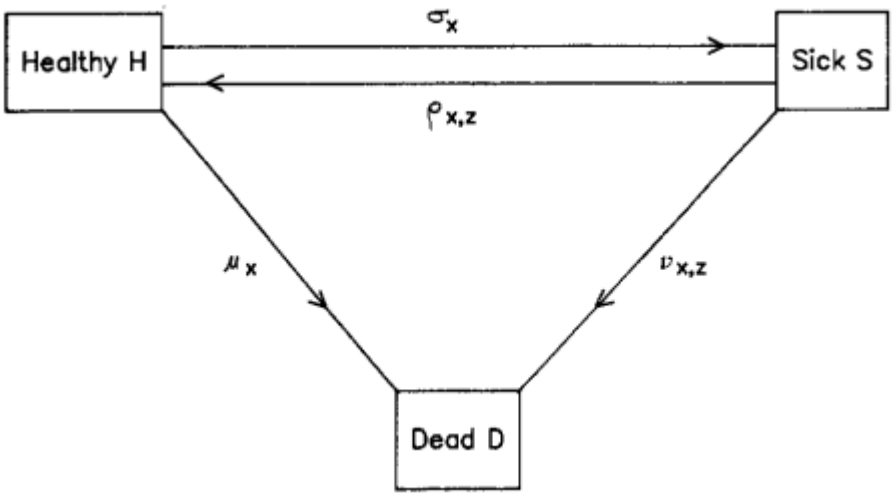
The model that Howard and David focussed on is illustrated in the diagram below (Figure A1 from CMIR 12). The report explains:

> "On effecting his[51] policy the policyholder enters state *H* (since we assume he is not sick at that time). From state *H* he may transfer at any future time either to state *S*, i.e. become sick. or to state *D*. i.e. die. (Note that entering state *S* is not equivalent to making a claim since to make a claim the policyholder must remain in state *S* for at least the deferred period of his policy.) The transition intensities, or forces of decrement, for these two transitions are denoted σ_x and μ_x, respectively and depend only on x, the policyholder's attained age. Once in state *S* the policyholder may transfer back to state *H*, i.e. recover, or transfer to state *D*, i.e. die. The transition intensities for these transitions are denoted $\rho_{x,z}$ and $\nu_{x,z}$, respectively and depend on x, the policyholder's attained age, and z, the duration of his current sickness. Note that all the

[51] It is a reflection of the times that the CMI felt no need to be gender-neutral in the wording of CMIR 12!

probabilities in this model depend only on the policyholder's attained age and, in some cases, on the duration of his current sickness. These probabilities take no account of any other information; for example, they do not take account of the number of, or durations of, or time since, any previous periods of sickness."

A diagrammatic representation of the model for sickness:



Howard notes that there were two caveats with the model meeting requirement (ii) above:

- The model purports to represent all sicknesses experienced by an individual, including those which do not last beyond the deferred period and so do not result in a claim. Such sicknesses are not recorded in the data available to the CMI. The proposed way of getting around this problem was an iterative process: use a crude estimate of the exposure to estimate σ_x, use this estimate of σ_x to update the estimate of the exposure, re-estimate σ_x, and so on. It was hoped that the estimate of σ_x would converge to a plausible value but, without using the data to first graduate the intensities for sickness termination, $\rho_{x,z}$ and $\nu_{x,z}$, it was not possible to check this.
- Second, the CMI had no data to estimate μ_x, the intensity of mortality direct from Healthy. This was not regarded as a major problem since it could reasonably be assumed to be similar to the mortality for select assured lives and, crucially, it was unlikely to have any significant effect on the calculation of premiums or reserves.

Notwithstanding these caveats, the model was accepted by the Sub-Committee and its development clearly represented a considerable relief, as the introduction to CMIR 12 says "In this Report the Sub-Committee is at last able to present its investigations of sickness claims on a 'disability annuity' basis for consideration by the actuarial profession and by PHI offices."

The Sub-Committee also noted "A major advantage of the multiple state model used as the basis of this Report is that it allows the two different approaches, the Manchester Unity Sickness Rate approach and the Claim Inception Rate and Disability Annuity approach, to be seen as alternative representations of the same underlying model, providing alternative ways of calculating the same functions. The apparent conflict between the approaches is seen to be groundless…"

The "SM1975-78" graduations

The graduations published in CMIR 12 used the 1975-1978 experience (not the more recent 1979-1982, set out in CMIR 10) and were restricted to 'Standard' data for males, with deferred periods of 1, 4, 13 and 26 weeks[52]. There was no consideration in CMIR 12 of the other attributes considered in

[52] The graduations of 1975-1978 experience are later referred to as "SM1975-78", for example in WP 48, but that terminology does not appear to have been used at the time.

CMIR 7; i.e. females, Irish experience, duration in force, size of policy, type of benefit, medical evidence and occupationally-rated policies.

Considering the three elements of the graduations, key points to note are:

- Recovery Rates
  - The graduated recovery rates were based on data for all deferred periods combined but varied by age at commencement of sickness.
  - For deferred periods longer than one week, data for the first four weeks from the end of the deferred period was excluded. The suggestion was that there is a tendency for policyholders who would recover shortly after the deferred period not to make an insurance claim (defined as 'unreported claims'). This period of four weeks was referred to as the 'run-in' period.
- Mortality Rates
  - As there was little data on deaths, one set of mortality rates was derived for all durations and deferred periods.
  - There is an interesting pattern to mortality rates with a hump, by duration of sickness.
- Inception Rates
  - Although CMIR 12 is based on the same underlying dataset as CMIR 7, there were two adjustments to the data:
    1. The adjustment for duplicate policies was increased for deferred four week business.
    2. Unreported claims (in the first four weeks of a claim) were allowed for in the graduation process, so that both inception and recovery rates relate to underlying sickness rates, rather than claim rates.
  - CMIR 12 describes two methods of interpreting the period to which the inception rates apply; sickness from age x-d to age x+1-d ('type a') and from age x to age x+1 ('type b'), where d is the deferred period.

CMIR 13, published in 1993, contained a follow-up paper to CMIR 12 covering:

- How direct integration of the graduation formulae can be undertaken, enabling the calculation of continuation tables.
- How an allowance can be made for non-recorded claims for deferred periods 4 weeks, 13 weeks and 26 weeks.

It also included a section containing errata to CMIR 12.

An independent research paper

CMIR 14 (1995) contained a single paper on PHI; a research paper by Isabel Cordeiro at Heriot-Watt University. Isabel was a PhD student working under Howard Waters' supervision and this was the first in a series of collaborations, whereby a CMI dataset was made available to a researcher from Heriot-Watt, providing the researcher with real data and the CMI with valuable research[53]. The introduction to CMIR 14 notes that "The Executive Committee welcomes such contributions and is happy to publish suitable papers which are derived from CMI data or research."

The paper itself considers the sensitivity of the multiple state model from CMIR 12; specifically, analysing how claim inception rates and premium rates vary with changes in the values of σ_x, $\rho_{x,z}$, μ_x and $\nu_{x,z}$ (i.e. the transition intensities from healthy to sick, from sick to healthy, from healthy to dead and from sick to dead, respectively).

[53] The paper in CMIR 14 was part of Isabel's PhD thesis, noted in Appendix 8, which lists papers written at Heriot-Watt using CMI PHI and critical illness data.

Further reports on experience

CMIR 15, published in 1996, was – like CMIR 12 – a sizeable volume devoted solely to PHI and it covered several reviews of experience over various periods:

- Claim inception rates for individual business in 1975-1990 and group business in 1975-1986;
- Recovery and mortality rates of those claiming for individual business in 1975-1990 and group business in 1975-1986;
- Sickness experience in 1983-1986 for individual PHI policies; and
- Sickness experience in 1979-1982 and 1983-1986 for group PHI policies.

The first two of these reports compared experience with the graduated rates from CMIR 12 (i.e. rates for 'Standard', male lives under individual PHI) in what was intended to become a standard format: "…the methods of analysis and style of presentation will form the basis of reports on subsequent experiences in future numbers of C.M.I.R. and also the results given to contributing offices derived from their own data."

The results showed considerable variation by quadrennium, for claim inceptions, for example:

- The 1979-1982 male experience is generally lighter than that of 1975-1978:
- The 1983-1986 male experience is generally heavier than that of 1979-1982:
- The 1987-1990 male individual experience is generally heavier than that of 1983-1986; and
- The female experiences are generally heavier than the corresponding male experiences, but with a similar pattern by quadrennium.

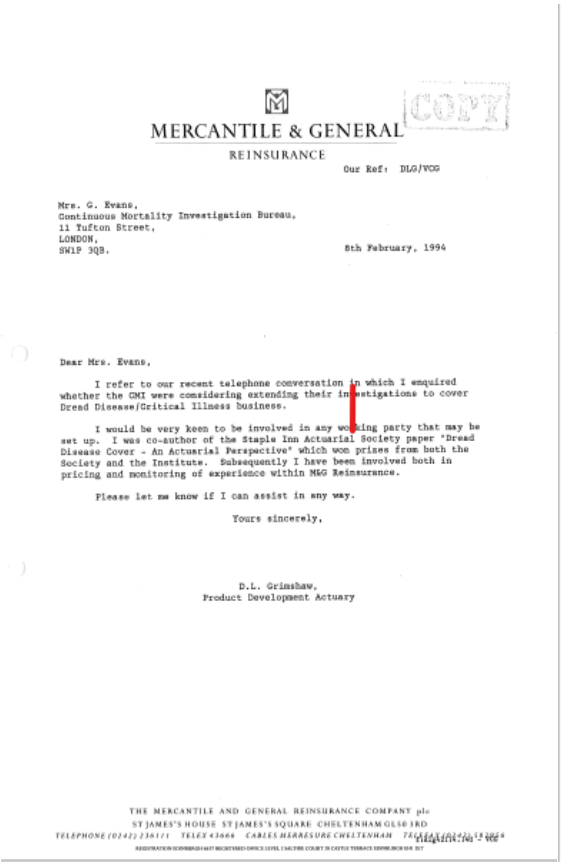
The final report on PHI in this period is in CMIR 16 (1998). This is, I think, the first and only case of a report in a CMIR containing an Executive Summary! The report compares the experience of group PHI policies in 1987-1990 with that in the previous quadrennium, 1983-1986, and – for the first time – compares the experience of unit-costed and individually-costed business.

B5. The Critical Illness investigation

The critical illness investigation was launched in 1994 with the aim of collecting data from 1995.

My involvement with this investigation began with a letter to the then Secretary, Jillian Evans, asking whether the CMI was intending to investigate experience under critical illness policies, a market that was expanding rapidly in the UK. My letter – and the response – are shown below. I can't recall what happened next, but I was soon appointed as chairman of the CMI Critical Illness Working Party!

My enquiry to the CMI about a critical illness investigation, and the response:



MERCANTILE & GENERAL
REINSURANCE

COPY

Our Ref: DLG/VCG

Mrs. G. Evans,
Continuous Mortality Investigation Bureau,
11 Tufton Street,
LONDON,
SW1P 3QB.

8th February, 1994

Dear Mrs. Evans,

I refer to our recent telephone conversation in which I enquired whether the CMI were considering extending their investigations to cover Dread Disease/Critical Illness business.

I would be very keen to be involved in any working party that may be set up. I was co-author of the Staple Inn Actuarial Society paper "Dread Disease Cover - An Actuarial Perspective" which won prizes from both the Society and the Institute. Subsequently I have been involved both in pricing and monitoring of experience within M&G Reinsurance.

Please let me know if I can assist in any way.

Yours sincerely,

D.L. Grimshaw,
Product Development Actuary

THE MERCANTILE AND GENERAL REINSURANCE COMPANY plc
ST JAMES'S HOUSE ST JAMES'S SQUARE CHELTENHAM GL50 1RD
TELEPHONE (0242) 236111 TELEX 43666 CABLES MERASURE CHELTENHAM

Continuous Mortality Investigation Bureau
INSTITUTE OF ACTUARIES · FACULTY OF ACTUARIES
11 Tufton Street, London, SW1P 3QB
Tel: 071-222 1963 Fax: 071-222 0783

Your ref:
Our ref: 0215/jcsw

15 February 1994

Mr D L Grimshaw
Produce Development Actuary
Mercantile & General Reinsurance
St James's House
St James's Square
Cheltenham GL50 1RD

Dear David

Thank you for your letter confirming the interest of your office in a Dread Disease/Critical Illness investigation. We appreciate, too, your offer to be involved in any working party which may be set up to consider the matter.

As I mentioned on the telephone, the Executive Committee has this matter under consideration; the Chairman is currently contacting people from offices who may be interested to obtain their views. Assuming sufficient interest is shown a meeting will be called to consider the best way to take things forward.

I shall keep you informed of progress.

Yours sincerely

Jillian Evans

Mrs J V Evans

c.c. A D Wilkie

Meetings were held with writers of critical illness business later that year, from memory in Edinburgh and London. According to an article I wrote in *The Actuary*[54], "The CMI's intention was enthusiastically endorsed, and the new investigation will commence with effect from 1 January 1995." That article also set out the aims of the investigation:

- "To separately report on the experience of accelerated policies, which pay out on the earlier of a specified critical illness and death, and stand-alone policies, with no attaching life cover.
- To look at the main causes of claim separately, namely heart attack, cancer, stroke, coronary artery bypass surgery and multiple sclerosis.
- To provide offices with analysis of their own data, as well as "all offices" results and, in time, to develop a "standard" table."

Although the investigation sought data from 1995, the volume of data submitted initially did not make it feasible to produce any meaningful results. Consequently, the first results from the investigation ('all offices' results for 1998 and 1999) were only released in March 2003, so fall within the scope of Part C. As noted in WP 14[55] "One key reason for the paucity of data was that much of the business was

[54] 'A critical investigation', December 1994
[55] This was not issued until May 2005, but included a description of the history of the critical illness investigation.

written by offices who were not then members of the CMI." Although not stated, the two offices who had the most early sales success were Abbey Life and Allied Dunbar, neither of which had previously submitted data to any CMI investigation. It is not a criticism of either office that they had not submitted data:

- The CMI Secretariat did not proactively seek data from new offices at that time and focussed on existing data contributors; these had issued critical illness products later and had much lower sales volumes.
- In addition, neither Abbey Life or Allied Dunbar made financial contributions to the CMI. This created an additional obstacle to submitting critical illness data, as the CMI normally only collected data from 'members'[56], who also made financial contributions.
- The data requirements were adapted from those used for the main mortality investigation; whilst this may have been convenient for existing data contributors, they were perhaps too onerous and too rigid for new data contributors.

A further internal issue was that the Critical Illness Working Party had been established as reporting into the Mortality Sub-Committee, hence the critical illness investigation may not have had the necessary focus within the CMI.

These issues were addressed, as described in WP 14:

> "In view of the continuing importance of the product to the industry, the investigation was re-launched under the auspices of a dedicated Critical Illness Committee. The data requirements were reviewed and revised with a view to collecting data that were both more useful and allowed offices more flexibility in the method of provision. Potential contributors were contacted in 2000 and invited, initially, to contribute data in respect of 1998 and 1999. In order to maximise the volumes of data, non-member offices were also invited to contribute data in respect of these two years only."

WP 14 did not explicitly say so, but this request to non-members for data for 1998 and 1999 was without making any financial contribution. The CMI Executive Committee recognised that some initial investment was required; this proved beneficial as WP 14 also notes "…non-members who contributed data were invited to join the CMI and to contribute data for 2000 and beyond and it is pleasing to note that most did so." The CMI also approached reinsurers, which had not previously paid financial contributions but were reinsuring a substantial proportion of most companies' critical illness business[57], and most began making financial contributions henceforth.

Although not a CMI initiative, it is worth noting that the experience of the earlier years of critical illness business was collected and investigated by the Critical Illness Health Care Study Group. This was not entirely independent of the CMI, as I was a member of that group. As well as capturing the experience in 1991-1997, the group produced a base table, CIBT93, using population data, which was subsequently used as the main comparison basis in CMI results[58].

It is also likely that the Critical Illness Health Care Study Group work was a key enabler of the subsequent re-launch of the CMI critical illness investigation, as Abbey Life and Allied Dunbar had participated in that study and had overcome any internal hurdles to participating in an industry data pool, thereby encouraging others to also participate.

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[56] This term was often used, but was never, to my knowledge, well-defined and there was no formal documentation around membership until the CMI introduced Terms & Conditions in March 2013 (discussed under 'Review of the CMI' in Section C9).

[57] In the mid-1990s, reinsurance volumes of (mortality-only) term assurances increased substantially, resulting in reinsurers having much greater interest in the CMI's outputs.

[58] 'A Critical Review' was produced by the Critical Illness Healthcare Study Group, a working party of the Health & Care Board of the Institute, and was presented to the Staple Inn Actuarial Society on 14 March 2000.

B6. Miscellaneous topics

Structure and operations

In 1973, the CMI committee structure consisted of the Executive Committee[59], which undertook all of the work on mortality, plus the PHI Sub-Committee. There were a number of changes to this simple structure during the years to 1999:

- A second sub-committee was set up in 1982 to investigate the experience of assured impaired lives; this was then merged into the Mortality Sub-Committee in 1999.
- The Mortality Sub-Committee was formed in 1990, taking on the detailed work that was previously undertaken by the Executive Committee itself.
- The AIDS Sub-Committee became part of the CMI in 1993 having previously been a working party of the Institute. Whilst a working party, it published five bulletins between September 1987 and March 1991. Thereafter, it adopted more of a watching brief prior to being disbanded in early 1999.
- Operational responsibility was delegated to the Management Sub-Committee in 1999; this was chaired by the Chairman of the Executive Committee and also included the Treasurer and the chairmen of the other investigation sub-committees.
- The Critical Illness Sub-Committee was set up in 1999, having initially been established as a working party under the Mortality Sub-Committee.

Consequently, at the end of the period, in 1999, the Executive Committee had four sub-committees: Management, Mortality, PHI and Critical Illness.

From the CMI's inception, the Presidents of both the Faculty and the Institute were ex officio members of the Executive Committee but this practice was temporarily broken in 1991 with, as noted in CMIR 11: "the appointment of Bernard Brindley as an ordinary member of the Executive Committee, replacing the former President of the Institute, Roger Corley." It does not explain why this change in practice arose and the next President, Hugh Scurfield, was also not a member but John Martin, the subsequent President, did become a member of the Executive Committee on his election in 1992.

The CMI Secretariat[60]

As noted in Section A3, the CMI Secretary was a remunerated appointment at the start of the period, in 1973, with a small staff directly employed by the CMI. At some point during the 1970s it appears that the latter aspect changed, with staff at Rodney Barnett & Co[61] taking on responsibility for data processing and liaison with offices, initially working in conjunction with the CMI staff. A second change during this period was the appointment of Barnett Waddingham to undertake the computing support to the PHI investigation, from PICS. These changes – and how they came about – do not appear to be documented.

There is mention of the three members of the team employed by the CMI at the start of the period in the introduction to CMI Reports during this period:

- CMIR 11 notes: "I should like to pay tribute to the service of Miss Una Archer, an employee of the Bureau, who worked within the offices of the Secretariat. She first retired after a full period of service with a certain life office in 1972, joined the staff of the Bureau at that time, and has retired again after a further 18 years full-time work, at what can only be described as 'at or after the normal pension age'. If all employees were like her, the volume of data in the

[59] Although the members of the 'Executive Committee' are listed in each CMI Report, the Introductions to the early reports refer to the 'Joint Continuous Mortality Investigation Committee of the Institute and Faculty'. It is unclear to me what the difference was between these committees, if any, and I have referred to the Executive Committee throughout. CMIR 7 and subsequent CMI Reports refer to the 'Executive Committee'.
[60] The first use of this term, which has been used much more extensively in recent years, that I have located is in CMIR 10, published in 1990.
[61] Rodney Barnett & Co merged with Waddingham & Co to become Barnett Waddingham in 1989.

pensioners experience would be substantially reduced. We wish her a long and happy second retirement."

- CMIR 13 notes: "I should like to pay tribute to the work of a former employee of the Bureau, Miss Kitty Hicks[62], who served the Bureau from 1961 to 1975. She died in 1992 in her 90th year."
- CMIR 16 includes: "Another event of note was the retirement at the turn of the year of Joyce Tallboy, the last of the "C.M.I. ladies" who were well known to the contributing offices and who have served the C.M.I. well. I wish her a long and happy retirement." The minutes of the Executive Committee meeting in July 1998 note that "…[her retirement] had been marked by a dinner in her honour." They also record that "Miss Tallboy was now a receiving an ex-gratia pension from the CMIB."

There were three significant changes to the CMI Secretariat during the period from 1973 to 1999:

- As noted in CMIR 11, "Mr H. A. R. Barnett, Secretary of the Committee since 1972, retired from this post at the end of May 1990, … Mrs Jillian Evans was appointed Secretary with effect from 1 June 1990." On his retirement, Rodney Barnett "…was immediately appointed to the Executive Committee of the Bureau as an Institute representative." This appointment would have ensured that Rodney's considerable experience was retained within the CMI, but it is unlikely it would now be considerable appropriate from a governance perspective.
- There was a further change around 1996 when the CMI undertook a tender exercise for the data processing and computing work for the PHI investigation that had previously been undertaken by PICS. This exercise resulted in Barnett Waddingham also taking on this role, a key factor was likely to be that this unified the responsibility for liaising with offices across all the CMI investigations.
- The final change in this period was that Tony Leandro succeeded Jillian Evans as the CMI Secretary in mid-1998, prior to Jillian's retirement.

CMI Reports

The rationale for commencing issuing CMI Reports is set out in the Introduction to CMIR 1:

> "In the past, sectional reports were published as and when they became available both in the *Journal* [of the Institute of Actuaries] and the *Transactions* [of the Faculty of Actuaries]. The two Councils recognized that not only was such duplication unnecessary but also that this arrangement was inconvenient for reference purposes."

To understand the context to this comment, it is helpful to review the bibliography of previous papers in Appendix 3 of CMIR 1. That shows that there were 43 reports into mortality issued between 1924 and 1968, all of which were published in the Journal whilst 39 were also published in the Transactions.

In total, 23 CMI Reports were issued, the first in 1973 and the last in 2009; i.e. approximately one issue every eighteen months. The reports were not evenly-spaced, however, with two reports in each of two years (1991 and 2000) and significant gaps between others; e.g. the second report was not issued until 1976. The length of the reports varied considerably – the shortest was CMIR 6, with 55 pages, and the longest was CMIR 20, with 317 pages[63].

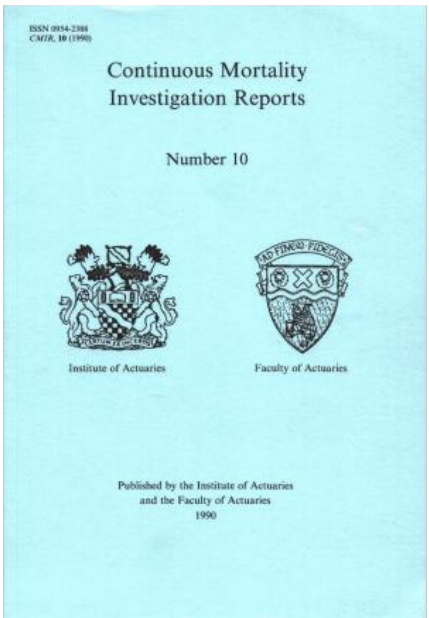
CMIR 10 to CMIR 20 were classified with an International Standard Serial Number, an eight-digit number assigned to many serial publications such as newspapers, magazines, annuals, and series of books; in the case of CMIRs, this was ISSN 0954-2388. It is not clear to me why this was not adopted sooner, or why it stopped after CMIR 20.

[62] Miss Hicks, like Miss Archer and Miss Tallboy, had also retired from the Prudential at the so-called 'normal' retirement age.
[63] I have used numbered pages only here; this excludes the title page, the introduction, the contents page and any 'inserts'.

The following generic points apply to (most) CMIRs:

- The front covers state that they were "Published by the Institute of Actuaries and the Faculty of Actuaries".
- Each CMI Report was printed ("…by Alden & Mowbray Ltd at the Alden Press, Oxford")[64] ; the same printers also produced the Journal of the Institute of Actuaries. CMIR 18 (in 2000) was the last to carry this statement but physical printing continued up to CMIR 22 (in 2005)[65].
- Copies of the reports (up to and including CMIR 20) were posted to members of both the Institute and the Faculty.
- They were A5 paper size (i.e. 148 x 210 mm) with a pale blue, cardboard cover:
  - A picture of the front cover (of CMIR 10) is included below; the inclusion of the crests of both bodies ceased with effect from CMIR 21 (the reason for this is unclear to me).
  - The inside front cover included a list of members of CMI Committees. Initially, this was only the Executive Committee but other (sub-)committees were included from CMIR 11.
  - The back cover detailed the contents of that report.
  - Some reports – such as CMIR 2 – contained larger charts, which were printed on larger, folded sheets inserted at the back of the book.
- Each report contained one or several papers, preceded by an 'Introduction'; initially credited to the Presidents of the Institute and the Faculty but later to the Chairman of the Executive Committee.
- Unfortunately, from my perspective in writing this book, there was rarely an Executive Summary!

The front cover of CMIR 10:



[64] The pdf versions of CMI Reports on the CMI pages of the IFoA website (https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-reports) were generated by scanning in printed versions of the documents, rather than being produced directly.
[65] I think the last report, CMIR 23, was issued online only, as a pdf.

Mistakes inevitably occurred and CMI Reports contained errata and corrigenda, when necessary. For example, the printed version of CMIR 8 included both:

- An erratum relating to Table 1.4.2 of CMIR 8; this was printed on a small slip of paper, inserted between pages 26 and 27 (which contained the relevant table)[66].
- Corrigenda, relating to CMIR 5 and CMIR 7, included on the last page of CMIR 8.

Volume 101 of JIA includes a very short paper 'Considerations affecting the preparation of standard tables of mortality' that notes (quaintly, in my opinion):

> "In this paper and the discussion upon it reference is made to the *Continuous Mortality Investigation Reports No. 1* published by the Institute and Faculty of Actuaries in 1973 and compiled by their joint Continuous Mortality Investigation Committee. It is sometimes termed the 'Blue Book' and other alternative expressions are used. It is suggested that in future references should be to *C.M.I.R.*, followed by the number of the Report and then the page reference. Thus the introduction to 'mortality of assured lives 1967-70, according to cause of death' would be *C.M.I.R.*, 1, 49."

Whilst the use of the term 'Blue Book' may have been discouraged in formal publications, it was certainly in everyday use between actuaries[67] and, indeed, was used by the CMI itself in explaining the rationale for introducing working papers (see Appendix 9).

The demise of CMI Reports is described under 'CMI Reports and working papers' in Section C9.

The Standard Tables Program

The initial development of the Standard Tables Program, or STP, is described alongside the "80" Series mortality tables in Section B2. An article entitled 'The Standard Tables Program (The "STP")' by David Dickson and Angus Macdonald[68] in *The Actuary* in January 1991 described the software. The authors were both lecturers at Heriot-Watt University at that time and the article notes "We were given an early version of the program with which to experiment".

Features of the program noted in the article included:

- In addition to the "80" Series tables, it included a(55), A1967-70(2), A1967-70(5), FA75-78, PA(90) and a(90).
- The program stored q_x values and projection factors for annuitants and widows and the article states:
  - "All other mortality functions and all financial functions are calculated from these data."
  - "The user also has the option to adjust the given mortality tables and calculate values based on adjusted mortality rates: $qx'_k = Aq_{x+k} + B$."

The article notes the price – £400 for offices who contribute data to the CMI and £500 to others (with additional copies at a reduced price) – and considers it "…does not seem overpriced".

It concluded: "…our overall impressions … are favourable. The STP is a simple but effective package. It is certainly more convenient than tables and provides the user with much more than any existing set of tables."

---

[66] Curiously, both of these pages appear to have been omitted from the pdf version on the website (as well as the erratum).

[67] In my research, I learnt that within one life insurer these were referred to as "out-of-the-blue books", presumably a reflection on the lack of publicity of what was coming!

[68] Angus was extensively involved with the CMI in later years. He can't recall how this earlier involvement came about, but considers it "…almost certain that we were roped in by Professor John McCutcheon [then a member of the Executive Committee] as willing helpers".

The first major update was released in 1993. This was described in another article in *The Actuary*, entitled 'Mortality Tables Program from the CMI' by Tony Leandro in December 1993. Key aspects of the new version were:

- **AIDS**. It incorporated all of the adjustments to normal mortality set out in the AIDS Working Party's bulletins.
- **PHI functions**. It incorporated the standard tables of inception, recovery and mortality rates published in CMIR 12 and calculated annuity values.
- **Table editor**. STP was originally intended to use CMI mortality tables only but "…users, particularly from overseas, have asked to have the facility to include their own mortality tables."

The price of STP was unchanged but there was an 'update price' for existing users of £250 per site and £25 per user (again, with a 20% discount for offices who contribute data to the CMI).

CMI 75

The CMI marked its 75th anniversary in 1999 with an event in Staple Inn Hall. A booklet was given out to attendees, the text of which is included in Appendix 4.

The event consisted of a number of presentations based around the various investigations, including a session by me on the nascent investigation into critical illness experience.

A photographer was present and some of the pictures taken after the event are included below. In the first picture, Colin Kirkwood is holding a printed copy of the "92" Series tables that I think were launched that day.

Members of the CMI Executive Committee and sub-committees at CMI 75:

Back row (L to R): Graham Clark (Chairman of the PHI Sub-Committee), Simon Margutti, David Forfar and Dave Grimshaw (Chairman of the Critical Illness Sub-Committee).

Middle row: Paul Seymour, Peter Nowell, Philip Bayliss, Colin Berman and Chris Daykin.

Front row (L to R): Rodney Barnett, Colin Kirkwood (Chairman of the Executive Committee), Peter Gatenby and David Wilkie.

Chairmen of the CMI Executive Committee, past and present, at CMI 75:

From left to right: Peter Nowell, Colin Kirkwood and David Wilkie.

CMI Secretaries, past and present, at CMI 75:

From left to right: Rodney Barnett, Jillian Evans and Tony Leandro.

Part C: Modern times, 2000 to 2023

C1. Introduction to Part C

Parts A and B described a number of changes in the years from 1924 to 1999 but the pace of change then increased with a series of fundamental changes:

- The scope of the CMI's work extended from life insurer data to also include mortality data for large self-administered pension schemes (SAPS) provided by actuarial consultancies, overseen by the SAPS Committee.
- The CMI began to attract funding from reinsurers and then from consultancies, once the SAPS investigation formally became part of the CMI.
- CMI Reports were complemented, then replaced, by CMI working papers.
- There was a much greater focus on mortality projections, in part driven by a lower interest rate environment, leading to the creation of the Mortality Projections Committee.
- There was a fundamental review of the CMI's structure and governance, most significantly replacing the reliance on voluntary financial contributions with subscriptions that firms had to pay to be able to access most of the CMI's work.
- There was a realignment of two of the investigation committees in 2013, when the Life Office Mortality Committee and the Critical Illness Committee were reconfigured to the Annuities Committee and the Assurances Committee respectively. The revised structure was better aligned to the internal structure of most life insurers and to the interests of volunteers[69].
- The COVID-19 coronavirus pandemic had a substantial impact on mortality rates in 2020 and continued to have an effect in the subsequent years. The CMI's reaction to this is covered:
  - In Section C8, in relation to the COVID-19 working party itself;
  - In the preceding sections, in relation to the actions of each of the investigation committees; and
  - In Appendix 10, 'Chairing the CMI during the pandemic', which captures the recollections of Matthew Edwards, the Chair of the Executive Committee at the time.

There were also a number of changes in terminology during the period:

- First, the CMI dropped the 'Bureau' from its name in 2004. This was first discussed by the Executive Committee in July 2000, with the minutes noting that, in recent media coverage, "…having to explain the name often deflected attention away from the message." The initial suggestion of 'The Actuarial Investigations Bureau' was not followed through; in part, I recall, because of potential confusion with the Allied Irish Bank, which already used the acronym 'AIB'. The change of name appears to have been made with little fanfare – the minutes of the Executive Committee in June 2004 record that "It was agreed that as CMI were initials and a name that were known and understood by many people they should be retained but the 'B' should be dropped whenever possible."
- The Executive Committee decided in 2004 that 'sub-' would be removed from the names of all of the sub-committees; I have used 'Committee' throughout this part of the book.
- 'Chairman' was shortened to the gender-neutral 'Chair' for all CMI committees in 2017. Similarly, I have used 'Chair' throughout this part of the book.
- The Mortality Committee became the Life Office Mortality Committee to avoid confusion with the SAPS Mortality Committee when the latter formally became part of the CMI in 2006.
- The Permanent Health Insurance Committee became the Income Protection Committee, in line with market terminology, in 2003.

[69] During my membership of the Mortality Committee, it had been noticeable that I was the only committee member more interested in term assurances than annuities. This was reflected in committee members' choices when the committees were realigned; only one opted to join the Assurances Committee, the others became members of the Annuities Committee.

This part describes work on the various investigations:

- Life office mortality / Annuities in Section C2,
- Impaired Lives[70] (Section C3),
- Permanent Health Insurance / Income Protection (Section C4),
- Critical Illness / Assurances (Section C5),
- SAPS mortality (Section C6) and
- Mortality projections (Section C7).

Section C8 sets out an overview of three working parties that were established during this period, covering Graduation and Modelling, High Age Mortality and COVID-19.

Finally, Section C9 covers a number of miscellaneous topics. As the CMI's remit had expanded, there was more activity that spanned the various committees; consequently, Section C9 is considerably longer than the corresponding section of Part B. Topics covered include:

- A description of the review of CMI and the resulting changes in structure and operations, from 2013.
- A description of working papers[71], which provide much of the content for this part of the book, and other forms of output that the CMI has adopted more recently.
- The evolution in the CMI's handling of personal data, that arose from the move to collect individual records;
- A discussion of the terms 'Adoption' and 'Standard tables'; and
- The changing nature of the CMI's relationships with universities and with the Republic of Ireland.

[70] As noted in Section B3, this came under the auspices of the Mortality Committee from 1999 but I have addressed it as a separate topic.
[71] Throughout this book, references to a specific working paper are abbreviated to 'WP *x*'.

C2. (Life office) Mortality / Annuities

A recap

In 1999, the Mortality Committee was responsible for four areas:

- The analysis of base mortality under annuity and pension contracts issued by life insurers, as described below;
- The analysis of base mortality under permanent and temporary assurances, which is described in this section up to the point when it was moved to the remit of the Assurances Committee in 2013 (thereafter, it is covered in Section C5);
- The analysis of the mortality of impaired lives, which I describe in Section C3; and
- Mortality projections, described in Section C7.

At the start of this period, the Committee had recently produced new tables – the "92" Series – based on data for the years 1991-1994, as described in Section B2.

Business as usual, 2000-2004

The Mortality Committee's first output in this period was an analysis of the mortality of various categories of insured lives in 1995-1998, published in CMIR 19 in 2000. The format was similar to that of CMIR 16, covering experience in 1991-1994; i.e. it considered separately:

- Permanent assurances[72] for each gender and sub-divided between:
  - Non-linked assurances on single lives, based on standard medical evidence;
  - Unit-linked assurances on single lives, based on standard medical evidence;
  - Joint life first death assurances, based on standard medical evidence;
  - Assurances on single lives based on minimum medical evidence;
  - Assurances on joint lives based on minimum medical evidence; and
  - Guaranteed acceptance assurances on single lives.
- Temporary assurances for each gender and sub-divided between 'traditional' policies and those associated with a personal pension.
- Immediate (i.e. non-pension) annuitants.
- Holders of retirement annuity contracts written under Chapter III of Part XIV of the ICTA 1988 and holders of personal pension policies issued under Chapter IV of Part XIV of the same Act both in deferment and in payment – for each gender.
- Insured pensioners, for each gender.
- Smokers and non-smokers for each gender but for permanent and temporary assurances, combined.

Comparisons were shown against both the "80" Series and the "92" Series tables, to allow comparison with past and future reports, in which it was expected to only use the latter. In many cases, the results were a continuation of trends seen in earlier reports, for example a decline in the exposure and lower mortality experience for male permanent assurances.

As was the case for CMIR 13, the section on permanent assurances in this report included an indication of trends over a longer period; the results of this are shown below.

CMIR 19 also included two papers following up on aspects of the "92" Series tables:

- Combined pensioners (i.e. both 'early' and 'normal' retirements), following those for the "80" Series tables in CMIR 13.

[72] For policies subject to underwriting, both permanent and temporary assurances considered cases accepted at standard rates only (i.e. rated lives were not included).

- Extension to young ages (from age 17 to age 0) of the assured lives tables, for both permanent and temporary assurances.

CMIR 20 (issued in 2001) included three mortality-related papers[73], two of which followed up on earlier analyses in CMIR 13:

- Mortality in 1987-1990 and 1991-1994 according to cause of death. This analysis again considered a subset of the whole life and endowment dataset; the report notes that this would be the last such analysis, due to the decline in the number of offices contributing data, the difficulty offices were experiencing in matching their cause of death returns to their main returns and the cost, both for the CMI and for the offices.
- Inter-office comparisons. This was the fourth such analysis of the variation in experience between offices; in each case, these followed the publication of a set of standard tables. The key finding was that "…there was, and still is, a very wide variation between the mortality experiences of the contributing offices."

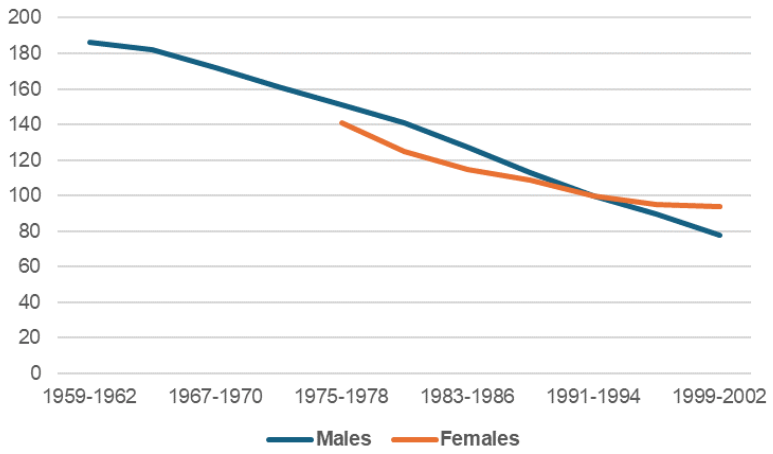
The third paper was entitled 'Mini-graduations of the mortality experience of smokers and non-smokers for assured lives'. These were, effectively, adjustments to the "92" Series rates for various subsets of the smoker and non-smoker datasets. They were termed "mini" graduations because "…no work has been done to make sure that the resulting graduations are consistent across durations, that male rates exceed the equivalent female rates or that the ends of the tables behave in a reasonable way." Consequently, it continued (in bold font!): "…the results in this report should not be relied on, without further investigation and evidence, to calculate separate mortality rates for smokers and non-smokers by an office."

CMIR 21, published in 2004, analysed experience in 1999-2002 for the same categories of policies as in CMIR 19, above. Comparisons were shown against only the "92" Series tables. Experience had diverged from the previous tables and the introduction to the report notes that: "Work is also in progress on constructing a new set of standard mortality tables to be based on the 1999-2002 experience and a new methodology for projecting future mortality."

As for CMIR 13 and CMIR 16, the section on permanent assurances in this report included an indication of trends over a longer period, for males starting with the 1959-1962 quadrennium whilst for females, the first results were for 1975-1978. The high-level results are shown below; this illustrates:

- There is a significant reduction in mortality throughout for both genders;
- For males, there is a more rapid fall in more recent years, from 1983-1986; and
- There is a lower reduction for females, indicating some convergence in rates between the two genders.

Permanent assurances experience relative to AM92 / AF92 (durations 2+, all-ages):



[73] In addition to papers on impaired lives, PHI and SAPS, covered in the relevant sections below.

The road to the "00" Series tables

Work on the proposed new tables, based on the 1999-2002 data, was undertaken by two working parties that reported into the Mortality Committee:

- The Mortality Graduations Working Party, and
- The Mortality Projections Working Party.

Both were chaired by Angus Macdonald, the Committee Chair, to ensure their work was aligned.

Progress to new base mortality tables is described in a series of working papers:

- WP 8, published in August 2004, contained the initial findings of the Mortality Graduations Working Party and proposals on which tables would be graduated. A draft version of this paper was published in May, for discussion at a seminar held at Staple Inn on 4 June 2004.[74]
- WP 12, published in April 2005, summarised the feedback on WP 8, and the Working Party's response, and contained proposed graduations for the assured lives tables.
- WP 16, published in September 2005, contained proposed graduations for the annuitant and pensioner tables.
- WP 21, published in July 2006, contained the final assured lives tables.
- WP 22, published in July 2006, contained the final annuitant and pensioner tables.
- WP 26, published in April 2007, contained extensions to younger ages of the 'early' and combined ('early' and 'normal') pensioner tables,

The tables, named the "00" Series, were then fully documented in CMIR 23, issued in 2009. Given the extensive detail in the preceding working papers, CMIR 23 contained little or no new information and, as described in Section C9, this proved to be the last CMI Report issued by the CMI.

All of these papers relate to base mortality only. The extensive work undertaken by the Mortality Projections Working Party, described in Section C7, did not produce a recommended set of projections.

The graduation methodology used for the ultimate rates was that developed by Forfar, McCutcheon and Wilkie that had been used previously for the "80" and "92" Series tables. The select rates for the assurances tables were derived from the graduated ultimate rates because, as noted in WP 12, "Scanty data at early durations … meant that separate graduations of data at individual select durations was impossible."

The significant developments in these tables, compared with their predecessor "92" Series tables, were the production for the first time of tables for:

- Smokers and non-smokers (as well as combined) for both permanent and temporary assurances.
- Personal Pensions, for deferred, vested and combined.

Another change from previous tables was that the CMI did not issue the tables in a separate volume. As noted in CMIR 23 "This is due to the lack of demand experienced for the "92" Series volume and increased preference from practitioners for obtaining such information electronically. The CMI Tables Program (STP) has been updated to include all of the "00" Series tables ... In addition, all mortality tables published by the CMI are available in spreadsheet form on the CMI section of the Actuarial Profession's website[75]."

[74] WP 3, produced by the Mortality Projections Working Party, was also discussed at the seminar; this is considered in Section C7.
[75] These can be found at: https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-mortality-and-morbidity-tables.

The ‘Per policy’ data initiative

With the benefit of hindsight, this initiative – although well-intentioned – was not implemented well, with a lack of flexibility in the approach, and it significantly damaged the progress of the Life Office Mortality Committee (as it was known from July 2006). Many of the aims of the ‘Per policy’ initiative were only realised some years later with a more pragmatic approach, described later under ‘The ‘2007-2011 data collection exercise’’.

The primary intention of the initiative was to improve the ‘richness’ of the data and the quality of the analysis by collecting individual records – one for each life under each benefit under each policy – instead of ‘scheduled data’, which was essentially unchanged from the days when it was submitted in paper form (as illustrated by the data submission form in Appendix 5).

Initial proposals were set out in WP 13, issued in April 2005. Key changes from the previous data requirements included:

- Data was required for each policy going out of force in a year, not just for deaths, as well as the cause of exit. The intention was that this would allow validation of the end-year in-force with that at the previous 31 December[76].
- Fields such as date of birth and commencement were included, enabling more accurate calculation of age and duration.
- Data was sought for all lives, both rated and non-rated, together with an impairment code for the former; enabling analysis of the experience of rated lives, both in aggregate and by type of impairment.
- Various fields were included to allow the Secretariat to determine the type of policy, instead of the office assigning data to a pre-specified ‘investigation’[77]. In particular, these fields included the ABI New Business Code[78].
- Various fields were included related to the benefit amount; specifically, the amounts at the beginning and end of year, the date of amount review and the rate of increment; the intention was that this would allow validation of the start- and end-year benefit amounts.
- Some fields would allow the CMI to expand its range of analysis – for example, the distribution channel and the first part of the postcode[79] (enabling analysis by location).

The following points also warrant noting:

- The CMI aimed to start collecting ‘Per policy’ data for 2004 (in late 2005) but would continue to accept scheduled data for the rest of the 2003-2006 quadrennium. It was intended that only ‘Per policy’ data would be accepted from 2007.
- The CMI expected a significant increase in the volume of data submitted by offices and asked them to identify the business previously included in their scheduled submissions, to allow the CMI to assess the impact of data changes on mortality experience.
- As well as adding the paper to the website, WP 13 was sent to key contacts at data contributors, with a request for feedback. It was also sent to reinsurers, with the covering letter noting “Direct writing offices will also be supplying data in various formats and standards to their reinsurers. Therefore, the CMI is consulting both direct writing and reinsurance offices

[76] Both type of exit and date of exit were included in the Coding Guide, which would have enabled the CMI to undertake analysis of lapses and other exits, but WP 19 notes: “This was not one of the intentions behind Working Paper 13, although it could be possible given the new Coding Guide.”
[77] The term ‘investigation’ refers to the various categories of lives which the CMI analysed, as detailed in Appendix 2 of the ’HISTORY AND DEVELOPMENT’ section of CMIR 1, reproduced in Section A2.
[78] As noted in WP 19, “Whilst these codes were developed by the ABI [the Association of British Insurers] for new business reporting, they have also now been ‘adopted’ by the FSA for statutory reporting (see PS05/02).”
[79] Postcode was also sought for other CMI investigations, so is discussed further under ‘Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles’ in Section C9.

> as to whether a single data standard could be used for both purposes. If this could be done, there would be significant benefits for everybody."

An updated coding guide was then issued in December 2005 alongside WP 19, which:

- Summarises the responses received to WP 13;
- Explains the changes made as a result of the consultation exercise; and
- Sets out a number of areas for further consideration.

One key change arising from the consultation was a proposal, from the Critical Illness Committee, that critical illness business should be incorporated, as "…most – but not all – of their data requirements were met by the Guide…"

There were also suggestions for a number of data fields to be added to the coding guide. As a result, the following fields were added: client identifier[80], type of entry, initial benefit amount, type of increment/decrement and previous investigation number.

Further changes to the coding guide were made between 2006 and 2009[81] prior to a new version being issued – initially for consultation – in WP 40, in August 2009. The key change here was the removal of impairment codes, marking the end of the impaired lives investigation (see Section C3). Another area of the coding guide discussed in WP 40 is the treatment of exits, where it notes:

> "Analysis of the Per Policy data that the CMI has received to date has raised a number of issues regarding the treatment of exits, including claims. In some cases these issues reflect a lack of clarity or consistency in earlier versions of the Coding Guide."

As noted above, WP 40 was released in August 2009, after the committee had originally hoped to have migrated to 'Per policy' data. Results for 2003-2006 were issued in WP 42, in December 2009, but these were based on scheduled data.

Three further working papers were issued relating to the analysis of 'Per policy' data:

- WP 45: 'Consultation on the proposed methodology for the analysis of CMI 'per-policy' mortality data' issued in April 2010;
- WP 56: 'CMI life office mortality 'per policy' results: the initial methodology and format'; and
- WP 57: 'CMI life office mortality 'per policy' results: consultation on the future format of results' (both issued in September 2011).

In fact, the volumes of useable data in the newer format received by this time were limited. This was partly due to the CMI failing to persuade offices to submit data but also, when data was received, the Secretariat applied an extensive range of tests, seeking to ensure the data was of a high quality, resulting in lengthy error reports being returned to many offices. The situation was summarised in WP 70 (see below) as follows:

> "The CMI recognised that the full 'Per Policy' data requirements may have been beyond the current capabilities of some insurers and was also highly conscious of the limited resources that offices had available for CMI data submission, given Solvency II and other developments."

Although no results were issued using 'Per policy' data, as it was originally envisaged, the methodology and results format set out in WP 56 and WP 57 were adopted, to the extent they could be applied.

[80] This would enable analysis of 'lives' (within an office), instead of 'policies'.
[81] In particular, the full postcode was requested from version 1.1; this is discussed further under 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9.

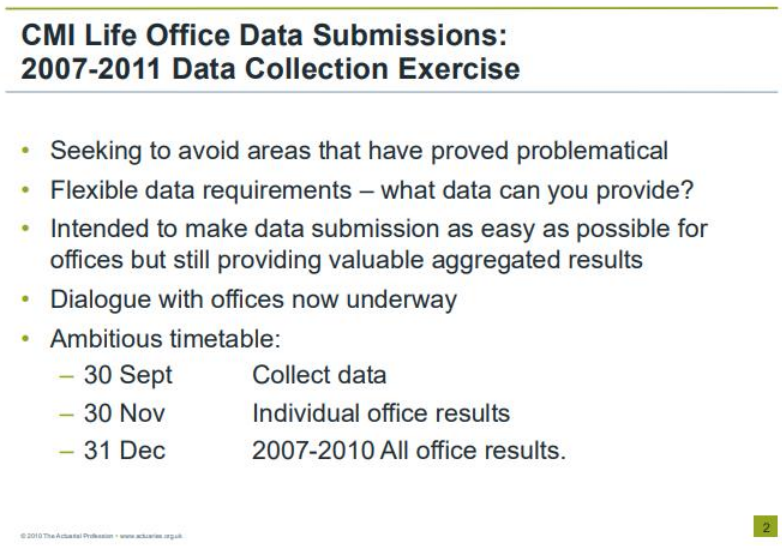
The '2007-2011 data collection exercise'

By early 2012, there was significant concern within the CMI at the lack of life office mortality and critical illness results, as a result of the issues with the 'Per policy' data initiative, noted above. The minutes of the March Executive Committee meeting record that:

> "Kevin Armstrong[82] reported that data collection was significantly behind, mainly due to the slow progress in relation to the transition to Per Policy data. With this in mind, both the Life Office Mortality and Critical Illness Committees concluded that it was necessary and timely to change the approach and to try to re-engage with offices to collect substantive volumes of data to produce up-to-date results. The longer term aim of transferring to full Per Policy data would continue to be progressed.
>
> The approach to be followed is to allow some requirements for Per Policy data to be relaxed and for more tolerance to be given for inconsistencies in the data provided. Communications with offices will also be less remote and formal and more understanding of the issues offices were facing in providing data in the Per Policy format.
>
> The Committee welcomed this initiative, noting the risk of the CMI losing credibility if it was not progressed."

The exercise was named the '2007-2011 data collection exercise' because the aim was to collect data for five years in order to produce results for the four years, 2007-2010, recognising that information on deaths/claims in 2011 would be incomplete.

I had given several well-received presentations at CILA (Current Issues in Life Assurance), the IFoA's premier event for senior actuaries in life insurers, in recent years and was able to persuade the organisers to squeeze in a short slot at the event in May 2012 at short notice. I was granted ten minutes, which I subsequently described as my 'Bob Geldof moment', channelling the singer's plea for cash at Live Aid into the CMI's plea for data! The aims of the exercise are summarised in the following slide from my presentation:



We followed up my plea directly with offices, with each office allocated to a member of the Life Office Mortality or Critical Illness committee, or the Secretariat, as appropriate, to make the initial contact. In essence, we asked them to submit whatever data they could easily provide and the Secretariat were tasked with making best use of the data.

The outcome was a substantial influx of data, in far higher volumes than prior to the launch of the 'Per policy' initiative. Indeed, the volumes of data made untenable the "ambitious timetable", noted on the slide. It also led to a need to prioritise annuities or assurances data as, until that time, the Secretariat

[82] The then Chair of the Life Office Mortality Committee.

had been dealing with each office's data in order of receipt, meaning that neither dataset was yet complete. As the annuities dataset was further progressed, this was prioritised[83].

Annuitant mortality experience in 2007-2010 and the "08" Series tables

The focus on annuities data collected though the '2007-2011 data collection exercise' resulted in the release of WP70, alongside results for 2007-2010, in October 2013.

As described in WP70:

> "The methodology used for these results is largely unchanged from that set out in Appendix 1 of Working Paper 56 (where it is fully described), which can be summarised as:
>
> > Comparing **actual incidences of death** with expected deaths, calculated using **forces of mortality** applied to the **central** exposure, derived on a **day-count** basis.
>
> The area in which it was not feasible to fully apply the methodology is in relation to the amounts results. Accurate tracking of changing benefit amounts was an especially problematic area within full 'Per Policy' data for many offices; hence the benefit amounts used in these results are necessarily an approximation."

The results were also broadly as envisaged in WP 56; of particular note is that the results were issued in spreadsheets alongside the working paper, for both the quadrennium and the individual years. They were issued at two levels – summary results and detailed results. As described on the website: "The summary spreadsheets provide a high-level overview of the results but do not allow a user to choose an alternative base table or alternative categorisation of the results. Users wishing to see more granular results and data should refer to the detailed spreadsheets." Consequently, the results were much more accessible to actuaries and this has become the established practice subsequently, for both annuities and assurances.

Two changes to the results from that envisaged in WP 56 were "…that it has not been feasible to drill down between types of business as deeply as described in Working Paper 56; in particular, only a minority of offices were able to provide data split between:

1. Life office pensioners (in insured group pension schemes), Retirement annuities and Personal pensions; and
2. Early and normal/late retirements for post-vesting pensions."

WP 70 describes the first of these points as "…a considerable disappointment as it potentially introduces a significant degree of heterogeneity into the results since there are significant differences between the "00" Series tables based on these different types of annuities."

WP 70 also notes a lack of comparability with preceding results:

> "There has been a significant change in the mix of offices contributing data compared with previous quadrennia. Even where the same office has contributed data in more than one quadrennium there is no guarantee that the office has provided consistent datasets; indeed, there are some offices that have significantly increased the amount of data submitted for the current quadrennium compared with the previous one.
>
> The Committee considers that the changes are such that it would not be appropriate to assume that there is any consistency in the data for the current quadrennium compared with previous quadrennia."

Other noteworthy points from WP 70 include:

- The limited detail regarding the types of business within the data submitted by some offices meant "…there is no natural comparison table for the experience of the pensions data." This was mitigated, to a degree, by the fact that actuaries could use different comparison bases, if they wished.

[83] The assurances results, issued later, are considered in Section D5.

- No allowance was made for late-reported deaths, but all deaths in 2007-2010 and reported by the end of 2011 (or later, in some cases) should have been included in offices' data submissions and included within the results. In contrast, under the scheduled data investigations, offices were asked to only include deaths reported by 30 June of the year following the investigation year and any subsequent deaths were never reported to the CMI.
- The detailed checks that were envisaged for 'Per policy' data were not applied to the data but the Secretariat did carry out (at least) high-level data checks for all submissions and:
  - It sent a summary of the assumptions made to resolve issues to each office and asked them to confirm that these were reasonable.
  - The paper includes a high-level overview of some of the common data issues encountered during processing and the assumptions that have been applied.

WP70 also points out that "It should be noted that the CMI was previously only able to conduct very rudimentary checks on the data submitted to the scheduled data investigations and for these submissions it would not have been possible to identify the data issues that have emerged in checking the 'Per Policy' and 2007-2011 data."

Specific areas where the results differ from planned that were noted in WP 70 include:

- Under 'Per policy' data, it was envisaged that enhanced annuities[84] should be identifiable. This was not the case here, but data known to relate to enhanced annuities was excluded and "…the Committee suggests that these results can be considered to relate to non-enhanced business".
- Little smoker-differentiated data was received, so smoker status was not retained in the results. This has also applied to subsequent annuities results.
- Instead of using the distribution channels specified in the 'Per policy' Coding Guide, which were more suitable for assurances, data was separated according to "…whether the annuity was purchased via an Open Market Option (OMO) or whether it was an "internal vesting" of a pensions saving contract with the same office." Again, this approach has been retained for future results.

The results issued alongside WP 70 were separated between pension annuities in payment, deferred pension annuities and life annuities. The paper made no attempt to compare these results with those from earlier quadrennia, based on scheduled data, consequently the results lacked some context although they clearly provided a basis for comparison with future analyses.

WP 70 proved to be the last output from the Life Office Mortality Committee, prior to its rebranding as the Annuities Committee (as noted in Section C1). Indeed the impending change was noted in WP 70.

The first output from the renamed committee was to issue proposed "08" Series annuities tables alongside WP 78 in March 2015. This was issued simultaneously with WP 77, as described under 'Graduation and Modelling Working Party (GMWP)' in Section C8.

The data underlying the proposed tables covers the years 2007 to 2010 and is similar to that underlying the results issued alongside WP 70. WP 78 notes that, as a result of the '2007-2011 data collection exercise', "The volume of Pension annuities in payment data available to graduate is materially higher than was used to graduate the "00" Series tables…" In contrast, "The volumes of Pension annuities in deferment data and Life annuities data are both lower than for the "00" Series tables; the former reflects the Committee's focus on in payment data which is of greater materiality and the latter is at least partly a function of a declining market."

As noted above, although the data collection exercise was successful in terms of data volumes, it resulted in less granularity in the dataset. WP 78 contains additional information on experience by

[84] As noted in WP 70 "In recent years, some offices have been offering "enhanced" (or impaired life) annuities to applicants with a reduced life expectancy." The Committee has subsequently reported on enhanced annuities as described later in this section, initially under 'The first analysis of enhanced annuities'.

duration, amount band, distribution channel and retirement type (for pension annuities) and on amounts compared with lives (for life annuities) but none of these were reflected in the "08" Series tables themselves, which comprise only eight tables:

- Pension annuities in payment, males and females; lives and amounts;
- Pension annuities in deferment; males and females; lives only; and
- Life annuities; males and females; lives only.

The graduations were heavily influenced by the work of the GMWP and all of the proposed tables used a simple Gompertz G(s) formula, with the work undertaken using the first version of the CMI's graduation software, issued alongside WP 77.

The proposed tables were issued with a deliberately short consultation period, given the paucity of recent tables – WP 78 was issued on 6 March 2015, with a closing date for responses of 10 April. The tables were then finalised alongside WP 81 in June 2015.

WP 81 notes that "Only a small number of formal responses were received but as these were supportive – and corroborated the feedback gathered at a Forum in London in November 2014 on the initial graduations – the Committee is comfortable that it has sufficient support to finalise the tables." It continued "Consequently, the final "08" Series tables … are unchanged from the proposed tables."

The first analysis of enhanced annuities

The Committee's next output was its first analysis of the mortality experience of enhanced annuities, based on data for 2007-2010, which was issued in WP 87 in December 2015. The approach to data was similar to the 2007-2011 data collection exercise, with flexibility in the requirements and a minimum number of mandatory fields. Data was received from nine insurers; given the concentration in this market, the dataset was believed to cover a substantial proportion of the UK market.

For this exercise, the Committee defined an enhanced annuity as:

> "A pension annuity whose annual payments have been increased as a result of an individual underwriting process based on medical history and/or lifestyle factors, such as smoking. It does not include annuities where the amount is varied according to the postcode of the annuitant(s) only."

The paper adds that "The Committee did not seek information on either the type of impairment or the level of enhancement applied."

The comparison tables used were the PML08 and PFL08 tables; i.e. lives-based tables, based on the experience of non-enhanced pension annuitants. Consequently, the overall actual/expected values significantly exceeded 100 and the paper notes "…there appears to be clear evidence of the A/E values reducing with increasing age."

WP 87 included results by duration but cautioned that "…the Committee is mindful that apparent effects by duration may in fact be masking commencement year effects, and that the growth in the market has, in part, arisen from less severe conditions gaining enhanced terms."

A focus on in-payment pension annuities

The next results for non-enhanced pension annuitants cover the years 2011-2014 and were issued alongside WP 101, in July 2017. This marked the start of a focus on in-payment pension annuities, with the Committee noting in the paper that: "We judged life annuities and deferred pension annuities to be of lower priority to users…"[85]

[85] The Committee has subsequently analysed life annuities, enhanced annuities and equity release mortgages; these are all covered later in this section. There has been no further analysis of deferred annuities to date.

The flexible approach to data had continued but with a focus on trying to better differentiate the data by product type. WP 101 notes the success of these efforts: "Compared with the dataset underlying "08" tables, the latest dataset:

- Is considerably larger; with over 60% more deaths.
- Allows analysis by product type. Most of the earlier data could not be accurately categorised by product and hence the "08" tables contain no such differentiation; in contrast nearly 80% of the latest dataset could be differentiated between Individual, Group and Pension buy-out[86].
- Also allows analysis of the Individual annuities by distribution channel, distinguishing between internal vesting and external annuities."

WP 112, released in November 2018, contained additional analyses of the 2011-2014 pension annuities dataset; specifically:

- Indicative graduations, including product-specific tables; and
- Multivariate analysis of a subset of the overall dataset using Generalised Linear Models (GLMs).

A significant proportion of the dataset included Acorn category[87] that WP 112 notes is "…an entirely new variable, in the context of our work." The decision to use Acorn (only) was entirely pragmatic, as described under 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9.

A key finding from the GLM analysis was "…the importance of multiple factors influencing mortality experience. In particular:

- socio-economic status – as measured by Acorn – appears to have a substantial impact; and
- "office" seems to have a material impact, even after allowing for other factors."

Following the release of WP 101 and WP 112, the CMI received resubmissions of 2011-2014 data from several insurers that resulted in both papers being reissued with a prominent 'health warning'. This means that further consideration of the results in these papers here is of limited value.

The data resubmissions are described in WP 117, which was released in January 2019 and accompanied 'all offices' results for pension annuities in payment in 2011-2016. It notes that, in some cases, the resubmissions of 2011-2014 data followed data cleansing exercises and the paper includes the following prominent message:

> "Processing the more recent data has reduced our confidence in the 2011-2014 data underlying Working Paper 101 and Working Paper 112 but has, we believe, resulted in improved data quality in the dataset that underlies the results in this paper."

The most interesting aspect of WP117 is the relative experience of the different types of pension annuity, as the Committee had been unable to identify product type with certainty for much of the 2007-2010 data that was used in the "08" tables. The paper notes that: "At a high level, experience is lower for Individual annuities than for Group business that, in turn, is lower than the experience of Pension buy-out business" and that "Within Individual annuities, the experience of external business is lower than that of internal vesting cases (i.e. where the annuity follows a pension saving contract with the same insurer)." On the latter, it notes that the different experience "…could reflect the different competitive forces when the annuities commenced, as the internal annuities may contain some annuities effected under Guaranteed Annuity Options whereas the external annuities may have faced greater competition from enhanced annuities."

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[86] Data for pension buy-ins was not sought at this time, due to a perceived overlap with the SAPS investigation (as the pension scheme continues for a buy-in). This stance changed in 2021, when data for pension buy-in business was also sought, as noted in relation to WP 172, below.

[87] As described in WP 112: "The Acorn user guide (2015) describes Acorn as "…a segmentation tool which categorises the UK's population into demographic types. Acorn segments households, postcodes and neighbourhoods into 6 categories, 18 groups and 62 types.""

WP 117 also considered experience by calendar year in an attempt to answer "…a key question, of how improvements of annuitants compare with those of the general population that is used in the CMI Model[88]…" The analysis used two approaches, using A/E values and changes in standardised mortality rates (SMRs); unfortunately, these produced different answers, so the outcome was inconclusive.

WP 117 covered a longer period, of six years (2011-2016), because the data resubmissions had undermined the earlier results for 2011-2014 (issued alongside WP 101). However the Committee then reverted to a 'norm' of considering experience in a quadrennium, 2015-2018, in WP 128. This was released in December 2019; just under twelve months after the end of the investigation period, which I believe marks a record for any CMI investigation using life insurer data. This should have improved the CMI's credibility with insurers, which may have been damaged by the delays resulting from the move to 'Per policy' data.

There were two principal factors that made such a prompt analysis possible:

- First, the Secretariat had established strong working relationships with the insurers who had submitted data for the preceding period. These represented a large proportion of the overall market and there was no delay whilst the Secretariat sought other, smaller datasets.
- Second, an explicit allowance for late-reported deaths was made. In contrast, when the 2011-2016 results were released, as noted in WP 128:
  - "[The Committee]… expected the vast majority of deaths incurred that correspond to the exposure in 2011-2016 to have been included…"; and
  - "We also chose not to issue results for 2017 alongside those for 2011-2016; this was in part due to uncertainty over whether offices experience would be well-developed."

  WP 128 adds "The key finding … is that the uplift, even for 2018, is small[89] and we believe we are warranted in issuing results for 2018, with an uplift for late reporting."

The 2015-2018 results were segregated by product type, as follows:

- Individual internal, where the annuity follows a pension saving contract with the same insurer.
- Individual external, where the annuity was purchased separately.
- Individual combined, including internal and external and also 'other individual', where the product type was known to be individual, but the purchase mechanism was unknown (although it was, presumably, either internal or external).
- Pension buy-out; i.e. pensioners insured following a buy-out from a self-administered pension scheme.
- Group; i.e. pensioners in insured group pension schemes.
- All, which uses all of the above data plus data where the product type is unknown.

For individual internal data (only), results were split between pensioner and widow(er), where known.

These product types have been used in subsequent analyses, with the addition of pension buy-in business, as noted in relation to WP 172, below.

The "16" Series pension annuities in payment mortality tables

WP 128 noted that the Committee's intention had been to produce tables based on the 2011-2016 dataset, but this approach was now being revised:

> "As well as being more up-to-date, the 2015-2018 dataset incorporates increased granularity by product type relative to the 2011-2016 dataset. As a result, we prioritised issuing these results ahead of further work on graduations and are now working to produce new tables using 2015-2018 data. We hope that this dataset will bear many similarities to the one we

[88] Discussed in Section C7.
[89] Specifically, the adjustments were zero for 2015 and 2016, +0.1% for 2017 and +0.6% for 2018.

were using (covering the years 2013 to 2016 only) and that much of our work to date will prove valuable and allow us to move swiftly towards issuing these tables in draft, for consultation."

The 2015-2018 results were, indeed, soon followed by the proposed new tables – the "16" Series pension annuities in payment mortality tables[90] – issued alongside WP 130 in May 2020.

As a result of the increased granularity by product type, the Committee proposed twenty tables – separate tables on both lives- and amounts-weighted bases for each gender for each type of annuity noted above, apart from group, as well as composite tables for all individual annuities and for all annuities.

In constructing the tables:

- The data was graduated, over the age range 60 to 95, using simple Gompertz G(s) formulae, again influenced by the work of the GMWP and using the CMI's graduation software.
- The extensions to higher ages used the method proposed by the High Age Mortality Working Party (see Section C8) to blend "…from annuitant data (up to age 90, for the lives tables, and age 85 for amounts) towards population experience; so reducing its reference to the annuitant data at the higher ages, because we believe there is under-reporting of annuitant deaths at these ages."
- The extensions to lower ages adapted the high age approach to also blend towards population experience. However, the Committee cautioned that: "The data at these ages is sparse and these rates do not represent a robust view of the mortality of the very youngest annuitants, where factors such as ill-health retirement may have significant impact. However, they are provided for completeness and we expect these rates would have very limited financial significance in any work where these tables are used."

The formal tables were accompanied by a number of indicative graduations (which were not performed with the same rigour as the formal tables) – for group business ("…for which the volumes of data are now relatively small…") and by pensioner type and duration.

The "16" Series pension annuity tables were finalised soon after, alongside WP 134, issued in July 2020. The tables were unchanged from those proposed in WP 130 and WP 134 contains a similar statement to that when the predecessor "08" tables were finalised, that "…[feedback was] generally supportive and the Committee is comfortable that it has sufficient support to finalise the tables."

Analysis of pension annuity data by IMD decile

A further paper analysing experience in 2015-2018 followed with the release of WP 138, in September 2020. This considered the subset of the overall dataset[91] that included Index of Multiple Deprivation (IMD) deciles and region, mapped using the 'CMI Postcode Mapping Tool'[92]. The CMI had begun collecting these fields for all of its investigations in 2018.

This was the first analysis of data collected by the CMI using IMD deciles[93] which, effectively, replaced Acorn category as the means of the Committee isolating socio-economic effects within the dataset.

It was also the first time that the CMI had issued a 'Tableau workbook', alongside the working paper. As noted in WP 138, this was intended "…to allow users to visualise aspects of the data more easily than by manipulating the underlying dataset." Recognising that some users would not have access to

[90] The fuller name is needed because the Assurances Committee also released "16" Series tables, for term assurances, as described under 'The "16" Series assurances tables' in Section C5.
[91] "…around half of the full 2015-2018 dataset…"
[92] The tool and the mapped fields are described under 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9.
[93] The Mortality Projections Committee had previously considered mortality by IMD decile based on population data from the ONS (this was first done in WP 103; see under 'Expanding the work of the committee, 2013-2019' in Section C7).

Tableau, the dataset underlying the Workbook was also made available, to enable users to undertake similar analyses using different tools.

High-level findings from the analysis were that: "For both males and females:

- The ASMRs[94] are well-ordered, for both the population data and the annuities data, with IMD 1 (most-deprived) having the highest ASMR and IMD 10 (least-deprived) the lowest.
- The annuitant experience is around 85% of the population in each of deciles 1 to 6 but the differential narrows to nearer 90% for deciles 8 and 9, then to 93% in decile 10."

The analysis by region showed that:

> "The ADSMRs[95] for England are below those of Wales, which are below Scotland. By region, there is some evidence of a "North / South divide" in annuitant experience, with the lowest experience in London and the highest in the North West (males) and the North East (females). For both nations and regions, though, the variations in experience are much smaller than differences between the highest and lowest IMD deciles."

WP 138 noted that the GLM analysis found that "IMD appears to be the most significant driver of mortality differentials…". It also found that ""Office" does not appear to have a significant effect in this analysis; this differs from our conclusion from the corresponding analysis of the 2011-2014 dataset, in Working Paper 112, which, with hindsight, was perhaps an overstatement."

Assessing the impact of COVID-19 on pension annuitants

Within a month of issuing WP 138, the Committee released its next output, WP 140, entitled 'Indicative analysis of pensioner annuitant mortality to 30 June 2020'. This broke the sequential nature of the Committee's analyses by preceding that of 2016-2019 data, which followed in WP 145 in December 2020, in order to provide an initial assessment of the impact of COVID-19 on UK annuitant mortality experience.

The analysis in WP 140 used information on deaths during 2019 and the first half of 2020, collected for this specific purpose, and the fact that insurers supplied such data was symbolic of the much stronger connections forged by the Secretariat, noted earlier, and the enthusiasm for a pooled analysis of the impact of COVID-19. There were two particular areas of estimation in the underlying calculations:

- Exposure was first extrapolated from year-end 2018, then interpolated to derive monthly estimates; and
- A significant adjustment was applied to the known deaths to allow for late reporting, particularly for the last few months.

These estimates enabled the Committee to release results much sooner than it could have done otherwise and, consequently, the paper carried a prominent warning:

> "The analysis is less rigorous than our usual analyses – both in terms of data validation and the estimation of exposure and deaths – but we hope it will provide valuable input to year-end basis setting."

The key findings included:

- "For 2020, the SMRs for the England & Wales data rise dramatically in April and remain elevated in May, but then reduce to a normal level in June."
- "The annuities data shows a very similar shape, relative to 2019, to the England & Wales data."

[94] Age Standardised Mortality Rates.
[95] Age and Deprivation Standardised Mortality Rates.

As noted above, the analysis of 2016-2019 data duly followed, in WP 145. Unsurprisingly, the paper yielded no striking findings, given the high degree of overlap with the 2015-2018 dataset that was used in WP 128 and underlies the "16" Series tables.

WP 148, issued in April 2021, described three analyses of the experience of pension annuitants:

- Seasonal mortality in 2015 to 2019;
- Mortality by socio-economic status based on IMD deciles in 2019 and 2020; and
- A comparison of mortality in 2020 with that in 2019 by IMD decile.

The paper carries a 'health warning' regarding the use of 2020 data, similar to that in WP 140, above.

The conclusion from the seasonal analysis was that:

> "… the overall experience for annuities is relatively consistent with that of England & Wales; the average ratio of the ASMRs in each year varies between 86.4% and 87.2%. Both datasets have a clear, similar seasonal pattern during the year, with higher mortality in the earlier and later months."

The analysis by IMD found that: "The ASMRs in 2019 are relatively consistent with those for 2015-2018; however, they are markedly higher across all IMD deciles in the first six months of 2020."

Given the impact of COVID-19 on experience it was no longer appropriate to consider four years combined and the next paper, WP 161, issued in March 2022, considered the full year of 2020 as well as indicative analysis of experience to mid-2021.

For 2020, the overall results were:

> "For males, 2020 experience is between 10% and 15% higher than the projected "16" Series tables[96] in the age range 60 to 90, but with a slight downward shape as age increases. For females, the shape is similar to males but experience is generally between 5% and 10% higher than the projected "16" Series tables."

The indicative analysis to mid-2021 was similar to that for 2020 in WP 140, and carried a similar 'health warning' regarding the additional assumptions that were needed. The key findings were that:

- "The SMRs rise dramatically in April 2020 but fall quickly, with a slightly higher than average figure in May and a return to normal levels from June. They remain broadly in line with 2019 SMRs until October, then start to increase again leading into a second peak in January 2021. After the second peak, SMRs again fall quickly and by June 2021 they are a little lower than 2019 levels."
- "The relative excess mortality for annuities at ages 65-95 in 2020 was a little lower than for England and Wales for males but for females it was higher. In 2021, it is lower than E&W for both males and females."

Experience of pension annuities in payment in 2021 was considered more fully in WP 172, issued in March 2023. The overall finding was that: "…experience for males remains higher than expected, potentially due to the continued impact of the COVID-19 pandemic while for females experience had returned to broadly to pre-pandemic levels."

There were two extensions to the scope of this paper, compared with its predecessors:

- First, data following a buy-in from a self-administered pension scheme was combined with buy-out data in this analysis (jointly referred to as 'Bulk Annuities'), reflecting the growth in this area of the market.
- Second, the experience of enhanced annuities was included in the annual update, rather than as a separate analysis "…although enhanced annuities are excluded from the "overall

[96] i.e. the "16" Series tables were adjusted for subsequent improvements in (population) mortality experience using the CMI Model.

experience" described above and similar figures elsewhere in the paper, due to considerable differences in the experience of enhanced and standard annuities."

An 'accelerated' analysis of mortality in 2022 followed in WP 178, in September 2023. This was similar to the indicative analysis to mid-2020 and mid-2021, in WP 140 and WP 161 respectively, but covered all of 2022. The key findings were that:

- "Although 2020 and 2021 saw sharp peaks in SMRs due to the COVID-19 pandemic for both population data and annuitants, there are no such extreme features in the data for 2022. Mortality in 2022 appears to be returning to close to 2019 levels, although it is still higher overall."
- "Mortality typically exhibits seasonal behaviour, with more deaths in the winter months. Compared with 2019, mortality in 2022 showed less evidence of seasonality and did not fall as much in the summer months as may have been seen prior to the pandemic."

Life annuities

Between issuing the proposed "16" Series tables, in WP 130, and finalising them, in WP 134, the Committee issued an analysis of the experience of life annuities, in 2013-2018, in WP 133 in June 2020. Considering the underlying data, WP 133 notes that:

- "The dataset is mature, with limited numbers of deaths below age 80" and
- "There have been significant changes in the mix of offices … so we chose to describe 2013-2018 experience in these results to allow us to report on the experience of a group of offices that provided data for all years."

The experience was compared with the LML08 and LFL08 tables, i.e. the "08" Series tables for life annuities based on 2007-2010 data, adjusted for subsequent improvements in (population) mortality experience using the latest available version of the CMI Model, CMI_2019. Again, the results included a small adjustment to the known deaths to make allowance for late-reported deaths.

WP 133 notes that: "The all-ages, all-durations experience of the 2013-2018 dataset is 12% lower than the projected "08" tables for males and 6% lower for females on a lives-weighted basis." However it cautions against drawing comparison with the earlier dataset due to the changes in the mix of offices.

With regard to future work on life annuities, WP 133 notes that: "…we will monitor the volumes of data received alongside the pension annuitant submissions and consider whether updated analyses are warranted. We do not propose graduating the life annuities data given the low data volumes overall and the limited age range with credible volumes." To date, no further analysis of life annuities has been undertaken.

Further analysis of enhanced annuities

As described earlier[97], the CMI's first analysis of the mortality experience of enhanced annuities, in 2007-2010, was issued in WP 87 in December 2015.

The next analysis covering experience in 2011-2019 was issued in WP 155 in October 2021. With regard to the dataset, the paper notes that

- "…it is a much smaller dataset than those for non-enhanced annuities…"; and
- "Although only five insurance companies submitted the data used in this paper, we believe that we have received data for a substantial proportion of the total market and we are especially grateful to Just Group, whose data forms a substantial proportion of this dataset."

The comparison tables used are the "16" Series tables and the high-level conclusions were that:

- "For both genders, the Actual/Expected (A/E) values reduce from figures substantially higher than 100% at the younger ages to figures closer to 100% at the older ages."

[97] See 'The first analysis of enhanced annuities', above.

- "Mortality experience appears to increase with increasing duration but this may be a function of "generational effects", not duration itself, as we are comparing experience on annuities purchased at different times."

The paper also considered experience by calendar year and found that the average improvements in the enhanced annuity dataset are similar to those for the population of England & Wales, for males. For females, it suggests "…that the fall in experience may have been a little greater than the improvements in the population…" but notes the lower data volumes and the uncertainty arising from the allowance for late reporting.

Similar to the recent analyses of non-enhanced annuities, WP 155 also assessed the impact of COVID-19, to 30 June 2020. The findings were broadly consistent with those for non-enhanced annuities noted earlier.

The Committee then issued a further report, in WP 165, in December 2022, based on the combined experience in 2015-2019 of enhanced and non-enhanced individual annuities. Specifically, the paper considered "…duration and commencement age as well as the impact of pensions freedoms[98]." The removal of compulsory annuitisation "…was expected to have a significant impact on the pensions annuities market" and the analysis found that: "…data volumes fell considerably in 2014 for both enhanced and standard annuities and commencements continued to be low from 2015 onwards. Fewer annuities commenced at younger ages (below age 65) post-freedoms but the vast majority of annuities continue to commence at age 65, particularly in the enhanced dataset."

As noted above, the experience of enhanced annuities in 2021 was included alongside that of non-enhanced annuities in WP 172, issued in March 2023. It is unclear whether this will now become the norm.

The first analysis of equity release mortgages (ERMs)

In October 2022, the Committee released WP 164 – an analysis of the mortality and long-term care experience of equity release mortgage holders in 2016-2019 and 2020.

The first, and obvious, observation is that equity release mortgages are not annuities! However, this was an area the CMI was keen to investigate and:

- The Annuities Committee was keen to 'own' the initiative, as many insurers invested in ERMs to match their annuity portfolios.
- This also meant that there was a close correlation between the insurance companies submitting data for the regular annuities analyses and the ERM analysis.
- Further, the use of an existing committee avoided the additional time and cost that might have arisen from establishing a separate working party.

As this was the first time that the CMI had collected data for ERMs, the paper included a definition of an equity release mortgage:

> "An equity release instrument, in which mortgage holders take out a loan secured against their property. The loan amount is repayable, with interest, when the property is sold due to either death of the mortgage holder(s) or their entry into long-term care. In addition, mortgage holders can volunteer to repay the outstanding loan amount before either death or long-term care entry occurs."

WP 164 continues: "As noted in the definition, there are three types of exits that trigger a redemption of the loan; deaths, entries into long-term care and voluntary early redemptions." The analysis considered "…mortality in isolation and mortality and long-term care combined, but not long-term care experience in isolation, due to low data volumes for this type of exit." It also notes that "Voluntary early

[98] WP 165 notes: "Pensions freedoms, announced on 19 March 2014, and implemented from 6 April 2015, removed the requirement for individuals to convert their pensions savings into an annuity."

redemptions are excluded from this analysis as we did not gain approval from all data contributors to analyse this experience, as it was considered to be commercially sensitive."

The analysis was also a first for the CMI in terms of the adjustments made to the data to reduce the dominance of an individual provider. As noted in the paper "The equity release mortgage market is dominated by a few large players. One of these providers made up a large proportion of the equity release mortgage dataset. In discussion with this contributor, it was agreed to:

- Only analyse data relating to mortgages commencing in 2005 or later for all providers, as the dominant provider made up an even higher proportion of loans commencing in earlier years.
- Apply an 80% weighting to the exposure and exits data for the dominant provider such that they remained the largest single data contributor but that their proportion of the overall dataset was reduced to a level acceptable to them."

It will be interesting to see whether a similar approach could, in future, allow the CMI to investigate other markets that have a (or a few) dominant providers.

In terms of methodology, the paper compares actual deaths (by age and gender) with those expected using mortality rates for the UK population and the "16" Series pension annuities tables, and actual deaths and long-term care exits combined with UK population mortality rates; i.e. there was no attempt to produce an 'expected' basis for long-term care experience.

Looking at mortality-only experience, the analysis found it to be "…lower than the projected UK population tables…" in 2016-2019 but "…slightly higher than the projected "16" Series tables…" (with evidence at convergence at older ages).

Although the experience in 2020 was higher than in 2016-2019, reflecting the impact of the COVID-19 pandemic, "…the increase is not as significant as was seen at population level or for pension annuities in payment." WP 164 suggested that: "This may be due to the large number of deaths in long-term care during the COVID-19 pandemic, which would not be included in the equity release mortgage exits."

The combined mortality and long-term care experience was found to be "…around 5% higher than mortality only experience for males and around 14% higher than the mortality only experience for females, indicating higher long-term care exit rates for females."

C3. The mortality of impaired lives[99]

As noted at the end of Section B3, the analysis of the mortality of impaired assured lives came under the auspices of the Mortality Committee from 1999.

CMIR 16, published in 1998, had noted the Committee's intention to report on a rolling 12-year period in future and this was maintained in three outputs, a CMI Report and two working papers:

- CMIR 20 (issued in 2001) considered mortality in 1987-1998;
- WP 10 (2004) covered 1991-2002; and
- WP 36 (2009) covered 1995-2006.

Each of these reports noted:

- A reduction in the number of offices submitting data since the previous report; and
- A reduced volume of new business reported by the offices that had provided data, in part reflecting reducing sales of the underlying products.

The extent of the decline in volumes is illustrated in WP 36, with the total exposure, for males and females combined, reducing from over 80,000 life-years in 1995 to around 20,000 in 2006.

Many of the results corroborated earlier findings; but CMIR 20 reported on analysis by duration that, contrary to earlier analyses, "…indicate that the additional risk for male impaired lives is more evenly spread for hypertension and late onset diabetes while there is some front loading of additional risk for early onset diabetes."

The decline in data volumes meant there was no longer sufficient data to support any analysis by duration in the two subsequent periods.

The data requirements for impaired lives were incorporated into the 'Per policy' coding guide (see 'The 'Per policy' data initiative' in Section C2) but WP 36 reported that "…the CMI has now decided to cease collecting data in its current form for years after 2006…" and the paper contained a consultation on possible approaches to the future of the impaired lives investigation.

The detailed results of the consultation were not released but the outcome was summarised in WP 40, issued in August 2009:

> "Responses to the consultation from data contributors have indicated that the CMI is unlikely to be able to collect detailed data on impaired lives from life offices in the short term, beyond an indicator of whether or not a life is subject to special terms. Consequently the impairment codes that were previously contained in Appendix B have been removed in version 1.6 of the Coding Guide."

It continued:

> "Notwithstanding this change, the CMI believes that the information yielded by an impaired lives investigation has strategic importance to the insurance industry, in demonstrating the need to underwrite, to charge additional premiums for impaired lives and also to help better understand trends in non-impaired mortality and hopes that it will be feasible to re-launch a revamped investigation in the future."

To date, this has not transpired but I understand that the Assurances Committee hopes to increase its coverage of rating levels for each life under term assurances, enabling it to assess the suitability to rated lives experience of standard lives mortality and morbidity tables produced by the Committee.

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[99] For the avoidance of doubt, the CMI's work on impaired lives up to this time, relates to insurance products (endowment, whole of life and term assurances), where an individual is charged a higher premium if they are considered to be an impaired life. The CMI's subsequent work on impaired lives has related to enhanced annuities, where an impaired life receives enhanced terms (as described under 'The first analysis of enhanced annuities' and 'Further analysis of enhanced annuities' in Section C2).

C4. Permanent Health Insurance (PHI) / Income Protection (IP)

PHI experience in 1991 to 1994

The first output from the PHI Committee of the new millennium was CMIR 18, published in 2000. This was another PHI-only edition, comprising four papers:

- Sickness experience in 1991-1994 for individual PHI policies;
- Sickness termination experience in 1991-1994 for group PHI policies; and
- Two research papers written by Athol Korabinski and Professor Howard Waters of Heriot-Watt University.

The report acknowledged the time-lag from the end of the data period, commenting: "The PHI Sub-Committee is acutely aware that it is unsatisfactory to publish quadrennium results at such a late stage after the end of the quadrennium to which the results relate. The difficulties related largely to system issues at contributing offices affecting a substantial section of the data." In view of this delay, the Committee produced an article[100] ahead of releasing CMIR 18 that reported on the 1991-1994 experience collected to date. However, the article included a health warning that the data was both incomplete and likely to contain errors!

CMIR 18 noted two significant developments in the individual business dataset:

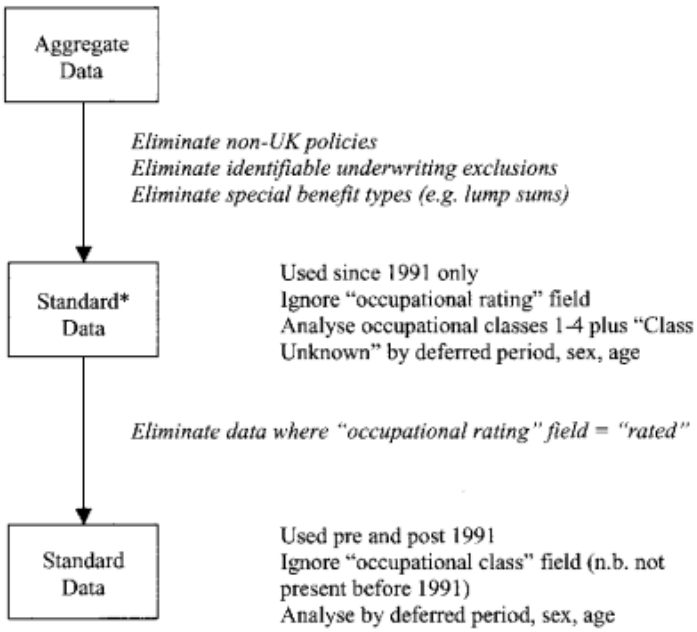
- From 1991, the CMI began collecting occupational class. Offices submitted this field using their own categorisation which was then translated into one of the four 'CMI occupational classes' by the Secretariat:
  - Class 1 Professional, managerial, etc;
  - Class 2 Master craftsmen and tradesmen, etc;
  - Class 3 Skilled operatives engaged in in non-hazardous occupations; and
  - Class 4 Skilled and semi-skilled operatives engaged in heavy manual work or subject to special hazard.

  Inevitably, the coverage by occupational class in the dataset for 1991-1994 was incomplete, but some results were included in the paper.
- Analysis of the data by occupational class revealed that offices may have interpreted 'occupational rating' differently when coding previous data submissions. It was apparent that some offices excluded all non-Class 1 cases whilst others had applied a different definition; overall, though, as noted in CMIR 18, it appeared "…that the great majority of the Standard data, probably over 95%, is class 1". To bring greater clarity of definition, much of the analysis in CMIR 18 (and subsequent work) used a new categorisation of data, named 'Standard*', which ignored the occupational rating and consequently included data that would previously have been excluded on grounds of occupational rating. This meant that the Standard* dataset was a much larger proportion of the overall dataset than the previous Standard dataset. The relationships between the various datasets were helpfully illustrated in a schematic in Figure 1 of CMIR 20, reproduced below.

The results for both individual and group business were based on the model from CMIR 12 and used the approach set out in CMIR 15[101]. In particular, the expected inception, recovery and mortality rates were derived from the CMIR 12 model parameterised using males, individual policies Standard experience for 1975-1978.

[100] 'Individual PHI experience 1991-94' by Peter McGurk, Secretary of the PHI Sub-Committee, *The Actuary*, November 1996.
[101] These are both summarised in Section B4, under 'A CMI statistical model for PHI' and 'Further reports on experience', respectively.

Definitions of Aggregate, Standard* and Standard data:



Among the key findings for individual business were:

- "Overall recovery rates have continued to decline for both males and females, continuing the trend observed over the previous two quadrennia."
- "There is a strong tendency for inception rates to increase with occupational class, i.e. increasing from Class 1 (professional) to Class 4 (heavy manual). There appears to be little evidence of any similar link between occupational class and termination rates."

A key aspect of the report on group business was that "Volumes of both individually costed (where in force data is collected) and occupationally coded data were small for the quadrennium and it was decided that no meaningful publication of inception rates or analysis by occupational class could be made." Furthermore, the report noted that "The shrinking volume of data for individually costed business has been noted in previous reports and a decision to cease collection of in force data for this business with effect from the 1999 investigation year has already been announced…" This meant that the analysis in CMIR 18 and future reports was limited to analysis of terminations[102]. Consequently, the group PHI claim inceptions results published in CMIR 16 (for 1987-1990) proved to be the last set of such results.

A notable finding of the analysis was that the trend in recovery rates was markedly different to that for Individual business, with male recovery rates very similar to the previous quadrennium, whilst female recovery rates had actually increased.

The two research papers in CMIR 18 used data supplied by the CMI for individual PHI policies in the period 1987 to 1994, and consider claim inceptions and claim terminations, respectively[103]. The papers use different methods to analyse and model the data: a generalised linear model and credibility theory; the first time that I think either approach had been applied to CMI data. The papers focus on the difference in experience between the individual companies that contribute to the combined experience as well as the effect of deferred period, sex and investigation year. CMIR 18

[102] The Executive Committee minutes of July 1998 note the restriction to scope: "For the Group investigation the Sub-Committee would now collect claims data without matching "in-force" data which reduced the processing burden placed on offices. This would restrict future analyses to those of claims terminations only."
[103] These are two of a number of papers produced by researchers at Heriot-Watt using CMI data, listed in Appendix 8.

notes that "…great care was taken by both the Bureau and the authors to protect the confidentiality of contributors and all the offices whose data were used were given the opportunity to withhold their data from the study, although none chose to do this."

There were a number of interesting findings – for example, that there were no significant differences in recovery rates between males and females (in contrast to the conclusions of previous analysis) – but no claim that the models had any predictive ability.

IP experience in 1995 to 1998

Sickness experience in 1995-1998, for both individual and group business, was considered in CMIR 20. This was published in 2001, considerably sooner after the end of the investigation period than the preceding report!

Curiously, the report refers to "Income Protection" throughout, even though the committee is still referred to as the "PHI Sub-Committee".

The analyses were again based on the model from CMIR 12, parameterised using males, individual policies Standard experience for 1975-1978, and used the methods from CMIR 15. Volumes of data had increased for both individual and group business, due to new contributors joining or re-joining the investigation. In addition, the volumes of data that included occupational class had increased, enabling analysis of group business by occupational class for the first time.

Key points for individual business included:

- The male inception experience was generally lighter than in 1991-1994 for the shorter deferred periods, but heavier for the longer deferred periods.
- Recovery rates had generally reduced since the last quadrennium.
- The findings in respect of occupational class differentials were similar to those for 1991-1994, based on a much larger dataset but still showing a strong trend for inception rates to increase from Class 1 to Class 4 and little evidence of a pattern for recovery rates.

Key points for group business included:

- Male and female recovery rates for the Standard experience in 1995-1998 were at similar levels to 1991-1994, but were considerably lower than in 1987-1990 for both genders.
- There was no discernible pattern for recovery rates to vary by occupational class, for males or females.

CMIR 20 also included an analysis of the Standard experience for individual business over three quadrennia, 1987-1990, 1991-1994 and 1995-1998, using data for the subset of offices who contributed throughout that period. This showed:

- Trends for lower male inceptions for the shorter deferred periods (1 week, 4 weeks and 13 weeks), but higher for the longer deferred periods (26 and 52 weeks).
- A strong trend for lower male recovery rates for all deferred periods except 1 week.

The "IPM 1991-98"graduations; Part 1

The Committee next issued three working papers simultaneously – numbers 5, 6 and 7 – in 2004. These presented graduations of individual IP business termination experience for males in occupation class 1 for 1991-1998. There was then a significant delay until the graduations of inceptions were completed in July 2010 (these are considered later, under 'The "IPM 1991-98"graduations; Part 2').

This batch of three papers comprised:

- WP 5: 'The Graduation of Claim Recovery and Mortality Intensities for the Individual IP experience for 1991-98 of Males, Occupation Class 1.';
- WP 6: 'Date-Related Features of Individual Income Protection Claims 1975-1998.'; and

- WP 7: 'The Claim Termination Experience of Income Protection Business, 1991-98, for Other Male Occupations, Females and Group.'

The main paper, WP 5, notes that the recovery intensities showed many similarities to those inherent in the 1975-1978 experience, graduated in CMIR 12 (1991), with regard to the trends of intensities by sickness duration and by age at sickness inception. However, it revealed significant differences in the overall level of recovery intensities between different deferred periods and in the trend by sickness duration up to around 16 weeks, between policies with deferred periods of 1 week and 4 weeks.

Consequently, a more complicated graduation formula was developed to cope with these features of the data. The termination rates were substantially lower than the "SM1975-78" graduations[104] (except for the first few weeks of sickness), reflecting the significant deterioration in experience in the intermediate years, particularly for longer deferred periods.

Differences were also found in the mortality of claimants under different deferred periods, with lighter mortality rates for policies with a deferred period of 1 week than for policies with other deferred periods. These differences were reflected in the graduated rates.

IP experience in 1999-2002 and in 1991 to 2002 by cause of disability

The experience of individual IP policies in 1999-2002 was released in CMIR 22, in 2005.

Many of the findings were consistent with those for previous quadrennia, including a further worsening of recovery rates. However inception rates were lighter for all deferred periods, reversing the trend previously seen at the longer deferred periods.

The next output was an analysis of individual IP experience in 1991-2002 by cause of disability, published in WP 23 in 2006. The work underlying the paper was carried out by the Cause of Disability Working Party, established under the IP Committee in 2004. The paper considered both inceptions and terminations but focused on the latter because the Working Party considered that practitioners would find this more useful, in reserving for claims in payment using assumptions directly related to the specific cause of disability.

The analysis demonstrated that cause of disability could be an important rating factor for IP claim terminations but recognised that extensive further work would be needed to produce usable results. The paper therefore set out proposals for future work and sought feedback, to inform such work[105].

The experience of group IP policies in 1999-2002 was released in WP 24, in 2006. As with the preceding quadrennia, the analysis was limited to terminations and showed that – unlike earlier periods – recovery rates had generally increased since the previous quadrennium for both males and females.

The "IPM 1991-98"graduations; Part 2

A significant gap followed, until mid-2010, when the graduations of individual IP business experience for males in occupation class 1 for 1991-1998 were completed when the Committee issued another batch of three working papers:

- WP 46: 'Background papers on the analysis of CMI individual income protection claim records';
- WP 47: 'The graduation of sickness rates for the CMI individual income protection experience for males 1991-98 of males, occupational class 1'; and
- WP 48: 'An overview of the sickness inception and termination rate graduations'.

[104] As noted in Section B4, the graduations of 1975-1978 experience were not initially referred to as "SM1975-78", but that terminology was introduced later.
[105] The CMI Annual Review for 2006-2007 noted "Disappointingly, limited feedback was received…"

The last of these papers, WP 48, provides an overview of the other five working papers (WPs 5, 6, 7, 46 and 47) and states:

> "It is hoped that this overview paper, summarising both the methodology and the key features of the graduations and experience, will meet the needs of many practitioners on a stand-alone basis, and that it will also serve to provide an introduction and contextual 'road map' for the longer papers for those readers who wish to follow through all the detail."

WP 48 also acknowledges the time-lag since the graduations of terminations, noting that "This work has taken very much longer than we would have liked, reflecting the complexity of IP risks and the limitations of the available data." There were, however, factors outside the Committee's control that also contributed to the time-lag, as:

- The CMI's primary focus in the intervening years was on mortality projections; IP was given lower priority, and funding was not always available.
- An issue with the draft "S1" tables (see 'The first SAPS mortality tables' in Section C6) meant that there was much greater scrutiny and review of the software being used for the IP graduations.

Key features of the graduations of inceptions experience were:

- They were based on a larger volume of data than the "SM1975-78" graduations (which used data for a four-year period) and so reflect slightly more complex features in the data.
- They use the multiple state model described in CMIR 12 (see 'A CMI statistical model for PHI' in Section B4). As explained in WP48, "The model is based on the underlying state of Sickness, rather than 'Claiming', and so offers the prospect of comparing Sickness experiences across all the different Deferred Periods (DPs). In practice, the observed experience leads us to reflect different levels of Sickness Inception and Termination rates by DP, which is not an unexpected result as separate groups of policyholders, differentiated by employment circumstances and Income Protection priorities, tend to opt for different DPs. However, it is reasonable, and not inconsistent with the data, to 'borrow strength' across the DPs in graduating the Termination rates, so that the graduations use a single pattern of rates, by age and duration Sick, whilst varying the level by DP. "
- Overall the inception rates are similar to, or lower than, the previous graduations ("SM1975-78") for the shorter deferred periods, but significantly higher for longer deferred periods.

As the graduations are derived from only a subset of the data – for males in occupation class 1 – the experience of other occupation classes and of females were compared with the graduated rates in WP 7 (for terminations) and in WP 47 (for inceptions); these found:

- Inception rates rise steeply through occupation classes 1 to 4.
- Inception rates are significantly higher for females than males, with ratios ranging from 120% for policies with a 1 week deferred period to around 190% for longer deferred periods.
- In contrast, claim termination rates showed relatively little variation by sex and occupation class.

The papers were not positioned as a consultation exercise but WP 48 notes:

> "The Committee intends to propose the "IPM 1991-98" graduations for adoption by the UK Actuarial Profession in due course, but will not do so until after the publication of the next Working Paper, comparing the 1999-2006 experience with the new graduations."

However, as noted on the website page containing WP 48: "It was subsequently agreed that the concept of adoption was no longer relevant and this was not pursued. It should not be inferred that there was any dilution of quality standards in respect of the IPM 1991-98 tables." This is discussed further under ''Adoption' and 'Standard tables'' in Section C9.

The end of the group IP investigation

The group IP market had had a limited number of participants for many years and, in 2009, the largest writer – and the main contributor to the CMI's analysis – decided to cease contributing data. Extensive discussions with offices followed, to try to find a way forward, but the second and third largest contributors were not prepared to maintain their support for the investigation unless the largest office continued. These discussions were ultimately unsuccessful and this area of the IP investigation was closed in 2010 and all subsequent work has related solely to individual business.

Individual IP experience in 2003-2006

The IP Committee then issued two working papers simultaneously in 2012. The second, WP 60, analysed the experience for individual IP business in 2003-2006, compared with the experience of the three quadrennia covering the period from 1991-2002, and for 1991-2006 using the new "IPM 1991-98" graduations as the comparison basis. Because the analysis used a different methodology and reporting format from previous results, including a move to spreadsheet-based results, the approach was summarised in the accompanying WP 59. As well as results for 2003-2006, the Committee reissued results for 1991-1994, 1995-1998 and 1999-2002 using "IPM 1991-98" as the comparison basis.

WP 59 and WP 60 marked an important step for the CMI IP Investigation, bringing the "IPM 1991-98" graduations fully into use, incorporating a number of methodology refinements into the investigation and introducing the new format for the results to make them more easily accessible.

The key points arising from the analysis are:

- Data volumes for 2003-2006 had fallen substantially from the previous quadrennium, as some companies stopped submissions, but remained above those for 1991-1998.
- Almost 30% of the in-force data and 20% of the claims data was not classified by occupation class, so was analysed as 'Class Unknown'.
- Across all deferred periods, the claim inception experience for males and females was considerably lighter than the previous quadrennium, continuing the trend seen between 1991-1994 and 1999-2002 of generally improving inception rates.
- For the first time since the investigation started, the inceptions experience for policies with a 1 week deferred period was lighter for females than for males.
- The gradient of increasing inception rates from occupation class 1 to class 4 had become significantly shallower over time.
- Recovery rates had increased for almost all deferred periods, particularly for longer deferred periods.

Analysis of individual IP experience in 1991 to 2009 by cause of sickness

WP 72, issued in 2014, analysed individual IP experience over an extended period, 1991 to 2009, by cause of sickness. The analysis is based on over 56,000 inceptions and over 43,000 terminations, on a 'lives' basis, with "IPM 1991-98" as the comparison basis.

The analysis in WP 72 compares actual claim events (inceptions, recoveries and claimant deaths) with those expected according to the "IPM 1991-98" graduations of sickness experience (e.g. it compares the actual claim inceptions, by cause group, with the all-causes total of expected claims).

The data submitted to the CMI used 73 individual causes of sickness. To make the analysis by cause both more statistically sound and simpler to interpret, these causes were combined into 15 groups of 'medically similar' conditions; these were selected to enable comparison with groupings used previously, by the CMI and others.

The paper also provides a high-level analysis of claims experience for the seven most significant cause of sickness groups: infections, neoplasms, mental illness, circulatory, acute respiratory, musculoskeletal and injuries. Examples of the interesting results include:

- A reduction in claim inceptions due to mental illness and injuries over the period.
- A wide disparity between the distributions of claim incidence and claim cost by cause of sickness.
- Marked differences in claimant recoveries between the different cause groups which cannot be explained by variations in other rating factors (age, duration sick, occupation class, deferred period, time period).

The paper also reviews previous research that had been carried out on this topic.

The 'CMI Income Protection Rate Table Tool'

Another output in 2014 was the first version of the 'CMI Income Protection Rate Table Tool'. This was a spreadsheet-based tool and its purpose, was explained in the accompanying user guide:

> "The "IPM 1991-98" and "SM1975-78" graduations only provided formulae for calculating sickness inception, claimant recovery and claimant death intensities (together with some example tabulations). The calculation of rate tables and other quantities from the graduation formulae is complex (compared, say, with standard mortality graduations and rate tables). The CMI IP Tool was designed to help bridge the gap between these graduations and the tables of rates and factors used by practitioners in their income protection bases by allowing calculation of sickness, recovery and mortality intensities based on the graduations. Functions are included in the CMI IP Tool which use the intensities to calculate rates of decrement, continuance probabilities and claim annuity values. Examples are presented to demonstrate how these may be used and to help provide an understanding that will allow users to tailor them to their own needs."

Analysis of individual IP experience in 2007-2010

The next quadrennial results, for 2007-2010, were released alongside WP 96 in 2017. The analysis again uses the multiple-state model from CMIR 12, the methodology from WP 59 and the "IPM 1991-98" graduations to calculate expected inceptions and terminations, by recovery and death. Key findings include:

- Lower inceptions than in previous quadrennia for both males and females, and for the majority of deferred periods and occupation classes; continuing the downward trend observed previously.
- No significant differences in recovery rates in 2007-2010 from 2003-2006.

Further analysis of the existing dataset, covering the years 2003-2010, was released in WP 102 in 2017. Specifically, this analysed IP experience by benefit amount band and policy duration, both factors that had been available in the dataset from the start of the investigation but had not previously been used in analyses. The paper notes:

> "Although we do not propose incorporating these factors into our regular analyses, at least in the short term, we considered that analyses by benefit amount and policy duration would be of interest to CMI Subscribers."

The data was analysed in five amount bands (based on annualised initial benefit amount), chosen to provide a relatively even spread of the in-force data, and five groups of policy duration (up to the date of sickness), chosen by intuition as to where one might expect to see select effects. The analysis found:

- For inceptions, there was a downward trend as benefit amount increased for males but benefit amount had little impact on experience for females.
- For both males and females, there was some evidence of higher recovery rates for policyholders with smaller benefit amounts.

- There was limited variation beyond four years duration; however, the experience exhibited a select effect of lower inception rates at short durations for both males and females:
  - A selection discount of around 50% relative to ultimate inception rates for males for most deferred periods.
  - Four weeks deferred was the exception, with experience heavier at duration 0 than duration 1, but with limited credibility.
- For claimant recoveries, there was little evidence of policy duration affecting recovery rates.

The "IP06" graduations

New graduations were issued for consultation alongside WP 109 in 2018, covering claim inceptions only. These were based on data for 2003-2010 and the proposed name was the "IP06" graduations.

There were several new aspects to these graduations:

- They covered a broader range of IP business than the preceding "IPM 1991-98" graduations, for which rates were produced only for males in occupation class 1. The "IP06" graduations provided rates for both genders and four occupation classes as well as for the five deferred periods (1 week, 4 weeks, 13 weeks, 26 weeks and 52 weeks) used in previous graduations.
- Rates were first provided for claim inceptions. Previous graduations were based on sickness intensities and required sickness termination rates within the deferred period to calculate claim rates. It was suggested that the approach "…is simpler … and, we believe, better matches the needs of practitioners."
- Generalised linear models were used to graduate the whole dataset for each deferred period, "…with the smaller subsets 'borrowing strength' from the larger ones."

The paper notes that "For males in occupation class 1, the proposed rates are significantly lower than the "IPM 1991-98" rates, reflecting improvements in experience between their respective investigation periods. They are also generally simpler in shape, with no allowance for an 'accident hump' at younger ages, which was a feature of the previous graduations."

The inception rates were finalised in WP 120, in 2019. This paper summarises the feedback from the consultation, the changes made as a result and describes the final tables. Only the rates for 13-week deferred period were changed from the rates proposed in WP 109; these were modified to prevent the female rates falling below the level of rates for longer deferred periods at high ages.

WP 109 also states that "The IP Committee will begin work on accompanying "IP06" claim termination graduations later this year." In fact, these rates were never produced; as subsequently explained in WP 131: "…we were able to release "all offices" experience results for 2011-2016 while this work was at a relatively early stage and consequently had a more recent dataset available to work with."

Further analyses of individual IP experience

Three working papers were then released, as the IP Committee sought to get more up-to-date with its results:

- WP 124, in 2019, describes the experience of individual IP for the years 2011-2016. Experience was compared with the "IPM 1991-98" rates and, for inceptions only, also with the IP06 rates.
- WP 131, issued in 2020, set out proposed "IP11" claim inception and termination rates, based on data for 2007-2016 and using an approach similar to that for the "IP06" claim inception graduations, summarised above. The generalised linear model for termination rates included sickness duration as a continuous covariate (and its interactions with other variables).
- WP 136, also issued in 2020, finalised the "IP11" rates; these were unchanged from those proposed in WP 131.

Unfortunately, significant issues were identified with some of the data submitted to the CMI that underlies the inceptions experience for 2011-2016 (terminations experience was unaffected). On discovery of these issues:

- All CMI subscribers were contacted to notify them of this issue. Many would have little interest in IP experience, but it was felt safer that the CMI should notify all subscribers, rather than contacting a subset and risk missing any that could be affected.
- The working papers using this data (WPs 124, 131 and 136) were reissued with a prominent 'health warning' on the front cover, but without seeking to correct the results presented in those papers (which could only have been done very approximately).
- A spreadsheet of "IP11" claim inception rates, and indicative adjustments to reflect the data issues, was released (and is available alongside WP 136).

The issues are summarised in WP 149, issued in 2021. This notes that the principal issue "…arose from policies that had ceased to be in force (due to expiry, lapse or death) being inadvertently retained in the data" which "…leads to a material overstatement of inceptions exposure, for the years 2011-2016, and therefore an understatement of claim inception experience and rates."

Updating the methodology

The issues were uncovered during work to review how the methodology for the CMI's IP analyses could be improved and simplified, whilst using more detailed data that was already being provided by some data contributors. The conclusions of the review are described in WP 149 and substantial system updates were needed to use these fields. WP 149 notes that these changes would enable "…a wider range of analyses to be performed more easily, for example, analysis of experience by:

- Smoker status.
- Cause of sickness and, specifically, COVID-19.
- Socio-economic status, measured by the Index of Multiple Deprivation[106]."

The paper notes that "The feasibility of undertaking additional analyses is reliant on sufficient volumes of data being submitted for the key data fields, from a range of different offices." At the time of writing, the success of this initiative is not entirely clear, but WP 193 (released in September 2024) includes results differentiated by smoking status for the first time.

Assessing the impact of COVID-19 on IP business

The last output from the IP Committee during the period covered by this book was WP 156, titled 'Impact of COVID-19 on Income Protection business – qualitative analysis' and issued in 2021. In the absence of data to yet assess the impact of the pandemic on IP experience, the Committee issued a survey to insurers and reinsurers and the paper summarises the responses.

Amongst the findings, the views on claims experience included:

> "The impact on observed claim inception experience was mixed – although an increase in observed claim inceptions due to COVID-19 cases may have been the a priori expectation, this could have been limited or offset by a number of factors, such as furlough, operational issues, and potential delays in diagnoses."

[106] See 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9.

C5. Critical Illness / Assurances

Striving for a suitable methodology

The inception of the critical illness investigation, and the challenges it faced in collecting data, are described in Section B5.

The first results from the investigation, for 1998 and 1999, were sent to member offices in March 2003, accompanied by a paper on the methodology used to produce the results[107]. However, the paper acknowledged "The methodology can be criticised on a number of points", signalling that the Committee intended to seek to improve the methodology in future.

The results for 2000 followed, in December 2003, using the same methodology.

Some issues were subsequently identified in the data underlying these results, leading to resubmissions of data for the 1999 and 2000 (but not 1998). Consequently, the Committee decided to start its reporting again, with the 1999-2002 quadrennium and issued WP 14 In May 2005 to accompany these results.

Although it was customary for the CMI to publish summaries of the results for other investigations at that time[108], WP 14 describes only the methodology underlying the results, noting that: "The paper does not discuss the features of the data or the claims experience, except where they impact on the method of analysis." Restricting the availability of the results to CMI members may have been to provide a tangible reward of membership, as several offices that had not previously been members, or submitted data to other CMI investigations, had been encouraged to do so by the new investigation.

The Committee recognised that claim delays posed a key challenge for its analysis:

> "…the substantial delays observed in the claims data, firstly between the date of diagnosis of the underlying critical illness event and the date of notification to the insurer, and secondly by further significant delays between the date of notification and the dates the claim is finally admitted and settled. These delays indicate that Critical Illness business is subject to significant levels of "Incurred But Not Settled" (IBNS) claims… For some claims, these delays can be measured in years rather than months or weeks[109]."

These delays until claims were settled were much longer than those presumed to apply to mortality investigations[110] and so posed a novel challenge for a CMI investigation; WP 14 observes:

> "If claims are allocated to exposure years according to their date of diagnosis, it is clear that the final claims experience relating to an exposure year will not be known until a few years after the end of the exposure year. It is also clear that holding an exposure year open for an extended period, so that all claims with a date of diagnosis in that year that are eventually settled have been reported to the CMI, would be impractical. However, any investigation using a date other than diagnosis as the date of claim for analysis purposes will not reflect the true incidence of insurance liabilities. In particular, using the date of settlement will tend to underestimate overall experience where the number of expected claims is growing (due to increasing volumes and/or ageing portfolios) and will overestimate the extent of any positive initial selection."

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[107] The same methodology was then used for the 1999-2002 results and is described under WP 14, below.

[108] The mortality experience in 1999-2002 was summarised in CMIR 21, for example (see under 'Business as usual, 2000-2004' in Section C2).

[109] WP 14 notes that the average adjusted delay was around 260 days; i.e. just under 9 months. This is longer than the observed delay, of 176 days, because a skew in the delay distribution meant that the data was underweight in claims with long delays.

[110] The interval between death and settlement was not – to my knowledge – analysed by the CMI for their mortality investigations; indeed the two dates weren't captured in the data requirements, until the CMI began to seek 'Per policy' data (see 'The 'Per policy' data initiative' in Section C2).

The approach adopted by the Committee was to:

- "…allocate claims to exposure years according to their date of settlement[111];
- within each exposure year, allocate claims to an age and duration according to their date of diagnosis or, where this is not provided, a date of diagnosis estimated from the other available dates of claim."

This was a pragmatic approach taken in the context of an investigation based on annual data collection and recognising the need to further adjust the results – comparing actual settled claims with expected diagnosed claims – to compensate for the distortion caused by the combination of material delays in claim reporting and rapid growth in the underlying expected claims. The Committee reported in WP 14 that recent growth in the UK critical illness market, estimated to be "…close to 25% per annum…", meant that the number of expected claims was increasing and the paper includes "…approximate grossing-up factors to correct for this…". Overall, WP 14 concludes, "…the reported 100A/E for the 1999-2002 All Office experience should be multiplied by 1.15."

Dave Heeney, soon to become Chair of the Committee, recalls: "We all shared a discomfort with the concept of the grossing-up factor which seemed unsatisfactory in so many ways. To the technically minded, it felt like an empirical 'fudge', but I also recall how tedious it was having to explain and justify it every time we stood up to present at the Life Conference or similar events (which we did quite a lot!). It felt like an extra hurdle which the other investigations didn't have to deal with – very unfair!"

The methodology used to derive the grossing-up factor involved combining the claim settlement delay pattern with the rate of business growth (more precisely, the rate of growth in expected claims) to estimate the overall distortion of the reported A/E value. The methodology was complicated by the need to allow for discontinuities in the mix of data by office between years.

WP 14 sought feedback on the proposed methodology and "…the CI Committee took the unprecedented step of making the 1999-2002 dataset available to member offices to allow them to undertake their own analyses and explore other methodologies."[112]

The feedback was duly reported in WP 18, issued In December 2005. This notes that "In general the feedback received to WP 14 was very positive." However, there "…was a desire of practitioners for grossing-up factors that could be applied to subsets of the overall experience" and the paper notes that "Work has now commenced on additional grossing-up factors, in particular using more recent data."

WP 18 also noted that "…the Committee had hoped to graduate the data[113] to produce the first table of critical illness experience based on UK insured lives." However, it concluded this was inappropriate "…because of the immaturity of the dataset, its limited [age] range and the uncertainties that exist within the dataset due to the need to estimate dates of diagnosis and the application of grossing-up factors."

Around the time that WP 18 was released, I did a presentation on the committee's work at Staple Inn (I think it was a one-day seminar on healthcare). My final slide included an advert for the role of Chair[114] and, fortunately, Dave Heeney was in the audience and spoke to me afterwards. He took over as Chair in 2006 which ended an uncomfortable period for me; having joined Barnett Waddingham in mid-2005, I was both Chair and Secretary for around six months – a conflict of interest that certainly wouldn't be permitted now!

WP 28, issued in July 2007, was entitled 'Progress towards an improved methodology for analysing CMI critical illness experience'. It noted that development of additional grossing-up factors had proven problematic and set out an alternative methodology that was a pragmatic approach as the Committee

[111] If the record did not include a date of settlement, the latest date provided was used as the date of settlement.
[112] This quote is from a later working paper, WP 28 (see below).
[113] I.e. the 1999-2002 dataset.
[114] Knowing me, it may have included a picture of Kitchener and a title of 'The CMI needs YOU!'

"…seeks to make better use of the data fields available."[115] This was an unconventional methodology, to say the least:

1. It started with the in-force data, reported to the CMI at each year-end.
2. From this, it estimated the exposure in prior years, by rolling back the known in-force (adjusting for age and duration) and estimating the exposure that had been lost due to lapses and other (non-claim) exits.
3. A set of claim rates were then applied, to calculate the expected diagnosed claims in each year, by age and duration.
4. An assumed claim delay distribution was applied to convert the expected diagnosed claims into expected settled claims.
5. These expected settled claims could be compared with the actual settled claims (again, a figure reported to the CMI) to provide a measure of the experience relative to the claim rates.
6. Finally, the assumed claim rates in Step 3, above, could be adjusted iteratively to derive a set of diagnosed claim rates.

The methodology was illustrated using the 1999-2002 data and the population-based CIBT93 tables[116] as the initial claim rates.

Again, the Committee sought feedback on this methodology (which was reported in WP 33, issued in July 2008) but most of the feedback was from within the CMI[117], rather than from practitioners.

WP 33 presented an evolution of the approach described in WP 28. In particular:

- It introduced "…a refined model of the claim development distribution"; i.e. the time between diagnosis and settlement of a claim, which involved fitting a Burr model[118] to the data. This parametric approach made it easier to assess variations in the claim development distribution by risk factor or data subset.
- It included "Further analysis of off rates", which it describes as "…a necessary feature of the revised methodology."

Dave Heeney, Chair of the Committee, recalls "The introduction of the Burr model felt like a big step forward – a 'proper' parametric approach which allowed us to 'unbundle' the effects of new business growth and delays in reporting incurred claims. It opened the door to analysis by risk factor – the additional insight all industry practitioners were desperate to get but which, until then, we had been unable to provide."

Alongside the technical development, the Committee had been encouraging data contributors to improve the completeness of their data submissions and WP 33 records some success: "It is clear

[115] Dave Heeney commented to me recently that "We had some brilliant technicians on the committee but opinions weren't always aligned on the best methodology to follow. Such scientific differences are, of course, healthy in all branches of research and there were several occasions where my job was to steer the group to a 'sensible' conclusion even though I didn't fully understand some of the technical arguments."

[116] See Section B5. Note that CIBT93 covered the main critical illness conditions only, but was used as an overall claim rate. It is also pertinent to note that insurers included different conditions under their policies and used different definitions of a claim event (although the Association of British Insurers (ABI) later set minimum standards for these).

[117] Specifically, this was from the Technical Working Party that sought (inter alia) to encourage the committees to use suitable methodologies (see 'The Technical Working Party / Committee' in Section C9).

[118] This distribution was previously unknown to me and, I suspect, most of the Committee. It may have been suggested by Howard Waters, a member of the committee who oversaw work on critical illness by researchers, notably Erengul Ozkok and George Streftaris at Heriot-Watt University, using CMI data (see Appendix 8).

that the CMI is receiving each date[119] on an increasing proportion of the claims data… for example, the percentage of claims submitted with date of diagnosis increased from 37% in 1999 to 52%, 61% and 66% in 2000 to 2002 respectively." These values increased further, to 70% in 2003 and 75% in 2004, substantially reducing the proportion of claims for which this needed to be estimated and, therefore, improving the reliability of the results.

As well as seeking dates of diagnosis for more claims, the Committee had also engaged with an industry body for claims assessors, to improve the consistency of recording of these dates. As described in WP 33:

> "The date of diagnosis could relate to the original diagnosis of the underlying disease, or to a later date when the definition specified within the critical illness policy is met. Recognising this issue, the Committee launched an initiative in conjunction with the Health Claims Forum to draw up guidelines for claims assessors on what constitutes the "date of diagnosis" for Critical Illness claims… in essence, we now regard the date of diagnosis to be defined as "the date at which the critical illness definition was fulfilled"."

Whilst this was an important development for future reporting, WP 33 notes that "…since companies were asked to adopt this guidance from 1 January 2007, no common standard was in place during the investigation period we are currently considering."

WP 33 includes some fascinating insights into the claims process, for example: "Of the 100 claims where the interval from diagnosis to settlement exceeds 1500 days and where we also have a date of Notification … the claim dates supplied to the CMI indicate that nearly 90% of the total interval appears to arise prior to notification by the policyholder/claimant."

'Realistic' results[120]

The Committee used the methodology described above to produce results for accelerated critical illness experience on a lives basis for 1999-2004. WP 33 includes results for 1999-2002 whilst results for 2003 and 2004 were sent to member offices only.

These were termed 'adjusted' results and WP 33 notes "These are the first results that we have calculated that properly match claims to exposure, but they do so in terms of settled claims, not diagnosed claims, and so need careful interpretation." The 'adjusted' results were defined as:

> 100 x Actual Settled Claims / Expected Settled Claims, both based on the date of settlement.

(This was in contrast to the previous 'released' results, which were values of 100 x Actual Settled Claims / Expected Diagnosed Claims, as defined in WP 28 and described earlier.)

Because of the unusual nature of the results, WP 33 cautions that: "Patterns in the experience of settled claims will not be the same as the patterns that would be observed in diagnosed claims; this is especially true of duration (and, to a lesser extent, age) as experience in settled claims at any duration other than zero is necessarily a function of experience in diagnosed claims at that and earlier durations."

Notwithstanding this caveat, WP 33 notes that the results "…demonstrate some positive [initial] selection…" which was an important finding at the time as many commentators had expressed concerns about anti-selection by policyholders effecting critical illness insurance.

Another area that had not been explored in the population-based tables was that of smoking status where these results showed "…that smoker differentials are substantially higher for males than females…".

[119] The CMI requested four dates for each claim for the critical illness investigation – diagnosis, notification, admission, settlement – but all were optional fields.
[120] The term 'realistic' was used by the Critical Illness Committee but many uncertainties existed within these results, even though they addressed a key issue within the previous results.

WP 33 notes that: "The Committee now intends to use the revised methodology to … generate realistic claim rates" and rates based on experience in 1999-2004 are contained in WP 43, issued in February 2010.

Four sets of claim diagnosis rates for accelerated critical illness insurance are included in WP 43: for male non-smokers, male smokers, female non-smokers and female smokers. The rates were all based on life-years exposure, not amounts-weighted. The volumes of stand-alone business were much lower, and no rates were produced for that type of business.

The methodology was based on trial and error, rather than on a statistical model:

> "…we derive diagnosis rates by adjusting an initial set of rates (CIBT02[121]) first by age only, and then by duration only, to broadly fit the expected settled claims to the actual settled claims. This was done in a pragmatic manner – for each gender/smoker dataset independently – to reach a reasonable fit, having regard to the data volumes."

The experimental nature of the methodology led to:

- The Committee stating in WP 43 that "The rates are by no means the only sets of rates that could have been derived from the data."
- Spreadsheets containing summarised data being made available to member offices to "…allow practitioners to experiment with alternative approaches."

As the rates were the first results the Committee had produced that related to dates of diagnosis, the initial selection patterns were of particular interest. WP 43 notes that: "Three datasets show strong positive selection, with rates at duration 0 of 70-80% of the ultimate rates; however for male smokers, the rates at duration 0 are almost equal to the ultimate rates and higher than those for duration 1."

The shapes of the sets of rates by age were another noteworthy feature, as these "…differ significantly from currently available tables of critical illness rates."

Although the paper focuses on all-causes rates, it also included cause-specific rates for the main causes of claim for male non-smokers. This was another area the Committee intended exploring further; as noted in WP 43: "These are not only of intrinsic interest but also provide useful corroboration of the all-causes rates."

The first CMI critical illness tables

As envisaged in WP 43, the Committee used a similar approach to produce diagnosis rates for accelerated business using data for 2003-2006. These were released alongside WP 50 in January 2011. This notes several advantages to using the 2003-2006 dataset: "…[it] is more recent, covers a shorter period and is more stable in terms of contributing offices…" but also notes that both the 1999-2004 and 2003-2006 datasets "…are very immature in terms of age and duration."

These were collectively called the "AC04" Series and, as in WP 43, four sets of rates were produced. These were named ACMNL04, ACMSL04, ACFNL04 and ACFSL04, where:

- AC reflects that the rates are for accelerated critical illness;
- M / F refers to the gender;
- N / S specifies the smoker status;
- L signifies that the rates are lives-based, not amounts-based; and
- 04 indicates the (approximate) mid-point of the data period.

[121] The CIBT02 tables, like CIBT93, were population-based tables produced by a working party of the Health & Care Board. These tables are contained in 'Exploring the Critical Path' presented to the Staple Inn Actuarial Society on 6 December 2006.

Each table provides select rates (for curtate durations 0, 1, 2, 3 and 4) for ages 18 to 65 and ultimate rates (durations 5+) for ages up to 110 although WP 50 cautions that "Only the rates at ages 30 to 60 have genuine credibility as insured rates."

WP 50 was followed by two papers, both using the data for accelerated business in 2003-2006, that were intended to complement the proposed new tables:

- WP 52 was issued in June 2011 and contains cause-specific rates for the main causes[122]. Key findings include:
  - Higher cancer rates for females than males.
  - "A comparison of the four sets of death rates … produces a similar ranking to that visible in "normal" mortality experience."[123]
  - "…multiple sclerosis [claims] experience for female non-smokers appears to reduce with increasing age."[124]
  - "…relatively little positive selection on cancer, across all four gender/smoker datasets".
- WP 58 (issued in December 2011) contains supplementary analyses:
  - An illustration of the sensitivity of the AC04 rates to a key component of the methodology – the claim development distribution.
  - Approximate standard errors, to help actuaries understand and allow for uncertainty associated with the rates, as the derivation of the rates was not based on a formal statistical model.
  - Summaries of the experience of subsets of the data, to examine whether they exhibited different underlying claims experience. The most significant variations were by office, where "…the overall experience of the "worst" large office may be around 20% heavier than that of the "best" office."

WP 58 also considers stand-alone business, for which the data volumes continued to be much lower than for accelerated business. In order to provide a basis for assessing stand-alone experience, "…the Committee opted to impute stand-alone rates from the AC04 Series rates…"; this was done by subtracting the death-only rates (derived in WP 52) from the all-causes rates (derived in WP 50) for each gender and smoker status[125]. The paper includes analysis of the experience of stand-alone business with these imputed rates and found that:

> "This indicates that the overall experience appears somewhat heavier than the corresponding accelerated business, although the overall shape of the AC04 Series rates is broadly appropriate."

Both WP 50 and WP 58 note that the Committee intended to recommend the AC04 rates for adoption by the Actuarial Profession, once this phase of work was complete. However, as noted on the website page containing WP 50: "It was subsequently agreed that the concept of adoption was no longer relevant and this was not pursued. It should not be inferred that there was any dilution of quality standards in respect of the AC04 tables." This is discussed further under ''Adoption' and 'Standard tables'' in Section C9.

[122] Rates were derived for each condition with at least 200 settled claims meaning that the conditions varied between the four gender / smoker datasets; for male non-smokers, for example, rates were produced for cancer, heart attack, death, stroke, coronary artery bypass graft and total and permanent disability.
[123] I.e. female non-smoker rates were the lowest, followed by female smokers and male non-smokers, with the highest rates for male smokers.
[124] Multiple sclerosis rates were only produced for female non-smokers, as that was the only one of the four gender / smoker datasets with more than 200 settled claims.
[125] These were not 'formal' tables and no shorthand name was given to the rates at this time, but they were later referred to as the "SC04" rates.

The 'Per policy' data initiative and the '2007-2011 data collection exercise'

As described under The 'Per policy' data initiative' in Section C2, data for the critical illness investigation was sought on a 'Per policy' basis from 2007 onwards. The key aim of the initiative for mortality was to collect individual records (i.e. one per life under each policy); in contrast, individual records were already received for the critical illness investigation, but it seemed appropriate to coordinate the approach to data for the different investigations.

Unfortunately, that initiative was unsuccessful and there were delays in producing new results for both critical illness and mortality. A catch-up exercise was instigated for both investigations, as described under 'The '2007-2011 data collection exercise', also in Section C2.

A revised approach to analysing CMI critical illness experience

In May 2013, the Critical Illness Committee issued WP 67. This was to be its final output, prior to its rebranding as the Assurances Committee (as noted in Section C1).

The paper set out a revised approach for analysing CMI critical illness experience and also included restated results for accelerated business in 2003-2006. As noted in the introduction to WP 67:

> "The Critical Illness Committee has used a bespoke analysis methodology in its work to date. Following improved data coverage in recent years, particularly in relation to diagnosis date, it intends to adapt this for future work towards a more conventional approach".

At a high-level, the methodology was similar to that being adopted for the life office mortality investigations using 'Per policy' data (as noted under 'Annuitant mortality experience in 2007-2010 and the "08" Series tables' in Section C2) and was summarised in WP 67 as:

> "Comparing **actual incidences of claim** (diagnosis or death) with expected claims, calculated using **forces of claim** applied to the **central** exposure, derived on a **day-count basis**."

The key feature of the revised approach was the use of actual diagnosed claims; this was made feasible by the increased provision of dates of diagnosis by data contributors.

The principal difference from the methodology for the life office mortality investigations was to include an estimated allowance for Incurred But Not Settled (IBNS) claims; this was needed because of the longer (average) delays in settling critical illness claims compared with death claims.

Inevitably, the results using the new methodology differed from those produced previously. Fortunately, though, the conclusion stated in WP 67 was that:

> "…at an overall level, the AC04 rates would not have been significantly different, had they been derived from the 2003-2006 diagnosed claims, instead of the 2003-2006 settled claims."

Critical illness and mortality experience in 2007-2010

The first output from the renamed Assurances Committee was to issue results for 2007-2010, alongside WP 75, in December 2014. These results encompassed accelerated critical illness, stand-alone critical illness and mortality, under term, endowment and whole of life policies.

Key aspects of the underlying dataset were:

- "There has been a substantial decline in the size of …[the whole life and endowment assurances] dataset; partly due to the decline in sales of mortgage endowments during the 1990s." Indeed, these were to be the last results issued by the CMI for endowment assurances – the area where it all began back in 1924!
- "There has been a substantial increase in the size of the Term assurances dataset, with much of the increase being generated from existing data contributors." With hindsight, this indicated that the definitions of the different 'investigations' used for mortality had become inappropriate over time. Sales of joint life term assurance policies had increased substantially as they were often mortgage-related, following the demise in popularity of endowment mortgages. However, the term assurance investigation covered single life policies only and it appeared

that many offices had not included joint life cases in either the term assurance investigation or the joint life investigation, so such data was entirely missing from the CMI's analyses.

- The substantial increase in accelerated critical illness data volumes in previous quadrennia had slowed and there was "…a smaller increase in the 2007-2010 dataset [compared with the 2003-2006 dataset], when measured by numbers of claims."
- For stand-alone critical illness: "There was a slight decline in data volumes in 2007-2010, compared with 2003-2006, and it is now only 10% of the size of the accelerated dataset, when measured by numbers of claims."

For mortality, the shape of the lives-weighted experience was reasonably close to the "00" Series tables, by age and duration. This was a surprising finding, given the substantive changes to the underlying dataset and that the overall level of mortality experience was markedly lower – with actual/expected values of 77% for males and 76% for females.

WP 75 also included amounts-weighted results – an area not previously captured in the data requirements for the mortality investigation; with the amounts experience around 12% lighter than the lives-weighted experience for term assurances and 20% lighter for endowment and whole of life policies (combined).

For accelerated critical illness: "The overall lives experience for 2007-2010 for males is very similar to that in 2003-2006 (which underlies the AC04 tables); however female experience is a little heavier." However WP 75 also noted that "The shape of the latest experience by age and duration shows significant variations from the AC04 tables, suggesting that new tables may be warranted."

Terminal illness

WP 40, issued in August 2009 alongside a revised coding guide for CMI 'Per policy' data, included one area unrelated to 'Per policy' data – the treatment of terminal illness claims within the life office mortality investigations. This stated:

> "The Life Office Mortality Committee decided many years ago that – although both death and terminal illness claims are requested in Scheduled data (where relevant) – analyses would be carried out only on the death claims, i.e. terminal illness claims are ignored.
>
> In practice, very few offices submit terminal illness claims and it is not clear to the Committee whether this is due to offices excluding terminal illness claims (even though they are requested) or recording them as deaths. As a result, the Committee cannot definitively state whether or not terminal illness claims have been included in its analyses."

Part of the background to this statement in WP 40 was that, soon after joining the Secretariat, I noted an instruction in the internal processing notes to delete any claims identified by the office as 'Terminal illness'. I recalled a discussion on this at one of my earliest Mortality Committee meetings (in the mid-1990s) at which I argued that these should be included. My recollection was that I had won the debate, however when we checked the minutes, I found I had lost! Unfortunately, this practice was never stated in the CMI reports and working papers that accompanied 'all offices' results.

In terms of past practice, it should be noted that terminal illness was introduced into mortality assurances, from (I think) the early 1990s. Its significance was lower for endowment and whole life assurances, where the benefit would definitely be paid at the end of the policy, than for term assurances, where it might not, if the policy expired or lapsed prior to death.

This was an area that the newly-constituted Assurances Committee was closer to and the practitioners thought that the volume of terminal illness claims had increased over time, so that the omission of terminal illness claims from the CMI results gradually increased in materiality over time[126]. Consequently, WP 75 includes a clear statement that "…where [offices distinguished between death claims and terminal illness claims] …, the terminal illness claims have been included within these results and the Committee intends that future results will consistently include all terminal illness claims."

[126] My recollection is that some members of the newly-constituted committee were incredulous that terminal illness claims had been excluded from previous results.

The "08" Series assurances tables

Proposed "08" Series accelerated critical illness tables, using the 2007-2010 datasets, were released alongside WP 89 in May 2016; followed by proposed 'term mortality'[127] tables, alongside WP 92 in October 2016.

Key features of the accelerated critical illness tables are:

- Only the term assurance data was used, not that for endowment and whole life assurances; the Executive summary[128] notes that "…[endowment and whole life policies] are generally older products, with different underwriting and distribution practices and the Committee decided that the new tables would be more coherent if based only on the term data."
- The factors that were reflected in the tables – age, gender, smoker status and duration – were confirmed to be appropriate[129] by using a generalised linear model.
- The Committee decided to graduate the ultimate lives-weighted experience for the four gender/smoker datasets separately, over the age ranges 30-65 (males) and 30-60 (females); thus avoiding ages where the number of claims was small.
- The graduations used the CMI's graduation software and reflected the work of the GMWP, as described under 'Graduation and Modelling Working Party (GMWP)' in Section C8, which resulted in a simple Gompertz formula in each case.
- The data at short durations was not graduated; instead, the select rates were set as a flat percentage of the ultimate rates, for each dataset.
- The tables were extended to younger and older ages using "…a pragmatic means". In particular, the high-age extensions were blended to the population-based CIBT08[130] rates.

The proposed mortality tables were also based on term assurance data only but:

> "…we found a marked difference in experience between older term assurance business and policies issued more recently. Consequently we chose to base the proposed graduated rates on data for business written in 2001 and later."

The other aspects of the mortality tables were as described above for accelerated critical illness except that the data was graduated over a wider age range, 35-75, for both males and females.

Both sets of tables were finalised with the release of WP 94, in January 2017, which notes: "We are not changing the proposed tables and this paper sets out the feedback we received [and] our reasoning for not altering the tables".

Experience of term assurances in 2011-2016

The mortality, accelerated critical illness and stand-alone critical illness experience in this period was first considered in WP 108, issued in June 2018. This paper covered experience in 2011-2015 only and these were labelled 'interim results' as the Committee was expecting to receive substantial further data submissions for these years (as well as for 2016).

[127] This has been used by the Assurances Committee as shorthand for 'mortality (including terminal illness) under term assurances'.
[128] This was separate from the main working paper; see 'CMI Reports and working papers' in Section C9. A separate Executive summary was also issued alongside WP 92 and the quotes in this section are all from these summaries.
[129] I.e. there were statistically significant differences between the various sets of claim rates.
[130] The CIBT08 tables were, like CIBT93 and CIBT02, population-based tables produced by a working party of the Health & Care Board. In this case, the tables are contained in 'Extending the Critical Path' presented to the Staple Inn Actuarial Society on 3 December 2013.

These submissions were duly received and the experience in 2011-2016 was covered in WP 123, issued in July 2019, and WP 125, issued in November of that year:

- The first of these papers was accompanied by 'all offices' results and introduced two changes to the methodology for mortality that have been retained in subsequent results:
  - The results included an estimated allowance for late-reported claims; and
  - Some results were shown with improvements based on the CMI Mortality Projections Model[131].
- The second paper used generalised linear models:
  - To assess the fit of the "08" tables to the more recent data and to inform a decision as to whether new tables were warranted; and
  - To investigate the underlying risk drivers of experience, such as product type and sum assured band.

Unfortunately, the data underlying WP 108 and 123 was later found to have used only a subset of the data for durations 5+. These papers were not revised because resubmissions of data were received from some offices, so the Committee chose instead to proceed to 2015-2018 results that were issued alongside WP 132 (discussed below).

Using the CMI Mortality Projections Model for assured lives

The title of this sub-section was also the title of WP 110, issued in October 2018. The background to the paper was that: "Although the Model was not developed specifically for use with pensioners/ annuitants, this is a key focus for the CMI Mortality Projections Committee, which oversees the Model, in considering:

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

Consequently, WP 110 was a discussion document that "…sets out areas that we think should be considered when using the Model and its core assumptions in the context of protection portfolios." These areas include the different age range applicable to term assurances from that used in the Model and the use of smoker-specific rates, so that any improvement in population mortality arising from a reduction in smoking prevalence would not be relevant to a group of non-smokers.

Experience in 2015-2018

WP 132, issued in May 2020, considered the experience in 2015-2018 compared with the expected claims calculated using the "08" tables, for term mortality and accelerated critical illness and with the "SC04" tables; for stand-alone critical illness. The paper also illustrates the experience over an extended period but as this was complicated by some of the data resubmissions, noted above, only including revised data from 2014.

WP 132 identified areas where the "08" tables were an imperfect fit to the more recent experience and indicated that the Committee would commence work on new tables. It also included the first analysis of term assurance experience for the subset of the overall dataset[132] that included Index of Multiple Deprivation (IMD) deciles, mapped using the 'CMI Postcode Mapping Tool' (see 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9). The paper notes that "…the results are striking:

- There is a clear downward progression in the mortality results, with higher deciles (i.e. less deprived areas) showing lower experience.
- No evidence of any variation in experience by IMD decile for accelerated critical illness."

[131] The CMI Mortality Projections Model ('the Model') is considered in Section C7.
[132] "…around 62% of the total dataset…" for mortality and "…just over 50% of the total dataset…" for accelerated critical illness.

The finding for mortality is consistent with differences observed in population mortality and in other CMI investigations. This was the first time that the socio-economic profile in accelerated critical illness experience had been analysed and the finding that claims experience was broadly similar across the IMD deciles may have come as a surprise to many readers.

The "16" Series assurances tables

Proposed "16" Series tables – for both term mortality and accelerated critical illness – were released alongside WP 150 in April 2021.

The structure of the tables was unchanged from the "08" tables, and many aspects of the methodology used were also similar.

The most notable change was to adjust the graduated accelerated critical illness rates for females around age 50 to reflect "…a hump in experience that we believe arises from the start of routine breast cancer screening by the NHS at that age."

The paper notes other significant differences between the new "16" Series tables and the previous "08" Series tables:

- "The mortality tables reflect significantly higher smoker differentials at older ages, particularly for males…"; and
- "For accelerated critical illness, the select periods are generally shorter – most notably for female non-smokers, where it is now one year instead of five."

WP 150 was soon followed by two more working papers, both issued in June 2021:

- WP 151 added context to the accelerated critical illness tables by analysing the experience in 2015-2018 by cause of claim, illustrating the composition of the proposed rates by cause.
- WP 152 showed the experience:
  - In 2015-2018; with an additional year's settled claims and hence lower estimates for late reporting.
  - In 2019.
  - To mid-2020; these were indicative results, to assess the impact of COVID-19 (see below), similar to those produced for the annuities investigation (see 'Assessing the impact of COVID-19' in Section C2).

Neither of these subsequent papers, or the feedback received on the proposed tables, resulted in any change and both sets of tables were finalised with the release of WP 154, in August 2021. Although the tables were unchanged, WP 154 notes:

> "The one aspect of the proposed rates that attracted feedback warranting further consideration was in relation to the variation in mortality experience by sum assured band[133]. We have therefore undertaken additional analysis, also set out in this paper. We think this demonstrates that the data for the lowest sum assureds does not distort the tables – the specific aspect that was queried – although we would expect users to consider adjusting the tables for their business mix."

Assessing the impact of COVID-19 on term assurances

As noted above, WP 152 included indicative results to mid-2020, based on data from a subset of offices, to assess the impact of COVID-19.

[133] The specific question was whether small sums assured, probably arising as automatic cover with minimal medical questions, could be distorting the tables. The Committee had previously analysed policies with initial sums assured of £0-£25,000 as a combined group, but split this into smaller bands in WP 154 and found that "…the data for the lowest sum assureds does not distort the tables".

The results for term mortality for males were unsurprising: "…experience is significantly higher in 2020 than in 2019, with a pronounced spike in April 2020 and a similar impact to that in the population (at similar ages)". For females, however, "…term mortality experience is similar in 2020 to 2019 overall ... the impact [of COVID-19] appears much lower for insured lives than in the population (at similar ages)."

A more striking finding, though, was for accelerated critical illness, where "…experience is significantly lower in 2020 than in 2019, particularly for females." The paper suggested that this lower experience may prove to be temporary: "This may reflect a displacement of claims, as routine medical services were under severe pressure from COVID-19 and services such as routine breast cancer screening were disrupted. If this proves correct, we might expect more claims to emerge subsequently."

The experience in 2020 was more rigorously assessed in WP 162, issued in May 2022. This analysis was based on a larger group of offices, consistent with those who submitted data for 2016 to 2019. The analysis in WP 162 largely corroborated the findings of the earlier, indicative, analysis; in particular that: "Accelerated critical illness experience is significantly lighter in 2020 than in 2019. Male and female non-smoker experience decreased substantially during the second quarter of 2020, before returning to 2019 levels of experience later in the year."

WP 167, issued in January 2023, considered the experience of accelerated critical illness business in 2017-2020 by cause of claim. Consistent with the preceding analyses, this found that "…cancer experience … falls markedly between January and April 2020."

In line with earlier work by cause of claim, the analysis is limited to considering all cancers combined as "…a small number of offices still contribute a high proportion of the "known cancer site" data, to the extent that they were not comfortable allowing granular analysis of such a dataset to proceed." Given that cancers represent a large proportion of critical illness claims for females, in particular, this is a limitation in the analysis that the Committee hopes to resolve in future.

The last paper issued by the Assurances Committee during the period covered by this book was WP 176, in June 2023, which reported on experience in 2021. This found overall mortality experience in 2021 to be around 2% higher, and accelerated critical illness experience to be around 9% lower, than expected by the "16" Series tables. Unfortunately, the allowances made for late reporting in this paper were subsequently found to be inadequate, particularly for accelerated critical illness, and the experience for 2021 was restated in WP 191, issued in June 2024[134].

Following the release of WP 176, the CMI supplied data contributors with outputs that benchmarked their experience against the aggregate datasets described in the paper. This was the first time this had been done for Assurances and WP 191 reported the outputs to have been well-received.

Experience of underwritten whole of life assurances in 2015-2019

Whilst the Assurances Committee's primary focus, since its formation in 2013, has been on term assurances, it has continued to seek to report on mortality experience of whole of life assurances. This resulted in WP 170, issued in February 2023, which considers the experience of underwritten whole of life business in 2015-2019. Most of the results compare the experience with the latest term assurance tables and it found that: "The all-ages, all-durations experience is generally heavier than expected when comparing to the T16 tables[135], particularly for male non-smokers."

As noted in the paper: "We had also hoped to analyse the experience of non-underwritten whole of life business as part of this paper. Unfortunately, we were unable to secure participation from all key market players, which raised concerns regarding the market coverage of the resulting analysis and would have led to a small number of life insurance providers contributing a high proportion of a prospective dataset."

[134] WP 191 notes that "…the 2021 experience is significantly heavier, with 100 A/E values increasing by 8 for both male subsets and female non-smokers, and increasing by 3 for female smokers."
[135] Shorthand for the "16" Series tables for term mortality. WP 170 also notes that a high proportion of the whole of life dataset relates to older ages, where the data underlying the T16 tables is relatively sparse, so that this is not a straightforward comparison.

C6. Self-Administered Pension Scheme (SAPS) Mortality

A pilot investigation

The CMI began collecting data to analyse the mortality of insured pensioners in 1948 and this was used for various CMI tables as described in Sections A2, B2 and C2. These tables were widely used by actuaries in work on self-administered pension schemes but the suitability of the tables for such work was unknown for many years.

Consequently, as described in CMIR 20, issued in 2001:

> "In 1997 the Technical Support and Research Committee of the Pensions Board[136] began discussions with the CMIB about the possibility of conducting an investigation into the mortality experience of self-administered occupational pension schemes. In the light of these discussions it was agreed to run a pilot investigation. The brief given to the Secretariat of the CMIB was to compare the mortality experience of the schemes in the pilot investigation with published standard tables of mortality based on other similar experiences."

Interesting aspects of the structure of this initial investigation are:

- Data was requested from consultancies[137] acting as Scheme Actuary, not the schemes themselves; this has continued to be the case subsequently.
- The period to which the data should relate was not specified but: "It was hoped that each scheme experience would cover a three-year period" and most data has been submitted on a triennial basis subsequently[138].
- The report (in CMIR 20) was produced by the CMI Secretariat; it was not peer reviewed by any CMI Committee.

Probably the key conclusion from the initial investigation was that: "The experience is heavier than that predicted by the pensioner tables contained in the CMIB's "92" Series of tables".

Early results

Establishing an ongoing investigation posed considerable challenges. The minutes of the Executive Committee meting in July 2002 noted that:

> "Chinu Patel said that the pilot investigation into self-administered pensions had proved very useful, and that both the Pensions Board and the NAPF[139] were keen for it to continue. It was realised, though, that there were structural issues to consider such as cost, funding and the supply of data."

Nonetheless, as described in WP 4: "In 2002 the Actuarial Profession commissioned the CMI Bureau to begin an investigation into the mortality experience of self-administered pension schemes[140] and to report to the Technical Support and Research Committee of the Pensions Board."

Features of this investigation that were to be repeated for future analyses were:

- The restriction to pension schemes with more than 500 pensioners (i.e. members and dependents, with pensions in payment).

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[136] At that time, the practice boards, of which Pensions Board was one, were jointly run by the Faculty and the Institute.
[137] Throughout the investigation, the Government Actuary's Department (GAD) has also been asked for, and has supplied, data but I refer simply to 'consultancies' throughout this section. Data was also received for the Prudential staff scheme for the pilot investigation; it is unclear whether other insurance companies were also asked to submit data for their in-house schemes.
[138] The exception is public sector schemes, where data is generally submitted for four year periods.
[139] The National Association of Pension Funds, a predecessor of the Pension and Lifetime Savings Association (PLSA), now known as Pensions UK.
[140] I don't think the scope was explicitly restricted to defined benefit (DB) pension schemes (or has been subsequently) but in practice I suspect all of the data received has related to such schemes.

- The data was subdivided by type of pensioner – normal retirements, ill-health retirements, combined (where the health of the pensioner at retirement was not known), dependants of deceased pensioners, and unknown (where the data could not be split between members and dependants).
- The data was also subdivided by industry sector, broadly relating to those of the FTSE indices.

WP 4, issued in 2004, presented 'provisional results' for the years 2000 to 2002; a period covered by most of the schemes for which data had been received, although the overall dataset covered a longer period (from 1996 to 2003). This paper appears to have been issued at an early stage of the investigation – data collection started in early 2003 and the analysis was based on submissions received by February 2004 (comprising only around 100 schemes) with the paper issued in mid-March. It is not stated why the report was produced so quickly but it probably reflected a desire to demonstrate progress and to stimulate more data submissions.

WP 4 and its immediate successor papers were co-branded as being issued by the CMI and the Technical Support and Research Committee of the Pensions Board.

A further report on this data was released in WP 9, later in 2004, although these were still referred to as 'preliminary results', possibly because "…approximately 50% of the data comes from only six schemes." Again, there appears to have been a desire to release the paper quickly – WP 9 says "This Working Paper, due to pressure of time, concentrates on the male data, although some commentary on female data is included. We hope to produce a further paper concentrating on the female data in 2005."[141]

WP 9 notes that "…the amount of data collected to date is large (compared to that in the life office studies) and it demonstrates features that may be of importance to scheme actuaries (and others), not least in the analysis of results by amounts." The volume of data was sufficient to allow analysis of male experience in four pension amount bands; this demonstrated:

- Substantial differences in mortality at younger (pensioner) ages – at ages 65-69, these ranged from 108% of PML92 for the lowest amount band (under £4,500 pa) to 58% of PML92 for the highest amount band (over £13,000 pa).
- Much narrower differentials at older ages; for example, 111% at ages 85-89 for the lowest amount band and 83% for the highest amount band.

WP 9 goes on to state "Our most significant findings relate to the extent to which mortality varies with the amount of the pension in payment." The paper shows average pension amounts in the SAPS analysis to be substantially higher than the corresponding insured data and states:

> "The populations of pensioners of insured schemes and those of self-administered schemes are therefore so heterogeneous that standard tables based on life office data need to be treated with great care when being used for self-administered schemes."

The paper acknowledges the imperfect nature of amounts data " …small pensions [may result] from short periods of service which could be a false reflection of the total pension a pensioner was receiving." However, the data collected by the CMI is limited to a subset of the data used by actuarial consultancies for valuations, so amounts were viewed as probably being the best available means of segregating the data into more homogenous subsets at that time[142].

The next paper, WP 17 (2005), covered an additional year's experience, extending the analysis period to 2000 to 2003, and notes:

- The number of consultancies submitting data had increased to ten.
- The number of submissions was approximately 200 schemes, roughly double the number analysed for WP 4.

[141] Such a paper was never released, to my knowledge.
[142] Indeed, this has remained true until the investigation began using IMD deciles, described later in this section under 'Analysis of SAPS data by IMD decile'.

- The volume of data was around double that analysed for the years 2000 to 2002 in WP 9, with over 100,000 deaths for males and around 73,000 for females.

The release adopted what was to become a standard approach: the paper included summary details only, with more detailed analyses, in five-year age bands and by single ages, provided in accompanying spreadsheets. The paper notes: "The Working Party hopes that this form of presentation of the data will enable users of the report more readily to carry out their own analyses."

Funding an ongoing investigation

The work described above was funded by the Institute of Actuaries[143], but this was not intended to be a long-term approach.

The minutes of the Executive Committee meeting in June 2004 record that:

> "The meeting was told that the F&GP Board[144] had not put an amount in the Profession's 2004/2005 budget for this Investigation as it was thought the cost could be met out of CMI reserves. The CMI Executive Committee did not think that it was appropriate to use their reserves in this way, as they had been built up from the contributions from Life Companies. Work will cease after data processing takes place in September unless the Actuarial Profession obtains funds from other donors, makes a future donation or gives a guarantee to underwrite the cost on an interim basis while long term arrangements are put in place."

Those minutes continue:

> "Michael Pomery and Harvie Brown, the two new Presidents … agreed to take forward the issue on behalf of the Profession. It was hoped that support from NAPF could be obtained and funding from the PPF[145] and Pensions Regulator. It was agreed that this funding difficulty could be kept confidential up until September so as not to undermine the very valuable work that is being done. After this time it will be very difficult to maintain confidentiality, as all the major pensions consultancies are now supplying data and receiving results from the CMI."

The minutes of the Executive Committee meeting in October 2004 included an update that "…the two Presidents had written in September 2004 to seventeen consultancy firms requesting contributions from them to assist the funding of this investigation…" This request was for further short-term funding and produced sufficient donations to allow work to continue whilst discussions between the two Presidents and various parties regarding longer-term funding continued.

These attempts to attract funding from other sources proved unsuccessful and, in late 2005, letters from the two Presidents were sent to consultancies to seek their ongoing commitment[146]. At that time, "The [Executive] Committee was reminded that the current funding from contributions was expected to run out in February 2006." The consultancies agreed to provide support and, in June 2006, FIMC[147] approved the CMI collecting contributions from consultancies to fund the SAPS investigation[148].

The birth of the CMI SAPS Mortality Committee

Consequently, the CMI commenced seeking financial contributions from the larger actuarial consultancies and the Institute Working Party became the CMI Self-administered Pension Schemes Mortality Committee[149], from 1 July 2006. Its initial membership remained unchanged from that of the preceding working party and comprised four members who worked for the four largest consultancies:

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[143] If there was support from the Faculty, this is not obvious from the papers available to me.
[144] The Finances and General Purposes Board, I think.
[145] The Pension Protection Fund.
[146] I understand that this was with support from the Association of Consulting Actuaries (ACA), but have not located documented confirmation of this.
[147] The Faculty and Institute Management Committee; this was established to oversee the operations of the UK actuarial profession, under the auspices of the Councils of the Faculty and the Institute.
[148] At this time, CMI's proposals on financial contributions required approval from the FIMC.
[149] Hereafter I refer to this as the 'SAPS Committee' (and similarly the SAPS investigation), without the word 'Mortality'.

Brian Wilson (Hewitt Bacon & Woodrow), the Chair, plus Nigel Bodie (Watson Wyatt), Andrew Gaches (Aon) and Jonathan Lawlor (Mercer)[150].

When the SAPS Committee was established, the 'Mortality Committee', which analysed data from life insurers, was renamed the 'Life Office Mortality Committee'. Reading the minutes now, it appears that the Executive Committee was unsure whether the separation of the two committees should be a long-term position and it "…agreed that this should be reviewed in twelve months, unless matters of concern were raised in the interim." However, the two committees have continued to this day (albeit with the 'Life Office Mortality Committee' undergoing a further name-change to the 'Annuities Committee' in 2013) and, indeed, a third mortality-related committee (now called the 'Mortality Projections Committee') was subsequently established.

The Executive Committee also discussed (at length!) how best to manage the provision of regular, unpublished results before agreeing to: "Totally separate "Life Office members" and "SAPS members" where each category would only receive results relating to their own area." This position remained intact until the changes arising from the CMI Review took effect in March 2013[151].

The SAPS Committee later noted (in WP 35) that

> "The transition [from an Institute working party to a CMI committee] was seamless and the switch of reporting line had no adverse effect on the investigation. Indeed, the additional resources made available to the Committee by the CMI have greatly facilitated its work.".

Early work as a CMI committee

The newly-constituted committee's first output was WP 29 in 2007. To give 'SAPS members' (i.e. the consultancies that provided financial support and data) some benefit, a draft paper was first released to those firms in March 2007, prior to making the working paper publicly available in October 2007.

The investigation period was again extended for this report, which analysed experience in the years 2000 to 2004, based on data collected by 30 June 2006. The paper notes that:

> "[This paper] has been delayed as various inconsistencies have been spotted in the data. As a result of investigations, a number of schemes with significant questions as to the reliability of the data have been excluded from this analysis. It will be noticed that the exposures for 2000 and 2001 have both reduced compared with those in WP 17, although overall exposures have increased. The Committee is confident that it now has a much better set of data to analyse and from which to draw conclusions than before this investigative work was carried out and that the delay caused is more than justified by the results achieved."

There was also a change to the amount bands used for males, as the Committee had found that the lowest group could be better be split into two "…which may each be more homogeneous than in combined form."

Despite the extended period and the increased data volumes, the paper notes "The overall levels of actual to expected on both lives and amount bases and for males and females have not changed significantly since the WP 17 analysis."

WP 29 includes a comparison of the SAPS dataset with that for insured pensioner mortality, used for the "00" Series tables, that had recently been published at that time. It notes that: "The most notable features are the larger size of the SAPS dataset, the significantly higher average pension amounts and the proportionately much larger female dependant dataset."

The first SAPS mortality tables

Given the generally higher mortality evident in the SAPS data, compared with the CMI tables based on insured pensioners, the Committee was keen to progress to its own graduated tables. Draft graduations were published in WP 32 in January 2008, alongside WP 31, which analysed the

[150] Incidentally, the current CMI Secretary, Viv Sharples (now Maclure), was the Assistant Secretary to the Committee, her first 'official' role within the CMI.
[151] See 'Review of the CMI' in Section C9.

underlying dataset, based on data collected to 30 June 2007 and further extending the analysis period to cover the years 2000-2006. As with the previous paper, WP 31 had previously been made available in draft form to 'SAPS members', in October 2007, prior to being made publicly available. The graduations paper, WP 32, was not pre-released to members, probably to ensure feedback was received from as wide a group as possible.

WP 31 was less detailed than WP 29 but largely corroborated earlier findings. It also records further growth in the dataset, with data having now been received from 18 consultancies; noting that:

> "The rate of data submission has been relatively steady, until a concerted exercise the CMI undertook to chase consultancies for data in January 2007 yielded a substantial increase in the number of submissions[152]. Nearly 380 submissions have been made, with 350 of these being separate schemes and the remainder being resubmissions covering separate time periods. This compares with around 230 separate schemes plus 10 resubmissions in Working Paper 29."

WP 32 is a more extensive document, including:

- A brief summary of the data;
- Discussion of the different tables the Committee considered producing;
- An overview of the graduation methodology, which was that developed by Forfar, McCutcheon and Wilkie (see under 'Mortality experience in 1979 to 1982 and the "80" Series tables' in Section B2);
- Extensions of the graduated rates to younger and older ages, where data was sparse and potentially unreliable;
- A section describing certain anomalies within the various rates, and how these were removed;
- Comparisons between the various sets of rates and with the "00" Series tables;
- The proposed naming convention; and
- The questions on which feedback was requested.

Initially, the Committee considered a range of 40 tables. One particular reason for the high initial number of tables was that:

> "Analyses of the data have shown that splitting the data in bands by amounts of pension has produced groups that are relatively homogeneous (as demonstrated by amounts and lives experiences being relatively close) but which demonstrate distinctly different experiences from each other."

As a result, the Committee split the dataset into amount bands and produced 'Light' tables, based on the top two bands used previously, and 'Heavy' tables, using the rest of the data, as well as tables based on all of the data.

However, after preliminary consultation[153], it was decided to limit the number of tables; in particular "…[as] lives and amounts graduations were very close to each other … it was decided only to proceed with the amounts graduations."[154] The segregation of the dataset to produce Light and Heavy tables has been a feature of each successive set of SAPS tables.

This pair of working papers was followed by a second pair, in October 2008:

- WP 34 sets out the methodology and assumptions underlying the dataset that was used for the graduations (such areas had not previously been documented publicly); and

[152] This exercise was undertaken to boost data volumes for the forthcoming tables. A similar exercise was undertaken ahead of the next set of tables (the "S2" Series, considered below).
[153] At ACA meetings and Actuarial Profession 'Current Issues in Pensions' seminars.
[154] In most cases. In fact, the Committee did propose lives tables for the 'all' datasets: all male pensioners, all female pensioners and all female dependents (i.e. widows).

- WP 35 describes the final graduations and includes a summary of points made in feedback during the consultation on the draft tables and the Committee's response to the feedback.

WP 35 notes that sixteen written responses were received, which is more than the CMI received for most of the tables based on insurance data at that time; this may reflect the novelty of the tables. In addition, the draft tables had been discussed at sessional meetings of the Institute (on 28 January 2008) and the Faculty (on 5 February 2008) and WP 35 notes that: "At both meetings a "show of hands" was taken on some of the questions to gauge the views of the meetings as a whole."

The range of tables was unchanged from that proposed[155] but there were many other changes; as recorded in WP 35: "…revisions have been made to … various aspects of the graduations including changes to the following:

- The naming convention;
- Which graduations extend back to younger ages;
- The pension amount thresholds for 'Light' and 'Heavy' tables;
- The methodologies used to extend the graduations to younger ages and to older ages;
- The methodology adopted to calculate exposed to risk; and
- Correcting for the discrepancy in the age definition between the data and that assumed in the software."

Of these, two warrant further discussion here. The first is the naming convention where, as the graduation dataset covered the years 2000 to 2006, with a weighted average date of 2003, it was proposed that the table names would be "S…03", with the letter 'S' differentiating the tables from those derived from life office data and the '03' indicating the date, consistent with practice for life office tables, such as the "00" Series. Some respondents felt that '03' could give an impression to pension scheme trustees and sponsors that the tables were already out-of-date. Consequently, the Committee decided to label the tables as "SAPS Series 1", abbreviated to "S1" in the table names, and a similar convention has been adopted for subsequent sets of tables.

The second – which is the last of the bulleted items, above – related to an issue in the initial graduations work. WP 35 notes that:

> "Few comments were received on the graduated mortality rates themselves, however one response expressed surprise at the level of the rates in comparison with the (population) interim life tables for 2002-4. In addition, the CMI received an e-mail enquiry from an actuary who had been unable to reconcile the graduated values of q_x with crude death rates calculated from information in Working Paper 31. These two comments alerted us to a discrepancy in the age definition between the data and the graduations software that resulted in the draft tables overstating mortality rates by half-a-year."

This discrepancy arose because the age definition implicit in the SAPS data differed from that used in the life office mortality investigation and was implicitly assumed in the graduation software. The SAPS Committee were not aware of this assumption and the software was not modified accordingly. This was compounded by a lack of documentation for the software which had been produced for the CMI by a third party. The issue was highlighted to the profession via an e-bulletin as soon as it had been investigated, by way of a document entitled 'Preliminary response to consultation on the draft graduations of SAPS mortality experience' (released in March 2008) and by other means. It would also have significant ramifications for the CMI, as considered under 'Quality Assurance' in Section C9.

[155] The range of "S1" tables is compared with the "S2" and "S3" tables under 'The "S3" Series mortality tables', below.

Extending the basic analyses

Further regular updates on the development of the SAPS dataset were issued in:

- WP 44 (2010) reported on experience based on data collected by 30 June 2009; and
- WP 51 (2011) was based on data collected by 30 June 2010.

Observant readers will have noted that WP 44 skips a year from WP 31, which used data collected to 30 June 2007. The Committee had issued a draft paper based on data collected to mid-2008, with the intention that would then be finalised as a working paper. However, data for some schemes was found to be unreliable and, whilst waiting for those schemes to be re-submitted, a substantial amount of new data was received. The Committee therefore decided to proceed to using data to mid-2009.

In fact, some of the original, inaccurate data had been included in the dataset underlying the "S1" tables but the Committee decided not to revise the tables. Instead, as noted in WP 44: "[It] concluded that it would be most productive to publish analysis of the latest dataset against the "S1" tables" and the paper was issued immediately in final form instead of first being sent to CMI SAPS members in draft form. WP 44 also notes that: "A review of the data checks that are currently undertaken is due to be carried out and, following this, the Committee will consider additional safeguards that can be implemented to try and identify potential issues in future data submissions."

WP 44 established an approach of using a rolling eight-year period of data, and covered the years 2001-2008. The approach was also followed in WP 51, which covered the years 2002-2009, and has been used subsequently.

WP 44 was also the first in which an estimate of the coverage of the investigation was included, based on data from 'Pension Funds and their Advisors'. This found that around 40% of the possible total number of pensioners had been submitted and the Committee therefore encouraged firms to submit more schemes.

WP 51 noted further growth in the dataset, compared with that used in WP 44, by 35% for male pensioners and by 41% for female pensioners; indeed, the female dataset was already over double the size of that used for the "S1" tables. As a result, the estimated coverage had increased to over 50% of the possible total. It also notes that, for the first time, data had been received from the Pension Protection Fund (PPF) and that (unlike data received from other sources) this submission would include schemes with fewer than 500 pensioners.

Two areas that had previously been stated as planned future work were covered in the following working papers:

- WP 53 (2011) investigated mortality improvements in the SAPS dataset; and
- WP 61 (2012) analysed mortality experience by industry.

Both papers followed the usual practice at that time of first being sent to SAPS members.

WP 53 presents a high-level analysis of the mortality improvements experienced within the SAPS dataset over the period 2001 to 2009. The paper notes that such an analysis had not previously been possible, because of the time needed to develop a substantial dataset of sufficient length. In addition, the approach initially used by the Committee had been "…challenged internally[156] and it was agreed that the conclusions were not sufficiently robust to be published."

Instead, the analysis used standardised mortality ratios (SMRs) to analyse the mortality improvements and to compare the experience in the SAPS dataset with the England & Wales population dataset collected by the Office for National Statistics (ONS)[157]. The analysis suggests that the improvements in the SAPS dataset, for male pensioners, female pensioners and female dependants, were broadly

[156] By the CMI Technical Committee; see 'The Technical Working Party / Committee' in Section C9.
[157] WP 39, issued by the Mortality Projections Committee, illustrates the difficulties inherent in using a dataset smaller than that of the population to derive a mortality improvements model. Consequently, the CMI has analysed mortality improvements in the SAPS and Annuities datasets compared with those in the population.

consistent with those in the population. WP 53 notes the significance of this finding, as improvements derived from the England & Wales population data form the basis for the CMI Mortality Projections Model (see Section C7).

WP 53 also considered the mortality improvements of:

- Male and female pensioners with different pension amounts; and
- Male pensioners compared with female pensioners.

The paper notes that the methods used for the various comparisons "…do not allow the statistical significance of differences in the experience of datasets to be commented on." It adds that the Committee had been considering whether to investigate further the feasibility of undertaking a more detailed and rigorous statistical analysis of mortality improvements experienced within the SAPS dataset. This was intended for a future working paper: "However, subsequent feedback in respect of the draft version of this paper released to members in April 2011, indicated that the high level analysis presented here is valuable and that further research is not considered to be high priority."[158]

WP 61 analysed mortality experience by industry, following the earlier analysis in WP 29. This used data for 2002 to 2009, as reported on in WP 51, and broadly similar to that used in WP 53. The paper notes that two different industry classifications had been used for SAPS data, as a result of an update in 2007, to bring them into line with the FTSE Actuaries Industry Sectors. To maintain continuity, an exercise was carried out to map the old scheme industry classifications to one of the new classifications so that a consistent coding applied to all schemes submitted to the investigation.

The analysis showed considerable variation by industry. However:

- It also looked at the degree of heterogeneity within each industry group, which indicated that some industries (for example, Basic Materials) had a relatively heterogenous mix of schemes, so that the average experience could not be assumed to apply to any particular scheme; and
- Some of the differences could be explained by variations in average pension amounts; for example, industry groups with higher average pension amounts generally experienced lighter mortality.

Two annual updates followed in:

- WP 62, issued in 2012, reported on experience in 2003-2010 based on data collected by 30 June 2011; and
- WP 65 (2013) was based on data from 2004 to 2011 collected by 30 June 2012.

Both papers again followed the practice of first being sent to SAPS members but WP 65 notes that "…given the wider changes to the CMI from 1 March 2013, it is not intended to issue future annual papers in draft form."

These papers included comparisons of the experience against the "S1" tables projected forward using improvements from the CMI Model, as well as against the unadjusted tables. However, the practice of comparing the SAPS experience against the "00" tables, based on life insurer data, was discontinued.

The "S2" Series mortality tables

The use of a rolling eight-year analysis period means that the oldest year's data is lost in each of WP 62 and WP 65, as well as gaining a more recent year's data. The maturing of the dataset meant that the overall volumes of data had not increased from WP 51 but they were substantially greater than used for the "S1" tables (based on experience in 2000 to 2006). This growth, combined with generally lighter mortality experience and some differences in the relative experience by age, provided the rationale for new tables and the proposed "S2" tables were set out in WP 66, which was issued at the same time that WP 65 was made publicly available.

[158] As noted under 'Expanding the work of the committee, 2013-2019' in Section C7, subsequent analyses of mortality improvements in the SAPS datasets have been included in the 'Interim update' papers issued by the Mortality Projections Committee.

WP 66 is broadly similar in scope to WP 32, which set out the proposed "S1" tables. Particular points to note are:

- The methods used for the graduations were similar, although different approaches were needed for the extensions to younger and older ages, as the previous approaches used for "S1" produced unsatisfactory results for the latest dataset.
- Some practices established previously were retained; for example, the default naming convention was "S2", consistent with the earlier "S1" tables.

The "S2" tables were finalised in WP 71, which was issued in 2014. It is interesting that the level of response to the consultation was much lower than for the preceding "S1" tables, with nine responses.

In terms of the range of tables, the Committee had sought views on various changes from the "S1" tables, for example:

- Producing a 'Pensioner Middle' table for males[159], based on the data with amounts above that used in the Heavy tables, but below that used in the Light tables, as these would differ from the tables based on all pensioner data. This was supported by the majority of respondents so these tables were included in the final set.
- Not producing a female Normal Light table or female Dependants Light and Heavy tables, as these would be little different from other tables. There were mixed views from respondents here and the Committee decided to follow its proposed approach.

In total, therefore, the "S2" Series comprised the 18 tables the Committee had proposed, compared with 20 for "S1". The range of "S2" tables is compared with the "S1" and "S3" tables under 'The "S3" Series mortality tables', below.

Three new areas on which the Committee had sought feedback were:

- Whether to disregard the most recent year's data. This is necessarily incomplete given the triennial nature of most data submissions, in line with the triennial valuations used for private sector pension schemes. This was not widely supported by respondents so the rates were based on all eight years of data, as proposed.
- Whether to adjust the graduations to represent mortality rates at a specific date, using the latest CMI Model. This question arises because the mid-point of each of the datasets differs, typically by a few months, depending on the composition of the schemes underlying that dataset. Views on this were mixed but:

  > "…the Committee felt it would be better and result in more consistent outcomes if users were provided with a standard adjustment when discussing the tables: adjusting the table once during its creation seemed preferable to having different adjustments across firms. Consequently, after some discussion, the Committee has decided to adjust the tables to a common date … [and] that 1st January 2007 would be appropriate for q_x; with μ_x applying mid-year."

- Whether it remained appropriate to close the tables at age 120, as had been applied to previous CMI tables, given the continuing increase in life expectancy. Responses generally favoured retaining this age limit, hence it was used in the final tables.

[159] The Committee did not find a significant difference between the experience of the central dataset for female pensioners and that based on all pensioner data, so did not propose to produce a 'Female Pensioner Middle' graduation.

Business as usual, 2013-2017

After the "S2" tables were finalised, the Committee operated largely on a 'business as usual' basis, with regular annual updates on experience in a series of papers:

WP number	Analysis period	Data collected by	Issue date[160]
73	2005-2012	30 June 2013	July 2014
76	2006-2013	30 June 2014	December 2014
88	2007-2014	30 June 2015	February 2016
95	2008-2015	30 June 2016	February 2017
104	2009-2016	30 June 2017	January 2018

The first four of these working papers noted lower data volumes with the flow of new data failing to offset the loss of the first year of each investigation period. The last paper, WP104, reported growth. The Executive Summary issued alongside WP 104 noted:

> "A key reason for this growth is a substantial increase in the volume of public sector data that has been submitted recently, much of it covering the years 2012 to 2016 only. Some of this was data being submitted for some large public sector schemes for the first time."

As a result of the declining data volumes, the coverage of the investigation was slowly falling, below the 50% previously estimated based on data from 'Pension Funds and their Advisors'. In fact, the Committee identified a better source for such an estimate and, in WP 104, estimated the coverage of the private sector dataset using information on the defined benefit pensions universe from The Pensions Regulator (TPR). Using data for schemes with 500 or more pensioners, it found: "For the year with the greatest volume of private sector data (currently 2009), it appears that approximately 68% of eligible pensioners have been captured by the investigation at some point during that year."

The additional data available in WP 104 allowed the usual analysis to be extended – to compare the experience of private and public sector data and to include some results for male dependants which had previously been omitted due to low data volumes.

WP 104 notes that: "Overall, it will be apparent that the experience of the public sector data is lighter in each case than the private sector data." Given the potentially politically sensitive nature of this finding, it added "It is important to recognise that these results reflect the schemes that have been submitted to the SAPS investigation … Readers should not, therefore, conclude that the experience of any private sector scheme is necessarily heavier than any public sector scheme."

The other noteworthy aspect of this series of working papers was the radical new format adopted from WP 76 – a much more visually-appealing presentation than the earlier reports, suggested by a new committee member, Matt Fletcher.

In addition, the Committee undertook another analysis by industry, using data for 2006-2013, in WP 86, issued in 2015. The analysis included comparisons against the unadjusted "S1" tables, for consistency with the previous analysis in WP 61, and against the "S2" tables with mortality projections based on the CMI Model. The findings were broadly consistent with the earlier analyses; i.e. there are differences in experience between each industry group but these may be partly explained by other factors; in particular, average pension amounts.

The "S3" Series mortality tables

The final dataset from these analyses, 2009-2016, was then used as the basis for the "S3" Series mortality tables, with the proposed tables set out for consultation in WP 107, issued in June 2018.

The dataset was larger than for previous SAPS tables – the lives-weighted exposure had increased by around 14% for male pensioners and 63% for female pensioners compared with the "S2" dataset; the larger increase for females being principally attributable to the increase in public sector data.

[160] The date the paper was originally issued; WP 73, WP 76 and WP 104 were all re-issued, with minor corrections.

The Committee adopted a different principle in selecting the range of tables compared with the "S2" Series, in some cases including two tables with similar mortality rates. As a result, it proposed a total of thirty tables, adding twelve:

- Three new Middle tables and one new Light table, so there would be a full set of Heavy, Middle and Light tables for male and female pensioner and normal health datasets.
- Four new 'Very Light' tables, for the highest pension amounts, based on a subset of the data underlying the equivalent Light tables.
- Two male dependant tables, as the increased volume of data made these datasets credible.
- Light and Very Light female dependant tables.

WP 107 helpfully includes a grid (Table 2.1) comparing the tables proposed for the "S3" Series with those produced for "S1" and "S2", which is reproduced below. The digits (1, 2 or 3) indicates whether the table was included in the "S1", "S2" or "S3" Series, respectively, and gold highlighting indicates the tables proposed in "S3" that were not included in "S2".

Tables included in the "S1", "S2" and "S3" Series:

		Lives			Amounts			Amounts			Amounts			Amounts			Amounts		
					All			Heavy			Middle			Light			Very Light		
Pensioners	Males	1	2	3	1	2	3	1	2	3		2	3	1	2	3			3
Pensioners	Females	1	2	3	1	2	3	1	2	3			3	1	2	3			3
Normal health	Males				1	2	3	1	2	3			3	1	2	3			3
Normal health	Females				1	2	3	1	2	3			3	1		3			3
Ill-health	Males				1	2	3												
Ill-health	Females				1	2	3												
Dependants	Males			3			3												
Dependants	Females	1	2	3	1	2	3	1						1		3			3

One area considered by the Committee that could have increased the total number of tables even further was whether to produce separate tables for the public and private sector data. It decided not to for a number of reasons, including:

- The variations between the shapes of the private and public sector mortality curves are modest compared with the variation between industry groups, found in WP 86.
- The SAPS dataset includes a sample of pension schemes, and different schemes could have led to a different picture of public and private sector mortality in the "S3" dataset.
- "Recognition that scheme-specific analyses, particularly postcode-based studies, have become more prevalent and that many users are likely to be more interested in the shape of the table and less concerned about the absolute level."

There were a number of changes from the approach used to construct the "S2" tables:

- The Committee reconsidered the definitions of the Heavy, Middle and Light amount bands, based on the relationship between pension amount and experienced mortality, rather than simply increasing these in line with inflation. This led in particular to a higher threshold at the top of the Heavy amount band.
- The Committee adjusted the experience dataset to a common date before graduating the "S3" tables, rather than adjusting the graduated rates to a common date, as for the "S2" Series.

- The methods used to select graduation formulae for specific tables took account of the recommendations of the Graduation and Modelling Working Party (described in Section C8), set out in WP 77. As a result, the graduation formulae were simpler, with greater consistency between tables:
  - the "S2" Series used a range of Gompertz-Makeham (GM(r,s)) formulae, but
  - the "S3" Series used simpler, Gompertz formulae – G(4) for all male tables and G(5) for all female tables.
- The approach to extending tables to high ages was based on work carried out by the High Age Mortality Working Party (again; see Section C8), as described in WP 106, issued simultaneously with WP 107.
- A refined method for low age extensions.

WP 107 notes that mortality rates in the proposed "S3" tables are typically lower than would be obtained by projecting the corresponding "S2" table using the latest version of the CMI Model. It adds:

> "These differences may be partly due to higher mortality improvements for pension scheme members than the general population between 1 January 2007 and 1 January 2013, but also, particularly for females, reflect changes in the composition of the SAPS dataset. Because of this – if these proposed tables are issued – we will encourage users to consider the appropriateness of specific S3 tables for their purposes and not simply to replace an S2 table with the S3 table with an equivalent name."

To allow actuaries to replicate the results in WP 107 – and to explore alternative approaches – the Committee released the software used in its work alongside the paper. This was a modified version of the software issued alongside WP 77 to accommodate the new high age and low age extension methods, and to produce the Quasi Bayesian Information Criterion (QBIC) statistic, which was a key criterion in choosing between possible formulae for each table.

The final "S3" tables were released alongside WP 113, issued in December 2018. The level of response to the consultation increased, compared with the "S2" tables, with twelve responses. The responses were broadly supportive of all of the Committee's proposals and no changes were made to the proposed tables, although the suffix for the 'Very Light' tables was amended from 'V to 'VL', to make it obvious that the table was 'Very Light' not 'Very Heavy'.

In addition, the feedback to the consultation prompted the Committee to include additional analysis in WP 113 to help users:

- Analysis of the sensitivity of the "S3" tables to the choice of the period smoothing parameter, S_κ, in CMI_2017[161]; this showed that the "S3" rates are not overly sensitive to the choice of S_κ.
- Analysis of alternative methods of graduating the female Pensioner and Normal health Heavy tables.
- High-level analysis of the "S3" dataset composition and experience by industry classification.
- Comparison of a private sector-only subset of the data to the equivalent "S3" table via flat scaling factors. For the majority of the tables, the scaling factors were found to be reasonably close to 100%. Alongside the paper, the Committee also made available separate public and private sector datasets, to allow users to undertake their own analyses.

Another 'business as usual' phase, 2019-2020

The Committee then entered another 'business as usual' phase, issuing:

- Three regular annual updates on experience:
  - For the period 2010 to 2017 in WP 118, first issued in February 2019[162];

[161] The version of the CMI Model that was used to adjust the data underlying the tables to a common date, prior to graduation.

[162] All of these papers, and several others, were re-issued in June 2022 as the data for a public sector pension scheme in 2012-2016 was found to be incorrect, as discussed later. None of the analyses

  - For the period 2011 to 2018 in WP 126, first issued in November 2019;
  - For the period 2012 to 2019 in WP 142, first issued in November 2020[163];
- An updated analysis by industry classification for the period 2010 to 2017, in WP 121, issued in May 2019.

The first two of these annual updates showed minor developments in the dataset (both were a little smaller than that used to produce the "S3" tables) and in the experience. The slow evolution is unsurprising given the use of a rolling eight-year period; indeed, the midpoint of the dataset used in WP 126 was only about fifteen months later than that underlying the "S3" tables.

There was, though, a significant change to the dataset underlying WP 142 as the Government Actuary's Department (GAD) had provided two large submissions of data in respect of English and Welsh Local Government Pension Schemes (LGPS)[164]. These submissions covered the period from 1 April 2013 to 31 March 2019 and included information on around 90 schemes. As a result:

- The total lives-weighted exposed to risk was around 18% higher than that for the "S3" tables, with LGPS data accounting for around 27% of that exposure.
- WP 142 includes analysis of private sector, local authority and 'other' public sector (i.e. not local authority) data. This found the mortality of the local authority and private sector to be generally comparable but that of other public sector schemes was much lighter.

Analysis of SAPS data by IMD decile

The non-standard output in this period was an analysis of the mortality experience of pensioners by region and Index of Multiple Deprivation (IMD) decile, issued in WP 146 in 2021. The CMI had begun collecting these fields for all of its investigations in 2018 and the background is discussed under 'Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles' in Section C9. The analysis used the subset of the 2012 to 2019 data underlying WP 142 that included region and IMD decile – around one-third of the lives-weighted exposure of the main dataset.

The findings from this analysis included:

- The overall dataset[165] has similar mortality to the general population of England & Wales in less deprived deciles, but lower mortality than the general population in more deprived deciles.
- For males, the dataset has similar mortality for all IMD deciles to that of pension buy-out policies, analysed by the Annuities Committee in WP 138 (see under 'Analysis of pension annuity data by IMD decile' in Section C2). In contrast, mortality for females in the dataset is lower than for pension buy-out policies at all deciles.
- There are material differences in mortality by region within the SAPS data:
  - Of the four UK nations, England has the lowest mortality, and Scotland the highest.
  - Of the nine English regions, mortality is lowest in the South East and South West, and highest in the North East and North West.
- There are material differences between regions even after allowing for IMD decile; for example, age-standardised mortality rates for the South West are lower than those for England as a whole within each IMD decile.

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were updated, but a note was issued that describes the nature of the incorrect data and the impact on the various analyses.

[163] This paper, and WP 146 and WP 158, were also re-issued in November 2022 as the data for a bulk submission of public sector data for 2013-2019 was found to be inaccurate. Again, the analyses were not updated, but a note was issued describing the nature of the issue and its impact.

[164] To avoid the risk of double-counting LGPS data that might have been submitted by both GAD and an actuarial consultancy, the Committee excluded any local authority pension schemes that were previously included in the SAPS dataset with exposure in the same period.

[165] I.e. private sector, local authority and other public sector combined.

Assessing the impact of COVID-19 on SAPS experience

The COVID-19 pandemic added complexity to the next two annual updates on experience:

- For the period 2013 to 2020 in WP 158, first issued in 2021; and
- For the period 2014 to 2021 in WP 169, issued in 2023.

Considering the experience over the whole analysis period was not necessarily appropriate when one or two years exhibited significantly different mortality. This was made more difficult by the nature of data submissions:

- Most submissions are triennial, so the exposed to risk for 2020 would only be complete after submissions are received for 2023 valuations, and that for 2021 after 2024 valuations.
- Submissions often follow a valuation at 31 March or in early April. Consequently, the exposed to risk for 2020 is weighted towards the start of the year in both papers and the exposed to risk for 2021 is weighted towards the start of the year in WP 169. This weighting is pertinent as the impact of the pandemic in the general population was particularly high in April and May 2020 (i.e. after the 2020 valuation date for most schemes) and in early 2021 (i.e. before the 2021 valuation date for most schemes).
- As private sector pension schemes have 15 months to complete a valuation, following the effective date, it will be 2026 before the CMI receives some of the data for 2024 valuations and the 2021 experience is complete[166].

In WP 158, the Committee included results for the full investigation period (i.e. 1 January 2013 to 31 December 2020) but assessed the impact of the 2020 experience by also showing results for 2013-2019 (i.e. excluding 2020) only. This showed that the differences in experience between the two periods are small for all pensioner types but the report cautioned: "While the data for 2020 currently has a limited impact on the overall results, this will likely change in future analyses as the volume of 2020 data increases."

In addition, the Committee analysed the experience by month in WP 158, because "Mortality for the general population was volatile during 2020, being unusually high during the second quarter and unusually low during the third quarter." For male and female pensioners and female dependants, the Committee found that:

> "… the experience in March, April and May 2020 was heavier than the corresponding experience in 2019, and April 2020 was the heaviest month. Experience in other months suggests lighter mortality in the third quarter of 2020 than in 2019, and heavier mortality in the final quarter of 2020 than in 2019. However, the confidence intervals mean we cannot reach firm conclusions about the second half of the year."

WP 169 notes changes to the dataset compared with earlier reports:

> "Since completing the previous experience analysis, we identified two issues with historical data submitted to the SAPS investigation. These affected various CMI analyses including the 2013-2020 experience analysis."

Following these changes, the total lives exposed to risk in this dataset was around 12% larger than that underlying the "S3" tables but the Committee decided not to restate the tables. This approach was similar to that for the "S1" tables, where there were changes to the dataset used but the Committee decided not to restate the tables (described under 'Extending the basic analyses' earlier in this section).

[166] 2026 assumes that data is submitted promptly, following the scheme valuation date It should be noted that these three features are not peculiar to these years, however they have less impact in years with a normal level of mortality.

In addition to considering the experience over the whole investigation period, the Committee also looked at experience by calendar year and found that "…mortality tended to become lighter over the period to 2019 but was heavier in 2020 and 2021." More specifically:

> "Mortality shows sharp peaks in April 2020 and January 2021 … corresponding broadly to the first and second waves of the COVID-19 pandemic. However, the increase in mortality between 2019 and 2020 appears to be lower for the SAPS dataset than in the general population."

WP 169 also includes analysis by sector, due to the changes to the public sector dataset noted above. The high-level conclusion was unchanged from that found in previous analyses:

> "The mortality experience seen in the other public sector data … is lighter than the experience seen in the local authority and private sector data."

The "S4" Series mortality tables

The SAPS Committee's final two working papers in the period covered by this book both relate to the proposed "S4" Series mortality tables, with the high-level approach set out in WP 174 and the proposed tables issued for consultation in WP 181, both released in 2023.

WP 174 notes that:

> "In normal conditions we would have based the S4 tables on data for 2014-2021, the latest available eight calendar year period which was analysed in Working Paper 169. However, our analysis in that paper shows that experience in 2020 and 2021 was unusual because of the COVID-19 pandemic. Because of this, we propose to exclude data for 2020 and 2021 and graduate the S4 tables using data for 2014-2019 inclusive."

Despite using a shorter period of data, the males dataset was similar in size to that for the "S3" tables and around 5% larger for females. The paper also notes that the dataset has a different composition, with less private sector data but more local authority data than the "S3" dataset.

The Committee also proposed:

- "…to exclude data for male Pensioners with pensions less than £300 p.a. due to the unusual experience of this group."
- "…to retain most of the "business as usual" graduation methods from S3. However, we propose to increase the amount bands that delimit the amount-banded tables to broadly reflect inflation from the effective date of the S3 tables to the proposed effective date of the S4 tables."
- To update all of the S3 tables and "…to include 12 new amounts-weighted tables in the S4 series, which incorporate IMD as well as pension amount."

These 'IMD tables' consist of four tables for each of male and female pensioners and female dependants[167]. These were derived by splitting:

> "…the data for each pensioner type into four groups based on the mortality experience of different "cells" (defined by a combination of IMD decile and pension amount) and assign each cell to a group so that cells assigned to the same group have similar mortality."

These tables generally have a wider range of mortality rates than those based solely on pension amount, particularly for female pensioners, where the 'amounts only' tables in each series of SAPS tables have shown relatively little variation in mortality.

The second consultation paper, WP 181, notes that twelve responses to WP 174 were received and that these "…were broadly supportive of our proposals." As a result, the tables presented in WP 181 were very similar to those in WP 174 but included, for example, extensions to younger and older ages that were outside the scope of the first paper.

[167] No IMD tables were produced for male dependants as this is a much smaller dataset.

The “S4” tables were finalised alongside WP 185. This was published in February 2024 so is outside the scope of this book but, in brief:

- The consultation on WP 181 received twelve responses.
- The responses were generally supportive, and the Committee did not make any changes to the tables as a result of the consultation responses.
- The only change from the proposed tables was to update the general population estimates, used in the high age extensions and most of the low age extensions, to reflect new data published by the Office for National Statistics (ONS). The updated data reflects the results of the 2021 Census in England & Wales and the changes to the “S4” tables that had been proposed in WP 174.

C7. Mortality Projections

Setting the scene

Whilst, for the population of England & Wales[168], there were significant reductions in mortality rates at younger ages from the mid-19th century onwards, period life expectancy at age 65 showed little change from the 1850s even into the first two decades of the 20th century. Thereafter mortality rates at pensioner ages began to reduce: slowly at first, with life expectancy at age 65 gaining around one year over the period from 1920 to 1970 for men (although closer to two years for women), but then accelerating markedly, decade after decade, through the 1970s, 1980s, 1990s and into the first decade of the 21st century.

Alongside higher mortality improvements at pensioner ages, the economic environment also changed substantively – the high investment returns of the 1970s and 1980s were replaced by an era of low interest rates[169]. These changes increased the importance of assumptions regarding future mortality for annuities and pensions.

Despite this backdrop, at the start of 2000, the CMI's work on mortality projections remained within the remit of the Mortality Committee and was afforded less attention than base mortality. The most recent published mortality tables – the "92" Series[170] – had included a single set of improvement factors; these tended to zero over time and applied to all the tables for pensioners, annuitants, and widows.

This situation was about to change substantially with mortality projections coming to the forefront of the CMI's work.

The Interim Cohort Projections

Heightened interest in assumptions concerning future mortality improvements led to a great increase in research, from the late 1990s. This included analysis of the patterns and variations in mortality improvement rates across the population by the Government Actuary's Department (GAD) and others and research into the drivers of observed mortality trends.

Richard Willets' SIAS paper 'Mortality in the next Millennium' (1999) drew the attention of actuaries to recent trends in mortality and, specifically, to an apparent cohort effect: the pace of improvement had been consistently more rapid for those individuals born in particular calendar years than for those born before or after. For the population of England & Wales, this 'golden cohort' was centred on the generation born around 1931. It was, therefore, of considerable financial significance at that time to insurers writing annuities, which were sold principally to males at age 65.

The CMI invited Richard to join the Mortality Committee in 1999 and, soon after, it established a Mortality Projections Working Party[171] to analyse the available data further and develop proposals for revised mortality projections. The Working Party analysed both the CMI's data, for example for permanent assurances from 1947, and population data. The approach used was to graduate the crude mortality rates by both age and calendar year using fitted two-dimensional splines. The

[168] Although the CMI's interest might be in mortality trends for the UK, data for England & Wales has often been used as a more convenient proxy, as it is published separately from that for Northern Ireland and Scotland and is often available sooner.
[169] There was a further step-change – to 'ultra-low' long term returns – following the 2008 credit crunch, which lasted until late 2022. This further increased the relevance of mortality improvement assumptions but was less significant as a driver of the CMI's work, as initiatives such as the development of the CMI Model were well underway by then.
[170] See 'Mortality experience in 1991 to 1994 and the "92" Series tables' in Section B2 for more information on these tables.
[171] As noted in Section C2, this was a sub-group of the Mortality Committee, set up alongside the Mortality Graduations Working Party, which focused on producing the base graduations of the 1999-2002 data.

technique used was new and developed by Iain Currie, at Heriot-Watt University, specifically for this project, with the work undertaken by Iain's team. WP 1 (see below) notes that:

> "Besides producing a set of q_x that are smooth both by age and year, this approach has the considerable advantage of imposing no preconceptions about 'shape' on the graduation. Thus the results produced are entirely driven by the data. A second advantage is that the method does not over-smooth the data and so does not remove features in the data that may interest us."

The analysis showed clear evidence of cohort effects in past mortality improvements, with the CMI data appearing to show the peak of improvements was centred on lives born around 1926 – a few years earlier than that apparent in the population data.

The analysis was published in the first CMI working paper[172], WP 1, in December 2002. It also included the Interim Cohort Projections which provided possible modifications to the previously published projection basis and could be applied to all the base tables contained in the "92" Series tables. The Interim Cohort Projections assumed that improvements were most rapid for the generation born in 1910 to 1942, centred on 1926. They were based on CMI experience data up to 1999 and assumed that the impact of the cohort effect would begin to fade away from 2000, lasting until 2010 (Short Cohort), 2020 (Medium Cohort) or 2040 (Long Cohort).

The cohort projections were perhaps were the first CMI output to draw attention to uncertainty around future longevity as a risk requiring significant management. They also introduced the principle – that persists to this day – that it is for actuaries to make a conscious choice of which projection basis to use, rather than the CMI providing a single basis.

WP 1 notes that:

> "The newly updated projections are based on work done in the first half of 2002. This work is not yet complete. The updated projections have been produced relatively quickly with the intention that offices could use the suggested adjustments in their 2002 year-end valuations if they think it appropriate."

However, the timing of the release brought criticism, as it was considered to be too close to most insurers' year-ends. This led to many discussions within the Executive Committee over subsequent years about acceptable 'windows' within which it might be appropriate to release sensitive new material whilst balancing with the difficulty it could cause volunteers on CMI committees in having access to new findings that they could not (yet) share with their employer. As I recall, this issue was never fully resolved, other than the CMI seeking to ensure it kept stakeholders informed of its progress and plans.

A draft of WP 1 was distributed to CMI contributing offices and to Appointed Actuaries prior to a discussion at the Birmingham Life Convention in November 2002 and the responses are summarised in WP 2, released alongside WP 1. The publication of the Interim Cohort Projections was not universally well-received, possibly due to the large, unforeseen impact on reserves; for example:

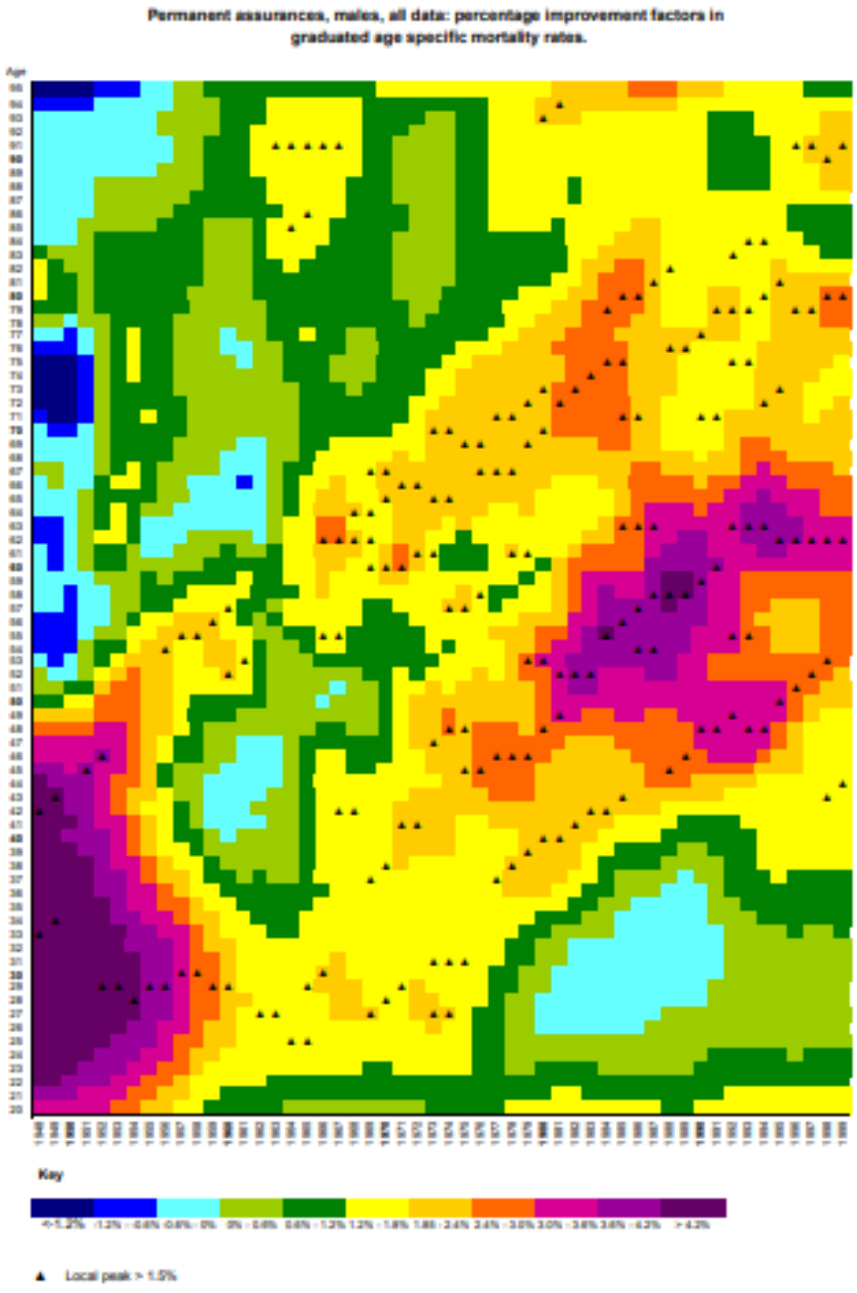
- Several speakers expressed concerns that the reason for the higher improvements was unknown and WP 2 notes "…that the draft report was silent on the reasons for the improvements seen and that credibility of the projections was damaged by this omission. One respondent said: "*Without any real understanding of cause, it is difficult to have confidence in the subsequent projections.*"[173]"
- There were concerns around "…the process used by the CMI to release the draft report and collect feedback on it. Some respondents felt that the timescale for consultation was too short and that, once finalised, the draft report, which is based on work in progress, would impose a standard that had not had full professional scrutiny.

[172] See 'CMI Reports and working papers' in Section C9 for the background to the CMI introducing working papers.
[173] WP 2 used italics to denote quotes from respondents.

> *" … there is a danger that the CMI will in effect be imposing a valuation standard which has not been subject to the level of attention appropriate to the scale of the liabilities at issue."*
>
> *" … [the report] should be subject to full professional challenge, perhaps through a sessional meeting, before being adopted by the profession."*
>
> *"I'm very concerned that this work is being rushed through for the 2002 year end.""*

As well as using a new technique in the analysis, WP 1 also used 'contour maps' (or 'heat maps') to illustrate the historic rates of improvement. An example, for male permanent assurances, is contained below – the 'golden cohort' is visible in the patch of purple cells to the right of the chart, with a series of local peaks on a bottom left–top right diagonal:

A 'contour map' from WP 1:



In March 2003, the CMI submitted a paper, 'Mortality Improvements and the Cohort Effect' to the Staple Inn Actuarial Society. This comprised WP 1 plus WP 2, with a brief introduction and it may

have been an attempt to broaden the audience, as WP 1 had been presented to the Life Conference (i.e. it was unlikely to have come to the attention of pension actuaries).

The paper was one of two papers to be awarded an Institute prize for the session 2002-2003 and I am grateful to Richard Willets for supplying a photograph (reproduced below) of the authors receiving the prize:

The authors of 'Mortality Improvements and the Cohort Effect':

From left to right: Adrian Gallop, Angus Macdonald, Iain Currie (Heriot-Watt University), Jeremy Goford (President of the Institute of Actuaries), Tony Leandro, Richard Willets and Rajeev Shah.

The SIAS paper and the underlying working papers were published in the name of 'the Mortality Sub-Committee of the CMI', however WP 1 notes that: "This report has been prepared for the Mortality Sub-committee of the CMI by a working party consisting of Angus Macdonald, Richard Willets, Adrian Gallop, Tony Leandro and Rajeev Shah." Curiously, the group who received the prize also includes Iain Currie, whose role was noted in WP 1 (and above) but who was not a named author.

Further research on methods for mortality projection[174]

WP 1 set the scene for further work, noting: "The longer-term aim of the CMI is to have a rather more considered and robust projection methodology available for the next set of tables which will probably be based on the 1999-2002 quadrennium."

Accordingly, the Mortality Projections Working Party produced a series of papers and hosted events to stimulate discussion of mortality projections. The first paper, WP 3 (2004), set out preliminary thoughts on the uncertainty surrounding mortality projections and summarised different types of projection methodologies and their key features. It also included a summary of a joint seminar held by the CMI and the Government Actuary's Department (GAD), in Edinburgh on 6 October 2003, "…to discuss the views and approaches of demographers, statisticians and gerontologists, all of whom

[174] A fuller summary of the early work described in this section can be found in WP 15 (2005).

have a strong professional interest in the projection of future mortality and its underlying causes. Its three themes were:

(a) Projecting aggregate mortality versus modelling individual causes.

(b) Methodology of projection and statistical methods.

(c) Limits on human lifespan and molecular effects on ageing."

WP 3 notes that "[It] is intended to be a consultation document, to stimulate thinking within the profession and to invite discussion and responses." The responses received were set out in WP 11 (2005), together with a summary of the discussion at a seminar at Staple Inn[175] and the Working Party's responses to the feedback. The paper highlighted the need for quantitative measures of the uncertainty associated with mortality projections and confirmed there was no consensus at that time in respect of a preference for any particular projection methodology.

As well as the CMI's work, there were widespread parallel developments within the field of mortality trend analysis and projection models, by both actuaries and researchers in academia. In particular, Willets et al presented a paper 'Longevity in the 21st Century', to sessional meetings of the Faculty and the Institute in 2004[176]; the authors included a number of those involved in the CMI's work, as well as Richard himself.

Soon after the release of WP 11, the Mortality Committee issued new proposed base mortality tables in WP 12, which became the "00" Series tables[177]. These were issued without any accompanying projections, as there was no agreed basis for these. At that time, the CMI appeared to think that its work on projections could be rapidly concluded – WP 15 states: "[The new tables] will be published as one or more Working Papers later in 2005, once the work on projections is completed".

The Working Party continued its work with a number of papers exploring the use of statistical models for mortality projections. The first, WP 15 (2005), provided a summary of two methodologies for mortality projection: the penalised spline, or P-spline, and Lee-Carter models.

The title of WP 15 is "Projecting future mortality: Towards a proposal for a stochastic methodology", reflecting the CMI's hope that a single suitable methodology could be found and proposed for widespread use. In particular, the assessment of stochastic methodologies was driven by a desire for quantitative measures of uncertainty to be generated by any projection:

- WP 11 notes that: "In an informal show of hands, attendees at the seminar voted overwhelmingly in favour of measures of uncertainty being provided with the next set of projections. No one voted against the proposal" and the Working Party's response that: "[It] … believes cohort projections with measures of uncertainty could readily be created from the output of a stochastic projection by choosing a suitable confidence interval."
- WP 15 describes "…recent changes in the regulatory environment and professional guidance for actuaries…" that added to this desire.

WP 15 concludes: "Therefore, we intend to continue to develop both models [P-spline and Lee-Carter] into proposals for methodologies, while acknowledging the limitations of each." That intent manifested itself in two further papers:

- WP 20 (2006) explored P-Spline models in further detail; and
- WP 25 (2007) considered Lee-Carter models further, including an extension of the original, age-period Lee-Carter model by Renshaw and Haberman[178] to an age-period-cohort model, to incorporate cohort effects.

[175] The seminar discussed both WP 3 and WP 8, which was produced by the Mortality Graduation Working Party on the graduation of mortality data in 1999-2002 (see Section C2).
[176] Published in the British Actuarial Journal (2004).
[177] See 'The road to the "00" Series tables' in Section C2.
[178] Renshaw A. E. and Haberman S. (2006) 'A cohort-based extension to the Lee-Carter model for mortality reduction factors'. Insurance, Mathematics and Economics 38 (3), 556-570.

To support and encourage practitioners to work with these models, the CMI made available the illustrative software it used in its research into the P-Spline and Lee-Carter models. This was developed by James Kirkby, a PhD student at Heriot-Watt. At the time, the CMI noted: "The software is not commercial grade but was intended to allow users to experiment with the methodologies." The software used the statistical package R, together with the R(D)COM interface, and it was withdrawn[179] early in 2009 because it was not compatible with newer versions of R and/or the interface.

WP 20 includes a summary of the Working Party's findings on P-splines but WP 25 includes the Working Party's "high-level objectives desirable of projection models" and its assessment of the three models (P-Spline, Lee-Carter and age-period-cohort Lee-Carter) against these objectives. Its overall conclusion was:

> "We believe that both the P-Spline and Lee-Carter models have particular features that make them suitable for certain purposes but consider that neither of these models meets all the desirable objectives for projection models[180]. Therefore, we are not able to recommend any particular projection model for use with the CMI "00" Series tables."

As a result, the "00" Series tables were finalised (as discussed in Section C2) with the absence of any projections rather overshadowing the tables themselves!

The CMI 'Library' of Mortality Projections[181]

The resulting void led to a wide variety of practices (see, for example, 'Should Projections of Mortality Improvements be Subject to a Minimum Value?' by Steven Baxter[182]) and many high-level discussions, involving the two regulatory bodies, the Financial Services Authority and the Pensions Regulator, the recently-established Board for Actuarial Standards (BAS)[183], and the Institute and the Faculty, as well as the CMI.

As noted in WP 27, issued in 2007: "It soon became clear that the absence of projections [in the "00" Series tables] left a gap that has caused much debate in recent months, both within the Profession and between the Profession and interested external stakeholders."

In an attempt to prevent the absence of projections from becoming a major issue for the profession, and given the continuation of significant year-on-year increases in period life expectancy and concerns over the continued widespread use, albeit with modifications, of the Interim Cohort Projections which had inevitably become increasingly out-of-date, the CMI established a Task Force, chaired by the prospective Chair of the Executive Committee, Gordon Sharp. The minutes of the Executive Committee meeting in October 2006 that initiated the formation of the Task Force noted that:

> "…not to have the CMI involved would be a retrograde step. To this end, it was suggested that a project should be initiated to take this forward. It would take into account users' needs and how they use mortality projections in their own work. It would have an objective of building a set of tools that could be a starting point from which individual actuaries could decide suitable assumptions. The end result could include "benchmark projections". It was essential that the outcome could not be interpreted as a standard (which would be the role of the BAS)."

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[179] It was made unavailable to new users; existing users were notified of the issue, but no attempt was made to retract their software. The CMI also continued to make it available on request to anyone able to locate appropriate versions of R and the interface.

[180] For example, P-splines were regarded as good for fitting data but less good for projections, as they were vulnerable to 'edge effects', giving excessive weight to the most recent data.

[181] This is referred to as simply 'the Library' in the remainder of this part of the book.

[182] Presented to the Institute of Actuaries, 26 February 2007, with the paper published subsequently in the British Actuarial Journal (2004).

[183] The Board for Actuarial Standards (BAS) was set up following the Morris review and subsequently became part of the Financial Reporting Council.

The outcome of the Task Force's deliberations was to issue a consultation on 'The "Library" of Mortality Projections' in WP 27. The paper included a number of questions on which views were sought and the consultation exercise included meetings in London and Edinburgh in July 2007.

The aims of the Library were stated as "…a single reference source … for use by actuaries" and to provide "…a well-defined vocabulary for mortality projections". The Library itself was contained in an Excel spreadsheet, with each sheet containing a two-way table of cumulative mortality reduction factors, by age and calendar year, for a particular projection.

The 41 projections in the draft Library comprised:

- Previously-published tables of projections:
  - The original "92" Series projections,
  - The Interim Cohort Projections and
  - The ONS 2004-based National Population Projections[184].
- Adjusted Cohort Projections:
  - Applying a minimum value,
  - Using a percentage of the cohort projections,
  - Blending two cohort projections, and
  - Blending two cohort projections and applying a minimum value.
- Sample projections using the CMI's illustrative software:
  - P-spline projections and
  - Lee-Carter projections.

The responses received to WP 27 and the draft Library, as well as the Task Force's reaction to these, were summarised in WP 30, issued later in 2007 alongside version 1.0 of the Library. The high profile of mortality projections at that time was reflected in the extent of the responses; WP 30 notes:

> "Over 40 responses were received[185] from a variety of individuals and organisations, including many of the larger insurance companies and pension consultancies. The Task Force believes it can reasonably consider the feedback to be representative of the views of a wide spectrum of the UK Actuarial Profession."

As far as the need for the Library was concerned, WP 30 notes: "This was not a question on which we sought responses, though perhaps we should! The vast majority of responses either explicitly stated that they welcomed the Library or appeared to support its introduction from their general comments."

In addition to the concept of the Library, many detailed aspects of the Library were also supported but version 1.0 of the Library did incorporate a number of changes, including:

- The ONS provided its 2004-based projections for males in Scotland and these were included.
- The ONS also provided the 2006-based National Population Projections, which had recently been published, and these were also included.
- The P-spline projections were extended to include the values to enable a user to produce a projection for any percentile (only the 50th percentile projection, hard-coded, was included in the draft version).
- An additional variation on the Interim Cohort Projections was included to illustrate the methodology for applying a minimum to a percentage of a cohort projection.
- The projections in the draft Library ceased in 2100; these were extended to 2130.

[184] Following the Morris review, responsibility for the production of the official population projections for the UK and its constituent countries was transferred from the Government Actuary's Department (GAD) to the Office for National Statistics (ONS) with effect from 31 January 2006.
[185] An unprecedented response for a CMI consultation at that time!

The Library was always envisaged as a 'living document' – indeed WP 27 contained the Task Force's initial thoughts on future updates – and the Projections Library Committee was formed to oversee future updates, after the release of WP 30, when the Task Force was disbanded. Its initial membership was limited to three – Gordon Sharp, as Chair, plus Kevin Armstrong (representing the Life Office Mortality Committee) and Brian Wilson (SAPS). The inclusion of a member from each of the other mortality-related committees was intended to ensure that the Library served the needs of both the insurance and pensions communities and that the work of the three committees was aligned.

Several further versions of the Library were released:

- Version 1.1 in March 2009, alongside WP 37;
- Version 1.2 in June 2011;
- Version 1.3 in November 2011;
- Version 1.4 in April 2013; and
- Version 1.5 in August 2014

Each of these releases added projections to the Library (none were ever withdrawn); for example, version 1.1 contained 15 additional projections, generated using three models (P-Spline age-period, P-Spline age-cohort and Lee Carter) applied to five new datasets: ONS data to 2006 and to 2007 for both males and females, and CMI permanent assurances data to 2006 for males only.

WP 37 explained the change in classification of deaths that had occurred in the ONS data[186] used to generate some of the projections in the Library, and to illustrate its impact.

As there were no changes in methodology in the subsequent versions, no working paper was deemed necessary. It is pertinent to note that the CMI did not consider it necessary to consult on these versions of the Library and that a similar approach was subsequently adopted for the Model, with consultations undertaken only for non-routine updates.

In 2010, the Projections Library Committee took on the oversight of the CMI Mortality Projections Model[187], in addition to the Library, and was renamed the Mortality Projections Committee (as discussed below).

As the Model gained widespread acceptance, the need for the Library became less clear and, in 2013, the CMI issued a consultation on the future of both the Library and the Model, in WP 64[188]. The paper noted that:

> "…the Committee proposes to cease updating the Library, unless the consultation generates a strong endorsement for its maintenance. If it is retained, then feedback on which projections are valued will be useful to enable the Committee to limit the future scope to the areas of value."

The results of the consultation were reported in WP 69, issued in September 2013. With regard to the Library, it notes that:

> "Although some views corroborated … [ceasing updating the Library], a majority was in favour of its retention – the ONS National Population Projections were noted in several responses as being of considerable value, in particular because the versions in the Library are better suited to some actuarial purposes than the outputs issued directly by the ONS. Provided the ONS is prepared to make the detailed projections available to the CMI, the Committee is therefore happy to continue updating the Library periodically in its current format but intends to keep other changes to a minimum."

[186] The ONS datasets used for the Library contained data on deaths measured by date of registration for 1961-1992, and date of occurrence for 1993-2005; from 2006, the ONS reverted to using registration data.
[187] Referred to as simply 'the Model' in the remainder of this part of the book.
[188] See 'Oversight of the Model, 2010-2013' for a description of this paper (and WP 69) relating to the Model.

In fact, the next version of the Library, version 1.5, contained 20 additional projections: the ONS 2012-based National Population Projections and the ONS 2010-based National Population Projections (for the UK only) but also further extending the series of P-spline age-cohort and Lee-Carter projections, by applying the models to datasets running up to 2012.

The user guide for version 1.5 also noted an intention to release another version: "The next update is expected to be published shortly after the release of the ONS 2014-based National Population Projections." However, there appears to have been a subsequent change of heart and no such update appeared; instead, the CMI asked the ONS to publish the 2014-based National Population Projections in the form contained in the Library itself – which it duly did[189] – and there were no further updates to the Library.

Initial concept of a mortality projections model

Despite the release of the Library, in 2007, the CMI did not see its work as complete and discussions with representatives of a number of regulatory bodies led to a request that the CMI should try to produce 'up-to-date benchmark projections'. This led to the CMI establishing another working party, to consider whether and how the CMI could provide additional tools for actuaries in this area.

Specifically, the CMI aimed to produce a new model which would retain the most desirable features of the Interim Cohort Projections but which could more easily be kept up-to-date. It considered the advantages of the Interim Cohort Projections over more sophisticated models were:

- they offered an easy basis for comparison – a 'common currency';
- they could easily be modified (e.g. by adding floors); and
- they could be applied to any base mortality table or assumption set.

Whilst retaining those features, the Working Party's aim was for a new model to also:

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

Richard Willets, by then a member of the Executive Committee, thought that these aims could be met by developing a relatively simple spreadsheet model and recalls putting forward the proposal for such a model to Gordon Sharp, the incoming Chair of the Executive Committee in early to mid-2008.

Richard envisaged that this model would be based on annual rates of mortality improvement rather than absolute rates of mortality. Initial rates of improvement, based on analysis of recent experience, would blend over time into long-term rates of improvement, input by the user. Such an approach had been adopted by practitioners in a number of countries, including in the UK for the mortality projections that formed part of the National Population Projections. The approach reflects a view that the most recent experience is a good guide as to the likely pace of change in mortality rates in the short term but, in the long-term, the forces driving mortality change are likely to be very different. 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.

Gordon warmly received the proposal and asked Richard to lead a group to develop the proposal further.

[189] These can be found at: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/adhocs/0052542014basedmortalityprojectionsqxinputratesandcumulativeimprovementfactorsbysexuk.

The following two sections have been written by Neil Robjohns and Richard Willets, Secretary and Chair, respectively, of the CMI Mortality Projections Model Working Party, 2008-09; I have added some comments in footnotes.

Initial development of the Model

The CMI established the Mortality Projections Model Working Party in mid-2008 to develop and implement the proposal with Richard Willets as its Chair, supported by Adrian Gallop (representing the CMI Life Office Mortality Committee and also providing a link to the ONS), Brian Wilson (representing the SAPS Committee), Joseph Lu and Neil Robjohns (CMI Secretariat).

Richard Willets produced an initial draft of the Model as an Excel spreadsheet. Initial rates of mortality improvement were based on a P-spline model fitted to data covering 1961 to 2007 for the general population of England & Wales[190]. Simple linear interpolation was used to transition from initial to long-term rates of improvement.

The Working Party then further developed the structure and form of the Model, within the framework implied by the agreed principles and aims, and considered how to 'industrialise' the Model and make it suitably robust for the expected wide range of potential uses and users.

A key early decision[191] was that the new Model would not provide a single, central projection (unlike earlier CMI tables), nor even a small set of benchmark projections (like the Interim Cohort Projections). Whilst many elements of the Model would be given default values, a key parameter – the assumed long-term rate of improvements – would be a mandatory user-input. That structural design reflected the view that no single value (or parameterisation more generally) could be appropriate across the wide range of users and uses, and the approach was considered to be consistent with changes to the role, approach and governance of the Institute and Faculty following the Morris Review.

The development work was largely funded by a research grant from the Institute and Faculty, although the necessary work became a larger task than originally envisaged[192].

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

- base mortality rates, reflecting the estimated current or recent past position[193];
- 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.

[190] Separately, for males and females.
[191] We think this was a decision taken by the Executive Committee prior to the Working Party being established that the CMI should not provide a single projection.
[192] The minutes of the Executive Committee meeting in October 2008 note that "…a detailed plan of work had been drawn up which had highlighted the scale of the work needed" with costs estimated at £150,000. They continue: "The costs could be reduced if more volunteer input was used, instead of Secretariat time, but this was likely to delay the work" and Gordon Sharp agreed to submit a proposal to Management Board recommending "…that the Profession agrees to pay the £150,000 needed to fund this projection model to the consultation stage."
[193] Although the Model operates on rates of mortality improvement, to produce projected future rates of improvement and cumulative mortality reduction factors, it also contains a facility for users to input base mortality assumptions to enable calculation of projected absolute mortality rates and sample expectation-of-life and annuity factors.

The Working Party was keen to ensure the Model remained open, with all parameters and calculations fully visible to users. Two levels of parameters were developed 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 contained a large set of parameters, and by selecting it users could obtain unrestricted access with considerable flexibility to modify the projections generated.
- However, the 'Core' level provided an option for users to operate the Model at a much simpler level, by applying default values to most of the parameters (including initial rates of mortality improvement and the convergence assumptions) and leaving the user to concentrate on just two simplified parameters: the 'Long-Term Rate of Mortality Improvement' and a 'Constant Addition to Rates of Mortality Improvement'.

It was also decided that the Model should only use relatively basic and widely known features in Excel. In particular, VBA code was specifically excluded from the design following difficulties related to the CMI's illustrative mortality projection software[194].

A material portion of the development work focused on the initial rates of improvement. It was decided to subdivide both the initial and the long-term rates of mortality improvement into two components: age/period and cohort. These components would be projected separately, by age and by year-of-birth cohort respectively, and then recombined. The Core assumptions for the initial rates were derived by a three-stage process, fitting an age-cohort P-Spline model to determine aggregate rates of improvement, fitting a secondary age-period-cohort model to those fitted aggregate rates to determine the component parts, and then allocating the residuals between the two models in the initial year of the projection.

P-splines were regarded as being good for fitting historical data, without imposing undue structure, but vulnerable to 'edge effects', i.e. giving excessive weight to the most recent data. The Working Party undertook extensive research on this issue and concluded that mortality improvement rates derived on the leading edge of the data were subject to too great an estimation error, and that the issue could be best managed by taking estimates from inside the edge. A trade-off was required between estimation uncertainty and currency. The Working Party opted to base its estimates on improvement rates calculated two years inside the edge of the data, effectively using the last two years' data to allow a small amount of hindsight into the calculation so that the estimates were less likely to be significantly revised when further years' data were added.

For the prototype Model, age-cohort P-splines were fitted to data for years 1961 to 2007 (and ages 18 to 102) to produce smoothed mortality improvement rates for years 1963 to 2005 (and ages 20 to 100); in particular, the initial rates of mortality improvement were taken as those estimates for 2005 and the first year of the projection was therefore 2006.

The Working Party also built some additional flexibility into the Model for the convergence from initial to long-term rates with parameters to control the convergence time-period and the proportion of the total change in rate remaining by the mid-point of that period.

An early draft of the Model incorporated a parameter to enable the user to shift the peak birth-year for the 'golden cohort' effect, recognising that previous work had estimated the peak to be around the 1926 birth-cohort for insured lives and 1931 for the general population. However, that optionality was removed after further research suggested the peak for the insured population actually aligned more closely with that observed in the general population.

The Model was further developed to include a range of outputs, customisable by users, to illustrate the projection. These included sample annuity and expectation-of-life values when the projected rates of mortality improvement were combined with a (user-selected) base mortality table.

[194] Noted earlier, under 'Further research on methods for mortality projection'.

Building on the principles established with the Library for a well-defined vocabulary for mortality projections, a formal naming convention was proposed for projections produced using only the Core level of parameters. The prototype version of the Model was named 'CPMv0.0' ('CPM' for CMI Projections Model), vx.y for the version number of the Model and, for example, 'CPMv0.0 [1.5%] {male}' was proposed as a shorthand reference for a projection for males produced using the prototype Model with a Long-Term Rate of Mortality Improvement of 1.5% p.a., no Constant Addition to Rates of Mortality Improvement and all the other parameters set to their default values.

Alongside the development of the spreadsheet Model, a material body of research was produced to help inform the Working Party in setting default values for the Core parameters. This work was documented and released alongside the Model to assist users in forming their own view of a suitable parameterisation for their application of the Model.

Consultation and launch of the Model

The Prototype version of the Model was released on 19 June 2009 alongside WP 38 and a user guide. The body of research helping to inform parameterisation of the Model was released as WP 39 on 7 July 2009, and a consultation ran over the rest of July and August.

Consultation meetings were held in July 2009 in Edinburgh and London. We recall a period of very intense activity to get the prototype Model and working papers delivered in time for those meetings. Indeed, the sprint for the first meeting, in Edinburgh, culminated in finalising presentation slides on the flight there whilst also nervously anticipating the reactions and questions we might receive.

One point we thought could be sensitive was how the decision to use data for England & Wales (rather than all UK) would be received north of the border but it seemed the pragmatism of the approach was accepted. Overall, the meeting felt positive and collaborative with a relatively small but well-engaged audience of around 20 actuaries and academics. There were long delays on the flight home that evening which at least allowed time to wind down a little and reflect on the development of the Model to that point.

The run-in to the London meeting, a week or so later, felt much calmer. The audience at Staple Inn exceeded 100 and, again, the discussion felt engaged, constructive and positive overall.

Whilst there were some interesting and complex points of debate, the key messages emerging through the consultation exercise[195] 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 there was material debate 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.

[195] 39 responses were received.

The Model was then updated, in particular to incorporate England & Wales population mortality data for 2008, and the first live version of the Model was released alongside WP 41 in November 2009, together with a user guide and a set of parameter sensitivity test results. This was named CMI_2009, revising the naming convention in response to feedback.

A webinar was also held to promote the Model a wider audience. This covered how to use the Model as well as the derivation of the (updated) default parameters. Actuarial Profession webinars were relatively new then and the audience, estimated to be over 1,000, was thought to be the largest ever UK actuarial audience at that time. The webinar technology felt new then too. Of course, practice sessions and technical rehearsals were undertaken and all went well. However, the actual webinar was held at lunchtime and we were alarmed to discover that the general spike in internet use over lunchtime was too much for the primary link to cope with and some connectivity was lost immediately prior to the start of the webinar! Fortunately, or actually by good design, the Secretariat's IT support team had had the foresight to put an independent back-up line in place, so we were able to broadcast the webinar seamlessly, albeit with only one of the three co-presenters[196] having control of the slides.

Oversight of the Model, 2010-2013[197]

With the release of the first version of the Model, the Mortality Projections Model Working Party was disbanded. Oversight of the Model was assigned to the Projections Library Committee, which was duly renamed the Mortality Projections Committee. Despite the expanded scope, the membership remained at just three[198]; the minutes of the Executive Committee that approved this change record that: "The main tasks of the committee would be to oversee regular updates to the Model and the Library; it is not expected to commission new work on mortality projections in the near future".

The Committee oversaw three new versions of the Model:

- CMI_2010 was issued alongside WP 49, in November 2010;
- CMI_2011 was issued alongside WP 55, in September 2011; and
- CMI_2012 was issued alongside WP 63, in February 2013.

The only change in the CMI_2010 Model was to incorporate England & Wales population mortality data for 2009. WP 49 notes that: "Overall, the CMI believes that the CMI_2010 Model has shown a smooth evolution from the CMI_2009 Model.", which would have been hoped for given the newness of the Model – a less smooth progression could have undermined confidence in the Model.

The Committee next released WP 54, in August 2011. This set out a proposal to bring forward the release date of each year's version of the Model. WP 54 summarises the issue thus:

> "Both versions of the Model [i.e. CMI_2009 and CMI_2010] were released in late November, driven by the availability of data from ONS. The final piece of data required by the CMI has been released towards the end of September each year. Some users, in particular life offices, have commented that issuing the Model in November does not leave them enough time to make use of the Model at that year-end."

The "final piece of data" referred to above were high-age population estimates for single years of age, as the figures published earlier in the year grouped ages 90 and over. As the ONS produced their estimates using a published methodology, applied to data which was largely in the public domain a few months in advance of their publication, the Committee investigated whether it could produce an earlier close approximation to the figures itself using that publicly-available data. It concluded "…this can be achieved without material loss of accuracy in the context of using the estimates in the CMI Mortality Projections Model."

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[196] The three presenters were Gordon Sharp (Chair of the Executive Committee), Richard and Neil.
[197] As noted earlier, the preceding sections were written by Neil Robjohns and Richard Willets; I have taken back the pen from this point forward.
[198] However, the actual members changed – Jonathan Hughes took over as the Life Office Mortality Committee representative and Jon Palin as the SAPS Committee representative during this period.

As the CMI believed the issue to be non-contentious, it allowed only a short timeframe for responses – WP 54 was issued on 4 August with a deadline of 9 September.

The outcome was positive, and CMI_2011 was duly released a week after that deadline, alongside WP 55. The structure of CMI_2011 was unchanged from CMI_2010; the only changes being to use population data for 2010 and to change the process to use the Committee's high-age population estimates instead of waiting for their official publication by the ONS, as envisaged in WP 54.

Ironically, given the Committee's move to bring forward the release date of the Model, the release of the next version, CMI_2012, alongside WP 63, was deferred, until February 2013. The reason for the delay was that the CMI chose to wait for the ONS to release revised population estimates for England & Wales for mid-2002 to mid-2010, following the 2011 Census. Given the tight timescales, it was not possible for the CMI to undertake a full consultation on this delay but the Executive Committee minutes of 10 October 2012 record that "…a limited consultation had been undertaken to seek views on deferring release of CMI_2012 … before this was announced publicly."
The impact of the revised estimates took many actuaries by surprise and was especially pronounced at the highest ages (90+), where the 2011 Census led to reductions in the 2011 population estimates of around 15% for males, and 5% for females. As a result, the default initial rates of mortality improvement in CMI_2012 were significantly lower than those in CMI_2011.

In April 2013, the Committee issued a consultation on the future of both the Library and the Model, in WP 64[199]. As far as the Model was concerned, WP 64 includes specific questions regarding its use (for example, which version(s), were currently being used) and its structure and parameterisation.

The results of the consultation were reported in WP 69, issued in September 2013, alongside the latest version of the Model, CMI_2013. This was a routine update: the structure of CMI_2013 is identical to previous versions but the default parameters were updated to reflect population data for 2012. With regard to the consultation, WP 69 notes that:

> "There was widespread support for the Model. The principal area of comment concerned the method of convergence from initial to long term rates and the Committee is now investigating alternative approaches to this aspect of the Model."

WP 69 also notes: "Meantime, as before, users are able to adjust the convergence parameters in the model if they so wish" reflecting that the default (convergence) parameters were not necessarily recommended values and that users were free to apply their own assumptions instead.

Expanding the work of the committee, 2013-2019

Tim Gordon took over from Gordon Sharp as Chair of both the Executive Committee and the Mortality Projections Committee in mid-2013. In order that the CMI could become more proactive in the field of mortality projections and to be ready to undertake new research, four new members were approved by the Executive Committee in January 2014, including Neil Robjohns, who had previously been integral in the Model's development whilst a member of the Secretariat.

The first output from the expanded committee was the next version of the Model, CMI_2014, issued alongside WP 74 in November 2014. In addition to using population mortality data for 2013, "…the Committee … has revised the method used for calibrating the default Core parameters for the Initial Rates of Mortality Improvement." The changes were:

1. "Three related methodological changes because the Committee has observed that fitting the P-spline model to ONS data shows overdispersion (i.e. the fit has a higher deviance than would be expected)." These changes were:
    a) To use data from 1974 (not from 1961, as in previous versions) as analysis of deviance residuals had suggested that data in the 1960s to be less reliable than more recent

[199] See 'The CMI 'Library' of Mortality Projections' for a description of this paper (and WP 69) relating to the Library.

data. The Committee stated its intention to "…use a rolling period for future versions of the Model; e.g. CMI_2015 would use data starting in 1975[200]."

b) Adjusting the exposure data where the P-spline fit is very poor, i.e. where the deviance residual is extreme. This was notably for the 1919 and the immediately following birth-year cohorts where the approximation of exposure by the mid-year population is poor because of the unusual pattern of births following the end of World War I.

c) "Allowing for overdispersion in the fitting of the P-spline model by choosing the optimal level of smoothing using the quasi Bayesian Information Criterion (QBIC) rather than the Bayesian Information Criterion (BIC)" thereby applying a greater degree of smoothing to the data than in previous versions.

2. "Using data for the first nine months of 2014, based on provisional weekly deaths data. This makes the Model more up-to-date than just using calendar-year data, as was done in previous releases. It was further motivated by a desire to reduce the sensitivity of the Model to cyclical patterns in the deaths data, following the recent marked pattern of heavy experience in 2013 followed by lighter experience observed in 2014 to date."

WP 74 notes that: "The Committee did not carry out a formal consultation about these changes…" but that it had publicised them at several professional meetings. This included a meeting of the Staple Inn Actuarial Society (SIAS), which was to become a regular forum for the Committee. Tim Gordon commented to me recently "I was strongly of the view that if the Committee has information then users should see that information too (and on a timely basis) for transparency and efficiency reasons. To that end we:

- Accelerated the release of the Model using estimated final year data[201];
- Arranged annual joint CMI/SIAS meeting to explain the Committee's thinking; and
- Started publishing the 'Mortality Monitor'[202]."

The Committee next issued a consultation on the release date of future versions of the Model in WP 79, in March 2015. The paper notes that using weekly deaths data, introduced with CMI_2014, "…permits a greater degree of flexibility regarding the target month in which the Model is released, so the Committee is considering whether a different target date would be preferable."

Specifically, WP 79 discusses the modelling implications and practical considerations of the Model release date. It recognises the differing needs of the life and pensions sectors, noting: "In practice no single date will be ideal for both and it is necessary to balance these competing concerns", but concludes "…that September should continue to be the preferred release month as it raises no major concerns; it is the "least bad" option."

The results of the consultation were set out in WP 80, in June 2015. Although most responses (nine of eleven) supported the proposal for a September release, several "…stressed the importance of the CMI meeting a planned release date, irrespective of when that release date fell in the year" and WP 80 concludes: "Recognising the importance to users of not missing a target release date, it [the Committee] intends to adopt a target date of March … starting from CMI_2016 in March 2017."

The Committee then released three working papers simultaneously in September 2015:

- WP 82 is titled 'The CMI format for heatmaps of mortality improvements' and was accompanied by software allowing users to create heatmaps from any data. Tim Gordon recalls: "We changed mortality heatmaps from the full colour spectrum so that they would work for the 8% of males with red-green colour blindness and I'm pleased to note this has been taken up in other countries too."

[200] This was a period of 41 years, so CMI_2014 used data for 1974 to 2014 and CMI_2015 would use data for 1975 to 2015.
[201] As noted above.
[202] These were launched in WP 111 and are described below.

- WP 83 analyses recent mortality in England & Wales, with particular emphasis on the exceptional experience of 2015 to date, and the low mortality improvements since 2011, thereby providing background information on the data used to calibrate CMI_2015.
- WP 84 accompanied the next version of the Model, CMI_2015. This was a routine update, with an identical structure to previous versions but using the latest population mortality data – for the last three months of 2014 and for the first seven months of 2015.

WP 83 and WP 84 highlighted the high numbers of deaths early in 2015 resulting in an increase in mortality rates that "…is unprecedented in the lifetime of the Model." (Although as Tim Gordon noted recently: "That now seems trivial compared with 2020!")

The extended period between releases, with CMI_2016 not to be released until March 2017, allowed the Committee to undertake a full consultation on a substantial number of potential changes to future versions of the Model. Indeed, WP 84 notes that the Committee would hold meetings in October 2015 "…to discuss its current thoughts and to allow others to influence its proposals for CMI_2016, which are intended to be published for consultation in March 2016."

In fact, the consultation was set out in WP 90 in June 2016, with meetings in Edinburgh (June) and London (July) and followed by a supporting technical paper, issued as WP 91, and illustrative software (both released in August).

The outcome of the consultation was set out in WP 93, issued in November 2016. The exercise resulted in a number of changes from previous practice which are listed in WP 93[203] as:

1. "Simplifying the method used to adjust exposure data. The new method retains the broad principle of the previous method – that underlying mortality rates are smooth, and outliers are indicative of artefacts in the data.
2. Defining mortality improvements in terms of log $m_{x,t}$ but with results from the Model still being expressed using the existing definition in terms of $q_{x,t}$.
3. Using a new Age-Period-Cohort Improvement (APCI) model[204] to determine components of historical improvements. This means that:
    a. we can fit historical mortality rates and determine mortality improvements, both in aggregate and split into age-period and cohort components, in a single step;
    b. the fitting process is much quicker in terms of run-time; and
    c. we can implement the Model entirely within Microsoft Excel using Visual Basic for Applications (VBA), which makes it more accessible to users.[205]
4. Removing the "step-back" from the edges of the data when determining historical improvements and, instead, requiring the Model itself to deal with the issue of stability.
5. Allowing and encouraging users to adjust the responsiveness of the Model to new data by using a single "period smoothing parameter" (S_κ) that will be included in an "Extended" layer of parameters.
6. Enabling users to express the pattern of convergence in terms of the slope of mortality improvements ("direction of travel") as an alternative to the current approach of proportion remaining at mid-point.
7. Tapering the long-term rate of age-period mortality improvements to zero between ages 85 and 110, rather than between ages 90 and 120.
8. Shortening cohort convergence periods for the youngest cohorts.

[203] My numbering differs from that in WP 93 which also lists changes that were proposed in WP 90 but not implemented.
[204] The Committee considered a range of possible models, some derived by themselves and some published by others; these were reviewed in the technical paper (WP 91).
[205] Tim Gordon, Chair of the Committee at that time, recalls that "The CMI Model was a fantastic piece of work and a huge step forward for the UK actuarial profession. But its implementation was opaque, and the software was operationally brittle. A particular issue was that it used P-splines, which are non-standard and can give rise to modelling artefacts."

9. Making the "Constant Addition to Mortality Improvements" parameter, which we think is little-used, an Advanced parameter."

These changes, and the APCI model in particular, significantly reduced run-times. As Tim Gordon recalled recently: "The revised Model had a much simpler structure and runs solely in Excel and VBA, calibrating in less than 20 seconds (and much quicker for standard scenarios)."

A period of lower mortality improvements

CMI_2016 itself duly followed, alongside WP 97, in March 2017 and implemented the changes described in WP 93. There was also a marked change in the underlying data; WP 97 notes that:

> "Mortality improvements in the general population since 2011 have been unusually low compared to the earlier part of this century. Standardised mortality rates (SMRs) showed fairly steady improvements of 2.6% p.a. for males and 2.2% p.a. for females between 2000 and 2011. Since then, annual improvements have been close to zero, and SMRs for females are slightly higher in 2016 than in 2011. For both males and females, SMRs are about 11% higher in 2016 than an extrapolation of the earlier trend.
>
> The extra data now available provides increasing evidence that the low level of recent mortality improvements may be due to medium- or long-term influences, rather than just short-term events such as influenza in early 2015."

As a result, as noted in WP 97, CMI_2016 produces "…lower life expectancies than in all previous versions of the Model."[206]

Previous versions of the Model had been accompanied by a user guide as a stand-alone unnumbered document; for CMI_2016, this was replaced by two further working papers:

- WP 98 is entitled 'Methods' and contains technical details of the calculations; and
- WP 99 describes how to use the software.

The Committee's next output – WP 103 – was its first 'Interim update'[207], which have since become a regular output, late in each calendar year. These: "…[set] out a number of analyses intended to be helpful to users of [the Model]". Specifically, the analyses in WP 103 are:

- A comparison of actual experience with the mortality improvements obtained from the APCI model for various values of the period smoothing parameter ($S\kappa$), to assist users with putting values of that parameter into context.
- Analysis of mortality in 2017 to date, based on weekly deaths data from the ONS.
- Analysis of mortality improvements in the CMI SAPS dataset and by Index of Multiple Deprivation (IMD) in England & Wales[208], based on ONS data.
- The results of applying the Model to international data from the Human Mortality Database (HMD), focussing on other constituents of the British Isles and other G7 members. This analysis used an updated version of the CMI_2016 software that allowed users to easily calibrate the Model to HMD data.

CMI_2017 was released in March 2018. Curiously, this reverted to the approach of a single working paper, WP 105, with an unnumbered 'Methods' paper and a user guide. This was another business-as-usual update to the Model, as might be expected after the significant changes in CMI_2016, using data to 31 December 2017. Initial mortality improvements in CMI_2017 are lower than in CMI_2016,

[206] On a like-for-like basis; e.g. using a consistent long-term rate.
[207] The name 'Interim update' was actually only introduced for the subsequent paper, WP 115; WP 103 is called the 'Mid-year update'.
[208] R. Dale Hall, Managing Director of Research at Society of Actuaries in the USA, commented to me that: "[The CMI's work] became the impetus for the SOA to dig deeper into mortality modelling for the US population, and helped us spur further investigation, such as to understand how mortality improvements vary across socioeconomic variables."

reflecting lower than expected mortality improvements in 2017 providing further evidence that we had entered a period of lower mortality improvements.

WP 111, released in October 2018, marked the beginning of another recurring aspect of the Committee's work – 'Mortality monitors'. The paper notes:

> "Over the past few years the CMI Mortality Projections Committee has published various analyses of mortality in the general population in England & Wales, using provisional weekly deaths data published by the Office for National Statistics (ONS). We now intend to publish an "England & Wales population mortality update" along similar lines every quarter."

It then describes the data and the proposed method and includes the provisional first analysis, based on data for the first three quarters of 2018.

As the underlying data was publicly available, the analysis could have been undertaken by any subscriber, but the CMI saw value in undertaking the work centrally and acting as a definitive source. Tim Gordon expanded on the background to me recently: "The Monitors started life as the Committee trying to get a handle on where the next version of the Model would land in those turbulent times. It seemed only logical to expose this information to Subscribers too."

The Mortality monitors were recognised as being of interest outside the CMI, and also a valuable marketing tool to non-subscribers, and accordingly were made publicly available[209].

Prior to releasing CMI_2018, the Committee consulted on a proposed change in the default value of the period smoothing parameter, S_κ, from 7.5 to 7.0, in WP 114. This parameter determines how responsive the Model is to recent data and, given the reduction in mortality improvements since 2011, the proposed change "...would place more weight on recent low mortality improvements and lead to lower life expectancies."

As reported in WP 116, the consultation received eighteen responses; the majority were supportive of the proposed changes which was duly implemented in CMI_2018. In addition, the Committee stated its intention to add a new input to CMI_2018, an addition to the age-period component of initial mortality improvements, that would enable users to reflect historical differences in mortality improvements, without needing to modify $S\kappa$.

The Interim update, issued as WP 115 in December 2018, contained two analyses:

- An updated analysis of mortality improvements in the SAPS dataset and in the general population segmented by IMD. As with the previous analyses in WP 97 and WP 103, this again showed that mortality improvements had been higher in the SAPS dataset than in the general population, and higher for less-deprived groups based on IMD.
- An indication of how the smoothing parameters can be adjusted to have a similar smoothing impact on populations of different sizes. This was intended to illustrate that the Core parameters in the Model had been chosen to be suitable for the England & Wales population and may need to be adjusted to be suitable for other populations.

CMI_2018 followed, alongside WP 119, in March 2019; again accompanied by a methods paper and a user guide. In addition to using data to 31 December 2018 and implementing the changes set out in WP 116, the Committee adjusted the exposures at high ages for 1978-2017, using the method proposed by the High Age Mortality Working Party in WP 106[210].

Following the release of CMI_2018, the CMI briefly found itself a political football In the run up to the 2019 UK General Election. The Labour party claimed that a recent CMI release showed that people in the UK were dying earlier under the current (Conservative) administration. As Tim Gordon, the then then Chair recalls "Losing a day of my life to trying to explain the difference between period and cohort life expectancy in a way that could not be misquoted firmed up my view that the any use of the words 'life expectancy' is unsafe when communicating with the public."

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[209] The documents are all available at: https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/other-cmi-outputs/mortality-monitor.

[210] See 'High Age Mortality Working Party (HAMWP)' in Section C8.

The next Interim update was released in WP 127 in December 2019. This included a wider range of analyses than its predecessors:

- A discussion of the methods the Committee uses for calculating mortality improvements, intended to assist users in interpreting the results of its analyses of mortality improvements and potential limitations of the results.
- Updated analysis of mortality improvements in the SAPS dataset and in the general population segmented by IMD. The paper also notes the analyses of mortality improvements in the other CMI mortality datasets – Annuities and Assurances; the timing of these datasets becoming available meant it was more appropriate that the respective committees undertook, and first reported on these analyses.
- An analysis of excess winter mortality by IMD showing that those living in more deprived areas tend to experience higher levels of excess winter mortality.
- An analysis of international mortality improvements based on HMD data for 18 territories. This showed that a reduction in mortality improvements since 2011 had been observed in most of the territories, but that England & Wales had experienced the most severe reduction.
- An illustration of the impact of calibrating the Model to data for Scotland, Northern Ireland or the United Kingdom, instead of England & Wales. This showed that calibrating CMI_2018 to data for the UK would be similar to the Core Model, calibrated to England & Wales; thus supporting the ongoing use of England & Wales data, to enable prompt release of each version of the Model.
- An illustration of the impact on the Model if population revisions from the forthcoming 2021 Census were the same as those following the 2011 Census.

CMI_2019 was issued in March 2020 alongside WP 129. This version of the Model used data to 31 December 2019 and contained no changes in method but the paper forewarned of the impending storm: “We are mindful of the possibility that the coronavirus COVID-19 could lead to an increased number of deaths in 2020 outside the range of typical annual volatility.”

In late 2019, the Committee issued a survey to the CMI’s subscribers asking about their use of the Model. It also asked for feedback on the Mortality monitors and Interim update working papers, and asked for views on how the Committee should prioritise future work.

The survey attracted 35 responses – an indication of the continuing high level of interest in mortality projections. However, the timing of the survey was, perhaps, unfortunate, as it was issued in November 2019, so responses were received shortly before the COVID-19 pandemic, which was to materially alter the backdrop to the Committee’s work.

The results were summarised in WP 135, issued in July 2020, which includes:

- An indication of which versions of the Model the respondents used, and how they modified the parameters. This revealed an interesting division in the Model’s use:
  - Most insurers (and all reinsurers) were using the latest version of the Model, CMI_2018.
  - Pension consultancies used a range of versions, with a similar number for each of CMI_2015, CMI_2016, CMI_2017 and CMI_2018; presumably reflecting the triennial valuation dates of pension schemes.
- Views on the Committee’s other work, including Interim updates and Mortality monitors.
- A discussion of the areas where respondents would like to see changes to the Model; and
- Information on the areas of research that respondents would like to see in future, which covered three themes: cause of death, the structure of the APCI model and time series properties of mortality.

The impact of COVID-19[211]

As the impact of the COVID-19 pandemic on mortality became apparent, the Committee began issuing a shortened version of the Mortality monitors on a weekly basis – the first on 14 April 2020 – as well as the more detailed version quarterly. These focused on 'excess' deaths, which were significantly higher than the registered deaths where COVID-19 was mentioned on the death certificate. These regular bulletins attracted considerable publicity.

The weekly versions were originally intended to be issued only whilst mortality was exceptional and, indeed, their frequency was reduced during the second half of 2020. However the second wave of high mortality, later in 2020, led to weekly releases being resumed. The process for producing and releasing these bulletins was then streamlined and the Committee continued to release weekly updates until March 2025, since when they have been released monthly.

In September 2020, the Committee issued WP 137 to consult on how to adapt the next version of the Model, CMI_2020, for COVID-19. The paper summarises the backdrop thus: "The coronavirus pandemic has led to an increase in mortality rates in England & Wales in 2020 to date that is well outside the range of year-to-year changes that we have seen in the past forty years." Given this "…it seems likely that … a version of CMI_2020 that gave full weight to the data for 2020 would produce substantial falls in life expectancy, which we think would be in excess of what most users of the Model would consider reasonable."

The Committee's proposed solution was to modify the Model so that users could choose to place more or less weight on data for individual years. Specifically, for the Core version of the Model, the Committee indicated it expected to place:

- No weight on the data for 2020; and
- Full weight on the data for all other years (up to 2019).

The paper notes that: "In isolation, this change would lead to a much more modest fall in life expectancy compared to CMI_2019 than if data for 2020 were given full weight."

A second change, unrelated to the exceptional mortality experience of 2020, was also proposed – to calibrate CMI_2020 to data for ages 20 to 90, instead of 20 to 100 as in CMI_2019. WP 137 notes:

> "The intention of this change is to avoid unrealistically low initial mortality improvements at high ages, caused by limitations in how well the structure of the Age-Period-Cohort Improvement ("APCI") model used to calibrate the Model deals with large shifts in mortality improvements during the calibration period that also vary significantly by age."

The results of this consultation were set out in WP 143, issued alongside the latest Interim update, in WP 144, in December 2020. The consultation received twenty responses and the results were:

- The proposal that users should be able to vary the weight on data received broad support
- However, although many respondents agreed with the proposed change in age range of the dataset, "…a number of respondents noted that the analysis [justifying the change in the age range] was sensitive to the period of data considered, and alternative analyses would justify retaining the existing approach." Consequently, the Committee retained the age range of 20 to 100 for CMI_2020.

The Interim update again reported a number of analyses; including:

- Analysis of the impact of the pandemic on mortality in 2020 by:
  - Age band, where the Committee found the impact had been higher at older ages.
  - Index of Multiple Deprivation (IMD), where the absolute impact had been higher for more deprived areas, but the relative impact was broadly similar for all IMDs.

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[211] See also Matthew Edwards's thoughts on this period in Appendix 10: 'Chairing the CMI during the pandemic'.

  - UK region, which showed considerable variation, with London experiencing the highest level of excess mortality.

- Methods for customising the Model for future mortality scenarios. As noted in WP 144:

  > "The Model includes a number of parameters that can be used to customise the Model to reflect users' views of future mortality improvements. In this paper, we have shown how key Model parameters affect future mortality rates and mortality improvements, and suggested how users could adjust these parameters to reflect specific views of future mortality in light of the coronavirus pandemic."

- A summary of progress on analysing mortality by cause of death, where the Committee was seeking to work in collaboration with the ONS and the IFoA's Mortality Research Steering Committee (MRSC).

The mortality experience in 2021 was again exceptional, with significant excess mortality in the first quarter of the year and rising again in the second half of the year, so the Committee's work in 2021 followed a similar pattern to 2020, with:

- The Mortality monitors continuing, both in the shorter weekly and the fuller quarterly versions, throughout the year. These continued to attract considerable attention, both inside and outside of the actuarial profession.
- CMI_2020 issued in March 2021 alongside WP 147. This was as publicised ahead of release; in particular with zero weight applied to the data for 2020, in light of COVID-19. One particularly interesting observation in WP 147 is that: "The Model suggests that mortality improvements peaked some time ago with the highest improvements being seen in 2004 for males and 2005 for females."
- The results of the benchmarking survey of insurers and reinsurers were issued as WP 153 in June. Perhaps the most interesting aspect to emerge was that all of the respondents who indicated they would use CMI_2020 at 31 December 2021 indicated that they would use the Core weight of 0% to 2020 data.
- The plans for CMI_2021 were set out in WP 157 in November. This was not positioned as a consultation exercise; the key aspect of the proposed approach was that the Core version of CMI_2021 would use 0% weights for 2020 and 2021 data (and 100% weights for earlier years).
- The Interim update was issued as WP 159 in December. Several of the analyses updated those reported in WP 144 but in addition there was an updated analysis of the possible impact of revised mid-year population estimates following the 2021 Census on the results of the Core version of CMI_2021.

CMI_2021 was issued in March 2022 alongside WP 160. This had been publicised ahead of release; in particular with zero weight applied to the data for both 2020 and 2021. For the Core Model, this led to slightly lower cohort life expectancies than those produced by CMI_2020 (with other parameters held constant) for most ages.

The results of the latest annual benchmarking survey to insurers and reinsurers followed in WP 163, in June 2022. This reported that most respondents indicated that they intended to use the Core weight of 0% for 2020 and 2021 data; a consistent approach with the previous year.

An international perspective

Tim Gordon commented to me recently that: "One of the curious things about mortality projection models is that while, in theory, they should be equally applicable to similar countries, in practice, actuarial professions in different countries can take materially different approaches. Directly relevant comparators for many CMI users are countries with large private defined benefit pension sectors, of which the USA and the Netherlands are the largest. So, while I was chairing the MPC, I made a

concerted effort to have conference calls with the Society of Actuaries in the US and the AG[212] in the Netherlands for mutual sharing of experience and information."

Consequently, for several years, the Committee regularly engaged with the Society of Actuaries (SoA) in particular[213]. This collaboration was manifested in the release of a jointly-authored paper, attributed to the CMI Mortality Projections Committee and the Society of Actuaries Retirement Plans Experience Committee (RPEC), as WP 166 in December 2022. The paper compares two mortality projection models – the latest version of the CMI Model, CMI_2021, and the latest version of the SoA Model, MIM-2021 and the associated Mortality Improvement Scale, MP-2021, produced by the RPEC. The paper applies both models to data for England & Wales and the US and compares the results.

The paper notes that: "The two models have similar principles – both project mortality improvements by interpolating between recent mortality improvements, estimated based on historical data, and assumed long-term rates of mortality improvement. However, the details of the models differ, including:

- How they estimate current mortality improvements. The CMI model imposes a more rigid structure on historical mortality improvements, considering them as the combination of age, period and cohort terms. In contrast, the RPEC model has a more flexible structure, which enables it to fit historical improvements more closely.
- The period over which mortality improvements converge to the long-term rate. The convergence periods for MIM-2021 do not vary by age, but those for CMI_2021 do, and can be longer or shorter than the MP-2021 convergence periods at different ages."[214]

Key findings from the analysis were "…that:

- For younger ages, CMI_2021 tends to give lower projected mortality rates than MP-2021.
- For older ages, MIM-2021 tends to give lower projected mortality rates than CMI_2021.
- For most ages and datasets, MIM-2021 leads to higher cohort life expectancies than CMI_2021, as life expectancies are more strongly affected by mortality rates at older ages, when most deaths occur.
- Life expectancy is more sensitive to the long-term rate for the RPEC model than for the CMI model, for both genders and both datasets. This is likely due to the differences in the start years (2017 for the RPEC model and 2021 for the CMI model) and convergence periods between the models, meaning that the long-term rates apply in full for longer in the RPEC model."

The aftermath of COVID-19

The Committee had foreseen the potential need for a later release of CMI_2022, with WP 160 (released alongside CMI_2021) saying:

> "In normal circumstances, we would expect to publish the next version of the Model, CMI_2022, in March 2023 … However, we are conscious of the possibility that ONS may revise its population estimates following the 2021 census. We may delay the timing of the publication of CMI_2022 as a result – to avoid a situation in which the ONS restates its population estimates shortly after the release of a version of the Model."

As a result, both the consultation on CMI_2022 and the Interim update were issued later than usual.

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[212] The Royal Dutch Actuarial Association, the Koninklijk Actuarieel Genootschap, commonly abbreviated to the "AG".

[213] R. Dale Hall, Managing Director of Research at Society of Actuaries in the USA, gave me his perspective on this collaboration: "It has been very helpful to bounce ideas and observations off each other, to build better models and programs. We've enjoyed the camaraderie and peer review concepts that have emerged working with CMI."

[214] Another key difference is that the RPEC model derives the long-term rate directly from the data whereas it is a required user input to the CMI Model. This may not have been highlighted in the paper because the comparison between the models was based on equalised long-term rate assumptions.

The consultation on CMI_2022 was issued in WP 168 in January 2023. The key proposal was to set a weight of 25% for data in 2022 in the Core version of the Model. The Committee set out its intention for future years "…that the Core parameter for the weight should then increase for subsequent years until it reaches 100% for data in or around 2025."

The paper also gives an update on the timing of the Model:

> "…we intend to delay the release of CMI_2022 until June 2023. This delay is because we would like to calibrate the Model to revised population estimates for mid-2012 to mid-2020 which are due to be published by the Office for National Statistics (ONS) in the spring of 2023."

The outcome of the consultation was released in WP 173 in March and notes: "While respondents to the consultation have a range of views, the responses as a whole are broadly supportive of the proposals in Working Paper 168. Because of this, we do not intend to make any changes to our proposal."

The Interim update, in WP 171, was issued in March 2023. Several of the areas updated the analyses in WP 159 but it also included an analysis of monthly mortality in England by cause of death in 2001 to 2021, using data obtained from the ONS. This considered 19 cause-of-death groups, allocated by the tenth revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10), that were chosen to provide the most detail possible while having a sufficient number of deaths in five-year age bands to enable the data to be published by the ONS. The 19 groups were:

- Nine main cause of death groups; plus
- A further ten groups that are subsets of three of the main groups (neoplasms, diseases of the circulatory system and diseases of the respiratory system).

WP 175 issued in May 2023 contains analysis of historical mortality improvements and was positioned as intended "to assist Subscribers in setting the projection parameters in the CMI Mortality Projections Model…", particularly the Long-term Rate of Mortality Improvement. In addition to the analyses of England & Wales data, the paper also considered a range of other countries and an overview of the mortality projections models used by other organisations, including the ONS, the Society of Actuaries in the USA, the Canadian Institute of Actuaries, the Royal Dutch Actuarial Association and the Society of Actuaries in Ireland.

CMI_2022 was issued in June 2023 alongside WP 177. As had previously been announced, this applied zero weight to the data for both 2020 and 2021 and 25% for 2022. With regard to the underlying data, the release had been delayed to incorporate the results of the 2021 Census; although the ONS estimates for 2021 were used, the Committee interpolated between 2011 and 2021 to spread the known revision for 2021 back over the intercensal period to derive revised estimates for 2012 to 2020 as the ONS figures were not expected to be published until September 2023.

The estimated impact of the revised population estimates was described in a blog, issued in July 2023[215]: "The results of the 2021 census imply a lower population at pensioner ages in recent years than previously thought, which implies higher mortality rates and hence lower mortality improvements."

Following the summary of the third annual benchmarking survey, issued in WP 179 in September 2023, the Committee issued an analysis of excess mortality in 2020 to 2022 in 24 countries, in WP 180 in October. This was intended to provide context to the impact of the pandemic on UK mortality; for example the paper finds that:

> "England & Wales has the third highest cumulative excess mortality to the end of 2022 of the western Europe territories, measured from week 10 of 2020. The only western Europe territories with higher cumulative excess mortality are Austria and Italy."

[215] https://blog.actuaries.org.uk/revised-population-estimates-imply-higher-excess-mortality/.

This was the Committee's last release during 2023 and, indeed, the last working paper issued by the CMI in its first 100 years!

Ordinarily, we might have expected an Interim update and a consultation on CMI_2023. However these were delayed with the intention of incorporating revised ONS population estimates (for 2012-2021), and then released as WP 187 (in March 2024) and WP 183 (in February 2024), respectively.

C8. Working parties

This section covers three working parties, each of which had a significant effect on the work of the various investigation committees. All three were established with a membership drawn largely from existing committee members; this facilitated the working parties being set up promptly but – more importantly – ensured that the working parties understood the work of each of the investigation committees and that their work was aligned.

Graduation and Modelling Working Party (GMWP)

Tim Gordon, who had recently taken over as Chair of the Executive Committee, proposed establishing this working party in the light of his experience as a member of the SAPS Committee. Specifically, he recalls:

- "The graduation software (written in Fortran) didn't run on my laptop, was maintained solely by the individual who wrote it and was not the property of the CMI.
- The advice SAPS committee members were given for applying the AIC[216] ignored overdispersion and would have resulted in over-fitted models if it had been followed literally. (In practice, it was overridden by the SAPS Committee members applying common sense.)"

Consequently, the Graduation and Modelling Working Party (GMWP) was established in late 2013 to review the CMI's approach to mortality tables and projections and make broad recommendations on modelling (see Appendix A of WP 77 for the working party's Terms of Reference).

The Working Party was chaired by Jon Palin, then a member of the Mortality Projections and SAPS Committees. Notably, the members included David Wilkie who was, in effect, helping to assess whether the approach that he had developed with David Forfar and John McCutcheon[217] remained fit for purpose. Jon recalls that: "There was quite a bit of creative tension in the group. In particular, David Wilkie and I had different views on a number of aspects, and there were often frank but cordial discussions."

The group completed its 'interim report' in January 2014. Jon commented to me that "GMWP had a short timeframe – just three months to scope the work, do it, and report back. That helped give it a "buzz" and get lots done. Sometimes progress with volunteer bodies (not just CMI) can feel slow and it's easy to defer things if there's a distant deadline." This was certainly not the case here!

The interim report was written as an internal document and shared with the various CMI Committees and it began to influence their work almost immediately. It was decided that the report warranted wider dissemination and it was then issued with minimal updates as WP 77, in March 2015. Alongside the paper, the CMI also released 'beta' software[218] that allows users to investigate the techniques described in WP 77. The software was first used in earnest for the graduation of the 2007-2010 annuities data, described in WP 78[219], and has subsequently been updated to facilitate users wishing to explore subsequent sets of CMI mortality tables.

Jon also noted that: "Because the intention was initially for an internal paper, the outputs weren't as formal or polished as a working paper. That again helped with productivity – we had different members of GMWP doing different things in different styles without overly worrying about making everything consistent." Despite this, the report definitely deserves thorough study by anyone undertaking graduations, or other modelling, of mortality data and has continued to influence the CMI's work throughout the subsequent years, as acknowledged by numerous references in the relevant working papers.

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[216] The Akaike Information Criterion; one of a number of criteria that can be used to assess the suitability of a graduation.
[217] See under 'Mortality experience in 1979 to 1982 and the "80" Series tables' in Section C2.
[218] Tim Gordon recalls that he and Jon Palin agreed at an early stage that this should be written in Excel and Visual Basic for Applications (VBA) as these would make the Model accessible to all actuaries.
[219] See 'Annuitant mortality experience in 2007-2010 and the "08" Series tables' in Section C2.

It is interesting to note that the minutes of the Executive Committee meeting in October 2016 suggest that "…consideration should be given to a further review in around 3 years, to ensure CMI remains abreast of developments." This has not occurred to date (formally, at least).

High Age Mortality Working Party (HAMWP)

This working party was also initiated by Tim Gordon: "I felt it was important to standardise the CMI's approach to high age mortality, where data from individual investigations cease to be reliable. This was a result of (a) the inconsistency in treatment of high age mortality by different CMI investigations and (b) data I was seeing on a huge longevity swap."

The High Age[220] Mortality Working Party (HAMWP) was duly established in 2014, chaired by Steve Bale, a member of the Mortality Projections Committee. Its Terms of Reference are set out in Appendix A of WP 85, but that paper summarises these as:

- "Provide a broad indication of the potential financial impact of misestimating high age mortality.
- Investigate and summarise published research on high age mortality.
- Identify potential issues with existing data sources used by CMI (Self-Administered Pension Schemes (SAPS), insurers, Office for National Statistics (ONS)) and methodology specific to high age mortality.
- Outline specific analysis to assess the impact of any identified issues and propose potential ways to enable the CMI to address them."

Its first release was WP 85, issued in October 2015, which provided an update on its research and findings to date. The key findings noted in that paper include:

- "There are various issues with the data quality for all the data sources which might be used to model mortality at the oldest ages."
- "Analyses of historical mortality from extinct cohorts imply that mortality for the England & Wales population above age 90 as published by the ONS has been underestimated by around 5% for males and about 1-2% for females in the period considered. We understand the underestimation of mortality to be driven by overestimation of population exposures at very high ages."
- "There is wide variation in the level and shape of mortality assumed at high ages under different tables published by the CMI, the ONS and North American actuarial associations."
- "The debate on whether the shape of mortality at high ages is exponential or exhibits signs of mortality deceleration is inconclusive."

The Working Party's next release was WP 100, published in June 2017, which was accompanied by a supplementary technical paper. This considered the following areas:

- Population exposure modelling. The Working Party reviewed the Kannisto-Thatcher method used by the ONS to estimate high age population exposures for England & Wales, and analysed variants designed to address a number of limitations in that approach. These exposures are particularly relevant to the CMI, as they feed into:
  - the calibration of the CMI Model, for estimating past (and future) improvements; and
  - the determination of population mortality, that may be used to close-off portfolio mortality tables at high ages, where the underlying datasets lack credibility.
- Mortality at very high ages. The Working Party considered additional papers that have studied independent datasets of mortality rates at very high ages. It concluded "…we believe that a mortality curve which makes allowance for deceleration at advanced ages is appropriate for period mortality, i.e. mortality rates over the period analysed with no allowance for future

[220] 'High age' was not defined in the Terms of Reference, but WP 85 notes that "…we have focused on mortality for ages 90 and above."

improvements, at a population level. We also believe that currently a value of μ_{120} of 1 is justifiable and a reasonable assumption."[221]

- Closing-off mortality tables. The Working Party determined a framework with which to close-off mortality tables at high ages; this was constructed to assist the mortality-focused CMI committees with setting mortality rates for future tables. This has subsequently been used by the Annuities, Assurances and SAPS Committees.

Subsequent to the release of WP 100:

- It was reviewed by the ONS and the Working Party's recommendations to improve the Kannisto-Thatcher method for estimating populations at the older ages have fed into some of the improvements in the ONS's methodology in recent years.
- It marked the start of a dialogue between the ONS, the CMI and the IFoA that has continued to date.

The Working Party concluded its work with WP 106, released in June 2018. This develops the approach of WP 100 and describes methods for, and analyses the results of, determining populations at high ages; and extending graduating mortality rates to high ages. These methods were first used in the proposed SAPS "S3" Series graduations, which were released simultaneously in WP 107 (see 'The "S3" Series mortality tables' in Section C6). The paper was accompanied by two pieces of software:

- A spreadsheet that adjusted deaths and exposure data for the England & Wales population, as described in the paper. This has subsequently been updated to take count of more recent data[222].
- An updated version of the graduation software, described in the preceding section, to reflect the working party's recommendations on closing-off mortality tables at high ages.

WP 106 notes an intention "…to perform quantitative and qualitative analyses of mortality data for large pension schemes with the intention of producing a further Working Paper". This work was never released but it is unclear to me whether suitable data was not received or the analysis failed to produce meaningful results; consequently, there was no further published output from the Working Party.

In 2019, the Working Party was awarded the Peter Clark Prize for the best paper written for an actuarial audience for 2018[223].

COVID-19 Working Party

The COVID-19 Working Party was established in July 2020 to investigate the implications of COVID-19 on the CMI and to propose a consistent methodology that could be adopted by the CMI investigation committees. Like HAMWP, above, it was chaired by Steve Bale.

This Working Party produced a single working paper, WP 139, that was released in September 2020. The focus of the paper was to consider the features of the data available as at the time of publication. The paper set out to be methodological with the aim of providing context and an illustration of materiality for data from the first wave of the COVID-19 pandemic. The main areas that the paper focused on were:

- The use of population level data, including artefacts of the data.

[221] Steve Bale commented to me that "[HAMWP] had a friendly disagreement with Gavrilov and Gavrilova who swung between yes and no [on whether or not mortality decelerates at the oldest ages] and ultimately pinned their views on 'no', whereas we chose 'yes', as their analysis was based on limited data whereas Roland Rau's study was much more comprehensive in terms of territories and depth of analysis."
[222] Available at: https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/other-cmi-outputs/exposure-adjustment-software
[223] See https://actuaries.org.uk/about-us/prizes-and-awards/best-paper-prizes/peter-clark-prize/.

- Assessing the impact of the pandemic on mortality in the first three quarters of 2020.
- Considering differing methods to adjust for abnormal experience.
- Considerations for setting mortality and morbidity best estimate assumptions.

The paper served as an initial response to the pandemic – at the time of publication it was unclear how mortality experience would pan out, or indeed whether there would be any further COVID-19 related 'waves'. It stopped short of firm recommendations although its findings led to the investigation committees generally reporting experience for 2020 (and the immediate subsequent years) separately from other years rather than combining them as part of a quadrennium, say. As noted in the earlier sections, the investigation committees also sought to provide an accelerated view of 2020 experience using appropriate approximate methods.

The paper was positioned as a consultation exercise, seeking subscribers' views on future work, either by the Working Party itself or by the CMI more generally. Unusually, there was no published response following the consultation and the Working Party produced no further output, although there was a follow-up blog entitled 'The CMI's approach to the use of 2020/2021 data', issued in November 2021[224]. This reflected on the challenges of seeking to adjust mortality data for 2020 and 2021, either through removing COVID-19 related deaths, or by adjusting the data using a measure of excess mortality. It highlighted the challenges for producing graduated mortality and morbidity rate tables using data from the pandemic period, as well as the CMI Mortality Projections Model not reacting well to abnormally negative mortality improvements.

[224] https://blog.actuaries.org.uk/the-cmi-s-approach-to-the-use-of-2020-2021-data/

C9. Miscellaneous topics

Structure and operations: 2000 to 2013

The structure of the CMI, along with many aspects of its operations, changed following the review of the CMI that concluded in March 2013. I therefore consider the structure and operations in 2000 to 2013 first, then the review itself, with the structure and operations post-review considered in the subsequent section.

At the start of 2000, the CMI committee structure consisted of the Executive Committee, the Management Committee and three investigation committees – covering (life office) mortality, permanent health insurance (PHI) and critical illness. That structure continued with three additions:

- The SAPS Mortality Committee formally became part of the CMI on 1 July 2006.
- The Projections Library Committee was formed in March 2008 (see 'The CMI 'Library' of Mortality Projections' in Section C7) and later became the Mortality Projections Committee.
- The Technical Committee was formed in March 2009 (this is discussed under 'The Technical Working Party / Committee', below).

Up to 2004, the Executive Committee usually met only once each year, around 1 July, whereas the Management Committee was considerably more 'hands-on' and met much more frequently. From 2005, the Executive Committee met more frequently – typically, three times each year – as mortality became a high-profile issue for the actuarial profession and the number of underlying committees increased.

Another change in practice, initiated by Brian Ridsdale when he became Chair, was that each of the relevant practice boards of the Actuarial Profession (Health & Care, Life and Pensions) was asked to nominate a representative to the Executive Committee, to encourage collaboration.

Review of the CMI

From the papers available to me, it appears there were multiple drivers for the review of the CMI, for example:

- From the CMI's perspective, the consolidation amongst life insurers meant that its finances were dependent on a much smaller group of larger offices. In a paper to the Management Board of the Actuarial Profession[225] in November 2008, Gordon Sharp (recently appointed as the CMI Chair) noted that five sources contributed half of the CMI's income. This issue had been recognised previously but proposals for a fairer system had never been implemented due to a concern that insurers facing large increases could withdraw support altogether, given that CMI outputs such as working papers were published openly on the IFoA website.
- From the Actuarial Profession's perspective, there was concern about the governance and operations of the CMI, undoubtedly heightened by the issue with the "S1" tables (see 'The first SAPS mortality tables' in Section C6). This concern is illustrated by a comment in the minutes of the Management Board meeting in May 2008 that: "The Board felt it needed a better understanding of the work of the CMI and how it currently relates to the Profession and how best this could be structured going forward."

It was agreed to consult with stakeholders at the Management Board meeting in November 2008. It felt "…[this] should be seen as coming from the Profession as the sponsor of the CMI", and a working party was established under Nigel Masters[226] with representatives from each relevant practice area of the Profession, to draft the consultation.

[225] The Management Board was established in 2008, as a successor to the Faculty and Institute Management Committee (FIMC). Both oversaw the operations of the UK Actuarial Profession, under the auspices of the Councils of the Faculty and the Institute. Minutes are not in the public domain, but I was granted access to the excerpts from the minutes relating to the CMI for this project.
[226] The President of the Institute of Actuaries from 2008 to 2010 and, consequently, a member of the CMI Executive Committee.

In January 2009, the Management Board agreed that "…it may be better and more accurate to describe this as an assessment on how the Profession can fulfil a useful role [in] longevity and morbidity." The scope was duly broadened and the 'Consultation on the Provision of Mortality Information' was issued via a web-based survey in the summer of 2009.

The outcome of the consultation was summarised to the Executive Committee meeting in October 2009 thus:

- "…there had been a good level of response (165 responses) to the consultation"; and
- "…overall the tone of the responses was positive and very supportive of the CMI's work."

Precisely what happened next is unclear, but the drivers for a more in-depth review of the CMI, such as those noted above, still existed and the review followed the consultation, with Nigel Masters presenting a paper on the 'Future Structure of the CMI' to the Management Board in May 2010. The minutes of that meeting refer back to the consultation in recording that: "The Board was pleased to note that there was very strong support from those who responded to the survey for a CMI as an independent body not influenced by commercial considerations." The minutes also record that a paper should be developed "…covering:

a) Change to existing structure;
b) Future organisation and management of operations;
c) Funding and pricing arrangements."

It is interesting with hindsight that:

- There does not appear to have been any specific intended outcome; for example, the minutes note a suggestion to: "Bring it under main Profession umbrella as a 'Longevity Committee' without the need for its own set of accounts, etc."
- The planned timeframe concluded with the "new CMI in place" by February 2011.

In the event, the timetable slipped for a number of reasons[227]:

- The project proved more complex than had perhaps been envisaged; for example, the project team were unable to establish the basis on which the CMI had originally been set up[228].
- There were several changes to the key IFoA personnel managing the project.
- There was a need to consult widely with stakeholders to ensure that the proposed changes were acceptable. One-to-one meetings were held with a sample of the largest contributors and a wider exercise was undertaken in two phases, in July and October 2012[229], with feedback reflected in the final proposals, communicated in February 2013.

The changes to the CMI's structure and operations took effect from 1 March 2013. There were a multitude of changes; the more significant were:

- A new UK private company, CMI Limited, was established (Company number: 8373631). This is wholly owned by the (now-merged) Institute and Faculty of Actuaries and its Board comprises two directors – initially, the Chief Executive of the IFoA (Derek Cribb) and a nominated member of the CMI Executive Committee (Peter Banthorpe[230]).[231]

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[227] In this context, Gordon Sharp, the Chair of the CMI, commented to me on "…tortuous bureaucracy with the IFoA".
[228] As the formal basis of the CMI's structure was unclear, it was – understandably – more difficult for the project team to propose changes!
[229] The changes were also communicated to the wider actuarial community through an article in the November 2012 edition of *The Actuary*.
[230] One factor behind Peter's appointment was that some Executive Committee members were precluded from taking on a position as a director of a commercial company by their employment contracts.
[231] The role of the CMI Limited board is discussed briefly, under 'The board of directors', below, together with a note of the subsequent changes of director.

- The CMI Executive Committee now reported into the CMI Limited Board; its Terms of Reference clearly specifying areas that it should report on and what required approval.
- As noted in the February 2013 letter: “An integral part of our proposals for reform was that in future the full outputs of the CMI (tables, models, and other detailed analysis) will only be available to those organisations and individuals who register as CMI users, and who contribute the appropriate amount for their organisation.” (Older outputs remained open access.)
- Mandatory subscriptions for commercial organisations wanting access to the CMI’s outputs were introduced, in place of voluntary financial contributions. Organisations were categorised as life offices, reinsurers or consultancies with a separate fee structure for each category. An approach was also agreed for setting fees for organisations that did not fit into those categories whilst individuals undertaking academic research were granted free access.
- Terms & Conditions were also introduced, governing the use of the CMI’s outputs by ‘Subscribers’ (commercial organisations paying a subscription fee) and ‘Academics’ (academics and CMI Committee members using the CMI’s outputs for non-commercial purposes)[232]. Previously there had been no formal agreements with financial contributors.

A retrospective look at the CMI Review

The changes arising from the CMI Review were adjudged to be successful. For example, the Annual Review of 2012-2013 states:

> “From 1 March 2013, the structure and processes of the CMI have been revised, to ensure that it remains fit for purpose in the 21st century. The revisions result from a review, with the Management Board of the Profession, over the past two years. The changes address vulnerabilities in the CMI’s previous structure and funding, strengthen its processes and governance and will create a stronger and fairer organisation that will continue to be regarded as 'a jewel in the crown' of the Institute and Faculty of Actuaries.”

Looking back, ten years later, it is still hard to judge it as anything other than a resounding success, as demonstrated in the remainder of this section.

Key to the success of the changes was restricting access to the CMI’s outputs, which was proposed by Nigel Masters. This enabled the CMI to make significant changes to the subscription basis, compared with the previous basis of contributions, with much less risk than had previously been foreseen. As noted earlier, the concern that insurers facing large increases could withdraw support altogether had been an obstacle to implementing previous proposals for change.

With hindsight, the delays in the project, and implementing the changes, may have been helpful; for example, by March 2013, most UK insurers and consultancies made significant use of the CMI Mortality Projections Model, demonstrating the value of subscribing to the CMI.

The funding principle set out in the July 2012 communication was:

> “In order to ensure sustainability while retaining the CMI’s not-for-profits basis, funding arrangements should provide a fair, cost-effective and stable basis for the necessary funds to be raised.“

This statement has continued to be used when the CMI has subsequently reviewed the subscription basis and is embedded in the ‘Internal Governance Procedures’ (noted below).

[232] There were also revised ‘Terms & Conditions for Data Contributors’, governing the CMI’s use of data; these are discussed under ‘Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles’, later in this section.

The October 2012 communication stated:

> "We expect that [the subscription fees]… will result in more organisations supporting the CMI financially... In future years we anticipate that the costs can be shared across a wider financial base, to the benefit of all subscribers."

This has certainly happened, with an increased number of subscribers in each category (insurers, reinsurers and consultancies).

In terms of the key changes noted above

- The new structure is clear[233] and the CMI Limited Board has proven valuable, in my opinion, and supportive of clear, timely, decisions.
- The reporting lines between the Executive Committee and the Board are much clearer (and have proved easy to amend, when needed).
- The 'firewall', restricting access to CMI outputs, was easily implemented with all IFoA members employed by existing financial contributors given automatic access, based on the employer listed in their profile on the IFoA website[234], and appears to have raised few issues subsequently.
- The subscription basis has been amended annually but, apart from the changes needed to the basis for life insurers to reflect Solvency II reporting, other changes have been minor.
- Similarly, the changes to the Terms & Conditions each year have been modest.

Structure and operations: 2013 to 2023

There were substantial changes to the membership of the Executive Committee following the completion of the Review, in March 2013, as a number of members (including the Chair, Gordon Sharp, the Presidents and the Treasurer) extended their terms to remain on the Committee whilst the review was in process. In particular:

- The past practice of the President and the Treasurer of the IFoA[235] sitting on the Executive Committee ceased to apply whilst the review was in process, as it was deemed desirable to maintain continuity of membership. This practice was then considered inappropriate under the new structure, and was discontinued.
- The more recent practice of IFoA practice board representatives on the Executive Committee also ceased.
- The position of Chair of the Executive Committee[236] was advertised and the new incumbent, Tim Gordon, was appointed following an interview process.[237]

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[233] An insight into the tensions that occasionally arose previously is contained in the minutes of the Management Board meeting in September 2009: "Gordon Sharp accepted that the CMI had not thought to make the Management Board aware earlier [of the cost overrun in the CMI Model development], partly because there was no protocol of regular reporting from the CMI to the Management Board but also because three members of the CMI Executive Committee were also members of the Management Board. None of these members, nor the secretary, had picked up on this point."

[234] This came as a massive relief to me, personally! Although we had tested it internally, within the Secretariat, we had no way of testing it on the thousands of employees of subscribers who were given access from 1 March 2013.

[235] Previously, the Presidents of both the Faculty and the Institute and the Treasurer of the Institute. The IFoA terminated the role of Honorary Treasurer in mid-2012, although Robert Hails continued as CMI Treasurer until the review was complete.

[236] Previous holders were titled 'Chairman of the CMI'; this was amended to 'Chairman of the Executive Committee' in 2013, and the first term was then shortened to 'Chair', in 2017.

[237] In contrast, neither of the preceding Chairs, Brian Ridsdale and Gordon Sharp, is aware of how they came to be asked.

- James Tait was appointed Deputy Chair, with a clear intention that he would succeed Tim at the end of his term. This practice has continued and, as a result, the appointment of each Deputy Chair has since become the key appointment within the CMI.

The CMI committee structure is largely unchanged during this period, with the following changes:

- As noted in the introduction to this part, the Life Office Mortality Committee and the Critical Illness Committee were reconfigured as the Annuities Committee and the Assurances Committee respectively, in late 2013.
- The Technical Committee was disbanded in October 2015; as discussed under 'The Technical Working Party / Committee', below.
- The 'Resource Pool' was set up in 2020. This was suggested by Matthew Edwards (then Deputy Chair of the Executive Committee) to supplement the existing committee structure with an agile group "…formed from 'excess volunteers'"; i.e. candidates for positions as committee members who were not accepted due to a limit on the size of each committee[238].
- The chairs of the five investigation committees ceased to be members of the Executive Committee from June 2023. The chairs retain access to Executive Committee papers and minutes and the right to attend Executive Committee meetings and are encouraged to attend the meetings when the committees' plans are due to be discussed. This change was principally aimed at reducing the workload of the chairs but also made clearer the distinction between the roles of the Executive and Management Committees.

It is interesting to note one change in committee structure that has not happened … the need for both an Executive Committee and a Management Committee, as well as the Board, was questioned even before the Review was implemented in March 2013. Efforts have been made subsequently to avoid duplication but all three bodies continue.

Operationally, though, there have been many changes in practice following the review, including:

- Since 2015, Executive Committee meetings have taken place quarterly, soon after the circulation of a quarterly information pack, which summarises the CMI's financial position, the progress of each committee and other key information.
- Board meetings, which ordinarily include the Chair and Deputy Chair of the Executive Committee and the CMI Secretary, as well as the directors, also take place quarterly, soon after the corresponding Executive Committee meeting, ensuring any matters that require Board approval are resolved promptly.
- The terms of office are now well-specified; in particular, the Chair of the Executive Committee ordinarily serves a three-year term and is then normally succeeded by the Deputy Chair.
- Members of the Executive Committee require approval by the directors, normally based on a recommendation from the Executive Committee. Appointments as a committee chair and as Deputy Chair of the Executive Committee[239] usually follow an interview, typically by one of the directors, the Chair or Deputy Chair and one other Executive Committee member.
- Some members of the Executive Committee have assumed specific responsibilities:
  - Stuart McDonald took on the role of Chief Risk Officer (CRO) from 2018 to 2021, when Darryl Brundle took on the role.
  - Jonathan Hughes took on the role as Chief Financial Officer (CFO), from 2021, with the intention that this is a responsibility of the Deputy Chair going forward.[240]

[238] Matthew's perspective on this is included in Appendix 10: 'Chairing the CMI during the pandemic'.
[239] These appointments are not necessarily advertised outside the CMI, if there is an existing committee member who is a strong candidate and keen to take on the role. In such cases, positions on the committee are often advertised soon after the new chair is in place.
[240] Both roles rotated in 2024, with Michael Curtis succeeding Darryl as CRO and Stuart taking on the role of CFO when he became Deputy Chair.

- Key operational processes are now specified in the 'Internal Governance Procedures', including the points noted above and, for example, documented policies on funding and reserves and procedures for addressing issues in CMI outputs. Some of these procedures existed already, but they had not previously been formalised and documented; in addition the current Executive Committee members would not necessarily be aware of procedures agreed prior to them joining. The Internal Governance Procedures are reviewed (at least) annually to ensure they are well understood and remain appropriate.

The Board of directors

As noted earlier, the Board of CMI Limited was established in 2013 and comprises two directors. There have been several changes of director during the period covered in this book:

- In February 2015, Anne Moore, the IFoA Chief Operating Officer, replaced Derek Cribb. (Anne had joined the IFoA in August 2011 and one of her first projects was to support setting up the CMI as a private limited company.)
- In June 2015, the IFoA decided that the directors of all its subsidiaries should be members of the IFoA Executive and Paul Reynolds replaced Peter Banthorpe.
- Paul Reynolds left the IFoA in November 2017, and was replaced by Clifford Friend[241].

The Board is largely hidden from external view but Anne Moore commented to me: "My role as a director of CMI is to support the governance of the company, monitoring progress against its strategic objectives, and providing a link between the CMI and its sole shareholder, the IFoA." She added: "I am not involved in the day to day work of the CMI. That is undertaken by a fantastic pool of volunteers giving their specialist knowledge and expertise, combined with the diligent support of the CMI secretariat." During my time as the CMI Secretary, I found the directors' input to be highly-valuable (and their challenges were always warranted!).

The Technical Working Party / Committee

The Executive Committee first discussed a proposal to form a technical working party at its meeting in March 2006. The minutes note that the aims were "…to promote good practice and to deliver a quality control function across the work of all the investigations…". The Technical Working Party (TWP) was duly formed, with Howard Waters, a member of both the Critical Illness and Income Protection Committees, as Chair and a representative of each of the investigation committees as the other members. Later discussions within the Management Committee suggested that its role was to act as "…a bridge between the investigations, which may use different techniques and methodologies".

Howard attended the Executive Committee meeting in March 2008 to provide an update on the TWP's work at which he noted: "[This] covers reactive matters where it would review and comment on Working Papers presented to it by other committees, as well as proactive matters such as initiating a high-level international survey to investigate activities similar to the CMI's in other parts of the world." On the survey, Howard is minuted as saying "…on feedback received, it would appear that the CMI was well up with other similar organisations around the world."

The TWP was reconstituted as the Technical Committee in March 2009, as it was expected to be longer-standing than implied by the term 'working party'. In 2011, Angus Macdonald was appointed Chair, as Howard Waters was retiring.

Particular examples of the feedback provided by the Technical Committee on other committees' work that were noted at Executive Committee meetings were:

- In October 2010, it was noted that: "…the paper analysing mortality improvements in SAPS data had been delayed as the Technical Committee had some concerns about the statistical techniques." This led to changes in the methodology before the analysis was released[242].

[241] There has been one subsequent change; with Peter Walker, the IFoA Director of Membership, replacing Clifford in March 2024.
[242] This was released as WP 53, and is noted under 'Extending the basic analyses' in Section C6.

- In March 2011: "David Heeney noted that the request for formal feedback on Working Paper 50 had produced a detailed response from the Technical Committee but no other responses to date from users."

In 2012, the Technical Committee produced a paper "…on a range of models that committees could consider … for future graduations." This paper was circulated to all committee members for comment and then formed the basis for a technically-oriented Committee Member Forum[243] towards the end of that year. This was later issued as WP 68, in July 2013; this proved to be the only external output produced by the Technical Committee.

Angus stepped down as Chair in November 2013 and was not replaced, leading to the Technical Committee becoming dormant although it was not formally disbanded until October 2015. In the meantime:

- The CMI had set up the Graduation and Modelling Working Party which had reviewed suitable methodologies, and produced WP 77.
- The High Age Mortality Working Party had sought volunteers from other committees to review its draft paper, rather than seeking feedback from the TC[244].

Consequently Tim Gordon proposed disbanding the Technical Committee "…and, instead:

- seek reviewers for specific pieces of work, as appropriate; either from within our existing pool of volunteers or, potentially, external third parties with expertise in that particular field; and
- establish working parties to undertake one-off projects relating to alternative methodologies."

The CMI Secretariat

At the beginning of this period, the Secretariat was provided by Barnett Waddingham and the CMI Secretary was Tony Leandro[245].

There were two changes in CMI Secretary during the period covered in this part of the book – the first was when I took over from Tony in July 2006, and the second when Viv Maclure took over from me in March 2022. These changes preceded our respective retirements, so that there was ample time for handover.

The process ahead of my appointment is unclear, but I suspect consisted of little more than an informal conversation between Tony and Brian Ridsdale, the then Chair of the CMI, prior to this being provisionally agreed at an Executive Committee meeting in March 2006, where the minutes record: "The Committee agreed that a recommendation would be submitted to FIMC[246] in April 2006 that Dave Grimshaw would take over as Secretary to the CMI."

In contrast, ahead of my retirement, Barnett Waddingham were asked to put forward a number of candidates, a selection of whom were then interviewed by a panel comprising the Chair and Deputy Chair of the Executive Committee plus one of the directors.

The role of the Secretariat evolved during the period. For example, the minutes of the Executive Committee meeting of 1 July 1999 record that:

> "…[the deficit in the 1998 accounts] was largely a result of under recovery of contributions from the offices. Tony Leandro explained that this function was now being undertaken by the Secretariat who, in the normal course of events, had much more contact with the offices than the accounts department of the Institute of Actuaries. This year's contribution letters had been sent out and he was hopeful of recovering the missing contributions from the previous year."

[243] See 'Committee Member Forums' later in this section.
[244] Both of these working parties are considered in more detail in Section C8.
[245] In June 2004, this title was amended to 'Secretary of the Management Sub-Committee of the CMI', as the Institute provided the secretary to the Executive Committee, but the use of 'CMI Secretary' was reinstated from October 2004, the minutes noting: "…this was preferable to the longer alternative … especially when he acts as a spokesperson for the CMI."
[246] The Faculty and Institute Management Committee.

The role has also become better defined, alongside the evolution in the CMI itself, for example:

- The Terms & Conditions make explicit the role of the Secretariat as the data processor; and
- The Internal Governance Procedures detail the respective responsibilities of the Secretariat, members of the committees and the directors.

A more substantive change to the Secretariat might have occurred when a retender of the provision of services took place, commencing in 2018. Such an exercise had been discussed on numerous occasions, on the basis of good governance, but, to my knowledge, a full retender had not taken place since the original appointment of Rodney Barnett & Co during the 1970s (and one may not even have taken place then). Specific instances of a retender being considered are:

- A review of the Secretariat arrangements was included in the scope of the CMI Review (see earlier) but this was removed from the project scope when it was behind schedule and deferred to a phase two, that then didn't happen.
- A 'Value for Money' study was commissioned in 2016. This was proposed by the Directors and supported by the Executive Committee, one member commenting that "…retender exercises are time-consuming and generally only of value if there is a serious intention to switch provider." However one of the findings of the study was that a retender exercise should be undertaken on the basis of good governance, so this returned to the table.

The retender exercise was a lengthy process, complicated by several factors, for example:

- Almost half of the members of the Executive Committee were recused from the process, as they worked for a consultancy that might be interested in tendering.
- There were aspects of the Request for Proposals that needed to be reviewed, or even drafted, by the existing Secretariat, as the Executive Committee did not have access to sufficient detail.

Some aspects of the exercise were not well-documented, because only a subset of the Executive Committee (and no-one from the Secretariat) were involved, but the broad approach was:

- An initial message was sent to consultancies to determine whether there was interest in tendering.
- PwC was appointed to run the tender process.
- The Request for Proposals (RfP) was issued.
- Potential bidders submitted questions, seeking clarification of aspects of the RfP. (Again, the existing Secretariat were asked to draft answers to some of these.)
- Potential bidders submitted proposals.
- Preferred bidders were invited to present to a subset of Executive Committee members.
- Detailed negotiations took place with the proposed selected provider, covering aspects of service delivery, then the contractual terms.

The eventual outcome was that Barnett Waddingham LLP was reappointed.

CMI Reports and working papers

In 2000, CMI Reports (as described in Section B6) were well-established but the CMI had identified a need to be able to release material more quickly; in particular, without waiting for the time inherent in printing a document. It therefore decided to commence issuing 'working papers' online, initially to complement CMI Reports. The positioning of working papers was set out in a short document that was added to the IFoA website when Working Paper 1[247] was released (in 2002) and is set out in Appendix 9.

[247] These are abbreviated to 'WP *x*' when referring to a specific working paper in this book.

Working papers were, I believe, welcomed by the actuarial community because they were more timely, generally focussed on a single topic and generally less daunting than the longer CMI Reports.

As actuaries, and the CMI itself, gained confidence in working papers, the need for CMI Reports was repeatedly questioned. However, despite the appeal of working papers, CMI Reports continued as a more formal 'final' documentation of an area of work and their demise was somewhat protracted:

- In June 2004, the Executive Committee decided that "…in future the information covered in blue books will be produced electronically, with hard copy on request." This still required a (small) print run.
- In October 2009, the Executive Committee agreed "…that the distinction between formal CMI reports and working papers will be retained but that the "blue books" will no longer be printed... It was noted that if the CMI gets specific requests for hard copies, the Secretariat will arrange for an A4 copy to be printed and bound."

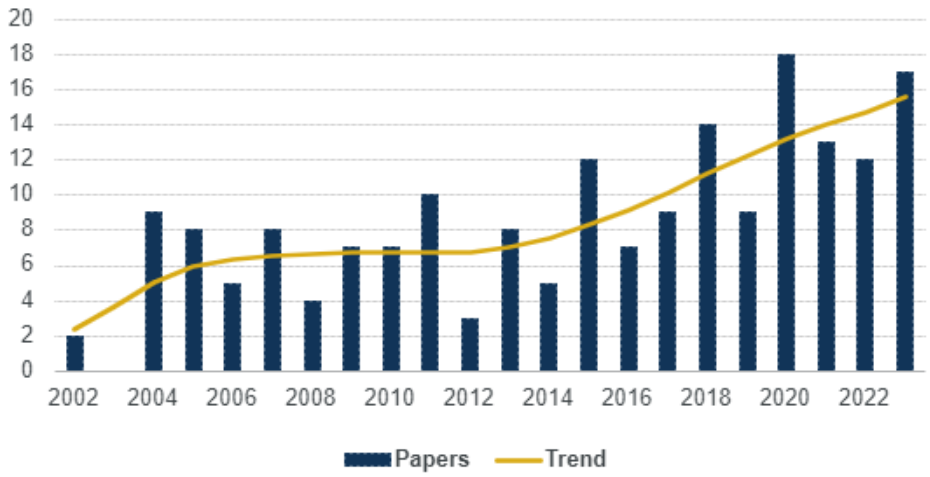
As I recall, the final nail in the coffin of CMI Reports came when Brian Wilson, Chair of the SAPS Committee, argued robustly in a Management Committee meeting that producing a CMI Report on the "S1" tables would be a waste of time and money as these had been finalised alongside WP 35 around a year previously and were already being used by consultancies. Asa a result, no more CMI Reports were produced.

In Section B6, I set out a series of generic points that applied to CMI Reports; some of these are contrasted with working papers below:

- Whereas CMI Reports were 'Published by the Institute of Actuaries and the Faculty of Actuaries', working papers are issued by the CMI.
- Whereas (most) CMI Reports were printed, working papers are issued online only, as a pdf.
- Whereas CMI Reports were A5 paper size, working papers are A4.
- Whereas CMI Reports often contained several papers, perhaps covering different investigations, working papers are generally focused on a particular topic.
- CMI Reports included an update on all areas of the CMI's work in the introduction. There is no parallel to this in working papers; instead, from 2007 to 2013, the CMI produced an 'Annual Review' that was sent to members alongside the request for financial contributions.
- Unlike CMI Reports, most working papers include an Executive Summary.
- Whereas CMI Reports contained errata and corrigenda, to correct errors in earlier CMI Reports, working papers are generally re-issued, with a revised version number and an indication of which areas have been updated.
- Whereas many CMI Reports contained extensive tables of numbers, many working papers are issued with accompanying spreadsheets.

Perhaps the biggest difference between CMI Reports and working papers, though, is the frequency of output. There were often gaps of several years between successive CMIRs; in contrast, after a slow start (two working papers in 2002 and none in 2003), there have been at least three working papers per calendar year with a peak of 18 in 2020, as shown in the chart overleaf.

The number of working papers issued by the CMI by year:



Initially, there was little standardisation of format of working papers, with each committee free to set out its material in a form that it was happy with.

This approach changed in 2016, when James Tait, then Deputy Chair of the Executive Committee produced a template that has been followed since, with the cover reprising the iconic blue that had been used for CMI Reports. The naming of the pdf documents, and the version numbering, has also been standardised. Templates for presentation slides and word documents were also agreed; all incorporating the new CMI 'logo', incorporating the IFoA's crest:

Continuous Mortality Investigation
Institute and Faculty of Actuaries

Another aspect of working papers that changed over time is the Executive Summary:

- Initially, it was down to the individual committee to decide whether or not one should be included.
- In 2016, the Executive Committee decided that an 'Executive Summary' should be issued as a separate document that was publicly-available, even if access to the working paper itself was restricted. As a result, the working paper itself did not include a summary.
- From 2018, the inclusion of an Executive Summary within a working paper became (almost) mandatory and the decision to issue a separate document was reversed. In its place, the CMI began to issue publicly-available 'Briefing notes' for some key papers. These were longer than an Executive Summary, perhaps including key charts, and were aimed at Non-Executive Directors and Trustees, for example.
- In 2019, the name of the summary within a working paper was shortened from 'Executive Summary' to just 'Summary'!

Other outputs

In addition to working papers, the CMI has issued a number of other forms of output during this period. The Annual Review, separate Executive Summaries and Briefing notes are all mentioned in the previous section. Other innovations have included:

- **'e-bulletins'**. James Tait proposed introducing these updates on CMI activity early in 2016 and they have been issued via the IFoA regularly since then. I reported to the Executive Committee in September 2017 on analytics provided by the IFoA that:
  - "The stats on "opening"[248] were exceedingly positive, in comparison with the Life and Pensions newsletters, given that the CMI newsletter had been set up on an opt-out basis, whereas the others were opt-in.
  - The number of people who had unsubscribed, to date, was remarkably low."
- **LinkedIn**. A LinkedIn profile[249] for the CMI was created in 2019, enabling the CMI to promptly publicise the release of working papers, etc. LinkedIn is also used as a means of publicising vacancies on committees, for example. At the time of writing, the CMI has almost 3,000 followers on LinkedIn.
- **Tableau workbooks**. These are intended to allow users to visualise aspects of the data beyond the selection of charts included in a working paper. The CMI was very conscious that some subscribers might not allow the underlying tool to be downloaded, so has also made available the underlying dataset alongside each paper that has an accompanying workbook. The first Tableau workbook was released by the Annuities Committee alongside WP 138 (see under 'A focus on in-payment pension annuities' in Section C2.
- **Blogs**. These were first suggested by Matthew Edwards in October 2020 as "…an efficient way to improve communications with minimal extra time/effort". Blogs have since been issued in conjunction with most new working papers as well as other topics[250].

Personal data: from postcodes to Index of Multiple Deprivation (IMD) deciles

For much of its history, the CMI collected only aggregated data from life insurers; i.e. the CMI asked for the total number of lives in force and the deaths at each age and duration (for each gender, etc) but not individual records for each life, as illustrated by the specimen data submission form in Appendix 5.

This changed with the launch of the PHI / IP investigation, which sought individual records from its commencement, as did the SAPS investigation, when that was launched. The critical illness investigation also sought individual records from an early stage. Initially, data protection legislation had limited impact on the CMI, as the records were not considered to constitute 'personal data' as they did not contain names, addresses or other information that might enable an individual to be identified.

When the CMI began to collect individual records for the mortality investigation from life insurers, as part of the move to collect 'Per policy' data (see 'The 'Per policy' data initiative' in Section C2), it initially requested only the first part of the postcode (e.g. TN11 in my case) and the records were still not considered to be personal data.

From 2006, the CMI began requesting the full postcode of each individual in 'Per policy' data for the mortality and critical illness investigations (and for the SAPS investigation from 2007). At that time, the Per policy coding guide "…referred to advice from the Information Commissioner's Office (ICO) that it would not consider a combination of full postcode with date of birth (and gender) to be personal data in terms of the Data Protection Act 1998."

Capturing full postcode would have enabled the CMI to stratify data by socio-economic group; mapping records to commercial tools, such as Acorn and Mosaic, and publicly-available indicators, such as the Index of Multiple Deprivation (IMD). It would also have enabled analysis by location and,

[248] i.e. people accessing the e-bulletin online.
[249] https://www.linkedin.com/company/continuous-mortality-investigation/posts/?feedView=all
[250] These can be found at: https://blog.actuaries.org.uk/search/?query=CMI

possibly, allowed the CMI to identify duplicate lives – thereby moving from analysis of policies to analysis of lives.

An interesting exercise took place around this time, in collaboration with the Office for National Statistics (ONS). As the CMI collected date of birth, date of death and full postcode, an attempt was made to match a sample of the CMI's deaths records with those held by the ONS, so that the ONS would be able to supply the cause of death for records that matched. The CMI met the ONS's costs of a pilot exercise and the results were adjudged promising although it was noted at an Executive Committee meeting in October 2007 "…that the matching could be considerably improved if we collected the name of the individual. This is possible for deaths as deceased people are outside the remit of the Data Protection Act." Unfortunately, in 2008, the ONS advised that it did not expect to have the resources to carry out further work soon and the exercise did not proceed further.

Doubts as to whether the CMI's position on personal data was correct resurfaced internally[251] and I contacted the ICO again in 2009, whereupon they informed us that their earlier advice had been inaccurate. (Helpfully, the person I spoke to also suggested they wouldn't take any action against the CMI, given our position was based on written advice from the ICO!)

This led to the CMI:

- Registering as a 'data processor' with the ICO; and
- Producing "…standard terms to regulate the relationship between data contributors and the CMI".

The CMI continued to collect full postcode, where data contributors chose to provide it, but for SAPS, the volume of postcodes submitted was low. This may have been due to the uncertainty over the position on data protection, but also to the fact that postcode was not a field that Scheme Actuaries used in valuations, hence the data contributors may not have held the data.

For the insurance investigations, some insurers chose to provide Acorn or Mosaic codes, instead of postcodes. Unfortunately from the CMI's perspective, insurers submitted the codes from the tool that they used internally and the mixture of the two types of codes made analysis difficult. The only actual use of these fields was to include results for pension annuities based on Acorn in WP 112 (described under 'A focus on in-payment pension annuities' in Section C2). The decision to use Acorn (only) was entirely pragmatic; as described in WP 112:

> "A combination of developments, at around the same time, led us to use Acorn for analysis of the 2011-2014 annuities dataset:
>
> - Under the then Terms & Conditions for Data Contributors (T&C), the CMI could only retain full postcodes for a limited time and we therefore needed to map these to one or more indicators, before the fields were deleted.
> - The CMI had signed a licence agreement with CACI, to use Acorn, but had not at that time agreed terms with Experian, to use Mosaic.
> - A large data contributor included Acorn types (only) in its data submission.
>
> This combination of circumstances led us to choose to map the full postcodes held at that time to Acorn; prior to deleting the postcodes."

WP 112 continues: "Subsequently, we received a data submission from another large data contributor that included a measure using Mosaic (only)." As CACI were prepared to supply a 'Mosaic to Acorn Look-Up Table', this data could also be (approximately) mapped to an Acorn category.

The 'standard terms', noted above, evolved into the Terms & Conditions for Data Contributors in March 2013 as part of the changes implemented under the CMI Review (described earlier). These

[251] From memory, it was Brian Wilson, the Chair of the SAPS Committee, who queried the advice from the ICO. In general, data protection was a more sensitive issue for SAPS, as the CMI collected data from consultancies but, ultimately, the data belonged to the originating pension scheme.

clarified the basis on which the CMI collected and processed 'Research data'[252], such that the CMI could be considered a data processor and not a data controller.

Further changes followed when the CMI reviewed its approach ahead of the implementation of the General Data Protection Regulation (GDPR) into UK law in May 2018. As described in 'Changes to CMI Research data 2018'[253]:

> "This led to changes in the data we collect (and how we process it). In particular, we sought to reduce the likelihood of an individual being identifiable by:
>
> - Moving to month and year of birth, instead of exact date of birth (and similarly for date of retirement);
> - Ceasing to collect the actual benefit amount, where this exceeds a specified cap; and
> - Ceasing to collect postcodes, which were previously an optional field for the life insurance investigations."

In addition, the CMI:

- Deleted all the postcodes it currently held.
- Introduced the 'Postcode Mapping Tool' which was designed to enable data contributors to provide a non-personal indicator of socio-economic status, based on Index of Multiple Deprivation (IMD) deciles.

The three particular variables that were available from the Postcode Mapping Tool were:

- Nation-specific IMD decile;
- UK IMD decile[254]; and
- 'NUTS 1' region of the UK[255].

Experience by IMD decile has since been included in a number of CMI analyses, as described in the relevant sections.

'Adoption' and 'Standard tables'

Historically, the CMI's mortality and morbidity tables were published jointly by the Faculty of Actuaries and the Institute of Actuaries[256].

In the early 2000s, it became clear that no-one who was currently involved was sure what process (if any) had been followed to gain the Councils' approval before publication of previous tables. The minutes of the Executive Committee meeting in June 2004 record that: "It was felt there needed to be a formal mechanism by which the CMI proposes a set of tables and the Actuarial Profession accepts them."

This concept became known as 'adoption' and its meaning was set out alongside the tables to which it applied; for example, WP 35, issued alongside the "S1" Series SAPS tables in October 2008 says:

> "These tables have been approved by the Management Board for adoption by the Actuarial Profession. It should be noted that adoption implies that the Actuarial Profession is satisfied that the tables have been well-constructed and subjected to rigorous peer review, such that the Profession is happy for the tables to be published in its name. It does not carry any

[252] This term was introduced in the CMI's Terms & Conditions. These also define 'Contacts data'; the data the CMI uses to maintain its relationships with subscribers and others, for which the CMI registered as a data controller.
[253] This document, issued in October 2018, is available from https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-data (under the heading 'GDPR changes').
[254] IMD is defined differently for the different nations; the UK-wide IMD decile is an attempt to combine these.
[255] The 'NUTS 1' regions are Northern Ireland, Scotland, Wales and nine parts of England: North East, North West, Yorkshire & The Humber, East Midlands, West Midlands, East of England, South West, London and South East.
[256] See, for example, the picture of 'The six volumes of the A1967-70 tables' in Section B2.

> implication that the tables are appropriate as a standard for any particular purpose and **it is the responsibility of any actuary or other person using a base table to ensure that it is appropriate for the particular purpose to which it is put**."

Following the CMI Review, it was no longer considered appropriate for the IFoA to be involved in approving the CMI's outputs. This was explicitly noted in several working papers; for example, WP 71, issued alongside the "S2" Series SAPS tables in February 2014 says:

> "Historically, CMI mortality tables have been referred to as 'adopted'. Since the "S1" tables were published, it has been agreed that the concept of adoption is no longer relevant. It should in no way be inferred that there has been any dilution of quality standards – the CMI is satisfied that the tables have been well-constructed and subjected to rigorous peer review – but, unlike their predecessors, the "S2" tables, and future CMI tables, will not be adopted. As with previous tables, the application of these quality controls do not carry any implication that the tables are appropriate as a standard for any particular purpose and it is the responsibility of any actuary or other person using a base table to ensure that it is appropriate for the particular purpose to which it is put."

It was also the case that the CMI's tables were often referred to as 'standard tables' historically, both within the CMI (including in the name, 'Standard Tables Program') and by actuaries more generally.

As noted in the 'Memorandum of Understanding' between the Financial Reporting Council (FRC) and the IFoA[257]:

> "Following the Morris Review of the Actuarial Profession, published in March 2005, HM Treasury asked the Financial Reporting Council to take on responsibility for independent oversight of the UK Actuarial Profession and the independent setting of technical actuarial standards."

As a result, the CMI ceased referring to 'standard tables' from this time.

Quality Assurance

Whilst 'adoption' related specifically to the publication of tables, the more general issue of quality assurance increased in importance during the 2000s. Prior to this, I am sure that the CMI made extensive efforts to ensure that its outputs were high quality however it is not clear what formal processes attached to this.

The picture changed following the issue with the "S1" tables (see 'The first SAPS mortality tables' in Section C6). This led to two immediate actions:

- An interim process was introduced "…a one-page approval sheet would be prepared for each "output" which will summarise the checks and reviews that have been undertaken." Formal approval to release would then be required "…high-profile outputs would be approved by the Management Committee whilst those deemed as low-profile would be approved by the Chairman of the relevant committee."[258]
- An independent audit of the CMI's processes was undertaken by Grant Thornton. This concluded "…that the CMI processes, in general, worked well"[259] but suggested a number of improvements. The Executive Committee set up a 'Steering Group' led by the Chair, Gordon Sharp, to oversee the actions from the report.

Further initiatives followed:

- The Management Board of the IFoA commissioned a second report from Grant Thornton in 2013[260], as part of the CMI Review, to assess whether their recommendations had been satisfactorily implemented by the CMI.

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[257] https://media.frc.org.uk/documents/Memorandum_of_Understanding_I2bsWVn.pdf
[258] Both of these quotes are from the minutes of the Executive Committee meeting in June 2008.
[259] This quote is from the minutes of the Executive Committee meeting in October 2008.
[260] As this related principally to the previous report, I don't think any firms other than Grant Thornton were approached for the second piece of work. In addition to reviewing the actions (and non-actions)

- Huw Evans, a member of the Executive Committee, undertook a desk-based review in 2015.
- The CMI has considered the applicability of Technical Actuarial Standards, issued first by the Board for Actuarial Standards and more recently by the FRC, to ensure its work is compliant.
- The CMI has introduced a number of internal 'Quality Assurance procedure documents'; for example, a 'Guide to graduating mortality tables'. These aim to capture (and share) good practice and are subject to regular review to ensure they remain appropriate.

The Standard Tables Program / CMI Tables Program

The background to the Standard Tables Program (STP) is set out in Section B6. During the 2000s, the STP was updated for new tables; for example, CMIR 18 (published in 2000) records that:

> "The Windows version of the Standard Tables Program has been launched and incorporates the "92" Series of mortality tables…"

As noted above, in 2006 the CMI ceased using the term 'standard tables' and the software was renamed as the 'CMI Tables Program' (although it was still commonly abbreviated to 'STP'!)

The updates continued, certainly until 2007, when it was updated to include the mortality projections in the first version of the 'CMI Library of mortality projections', issued alongside WP 30.

However the number of users had declined significantly by that time – in particular because the CMI was releasing mortality tables in spreadsheet form and actuaries were accustomed to performing their own calculations in spreadsheets. In around 2010, the CMI decided to cease updating the software.

The Chain of office

On his retirement from the Executive Committee in 2000, Rodney Barnett presented John McCutcheon (who was acting chair for that meeting, in place of Peter Nowell) with a 'Chain of office', pictured overleaf. This included the crests of both the Faculty and the Institute and was engraved with the names and dates of all the previous chairmen.

For some years, the Executive Committee only (normally) met annually, and the Chair would wear the chain to meetings (as well as some external meetings)[261]. As each President of the Faculty and the Institute joined the Executive Committee, they would cast admiring looks at the chain which was considered grander than either of their own, as President!

On the first occasion that Brian Ridsdale was presented with the chain to wear (as Chair of the CMI) he remarked that there was a spelling mistake in the Faculty's motto, which was rather embarrassing! He added that he doubted whether anyone would notice, or mind, but it was duly amended.

taken in response to their first report, they were also instructed to review the process followed for the "AC04" critical illness tables and the "IPM 1991-98" income protection tables, both of which were intended to be put forward for adoption, until that concept was dropped.

[261] It is normally kept in a safe in Barnett Waddingham's offices.

The CMI Chain of office:

Committee Member Forums

As the number of CMI committees had expanded, Brian Ridsdale (then Chair of the CMI) suggested bringing all CMI committee members together, to discuss common issues. The first such Forum took place at Barnett Waddingham's offices in March 2006, followed by dinner at a local restaurant. A picture taken at the end of the Forum is included overleaf.

Feedback from attendees was positive and similar events took place, initially at around three-year intervals. With the advent of COVID, and the resultant change to working practices, such events have become shorter and more frequent and, in some cases, virtual.

Notwithstanding these changes, the purpose of the Forum has remained essentially similar over the years:

- Foster a sense of community across CMI
- Encourage cross-fertilisation of ideas / sharing of issues
- Facilitate communication across the CMI:
  - Overview of research activity for Board/Executive/Management Committees
  - Awareness of strategic issues for Investigation Committees
- Opportunity for recognition and saying thanks

Attendees at the first CMI Forum, in March 2006:

Back row (L to R): James Kirkby (Heriot-Watt University), Simon Spencer*, Stewart Ritchie, Phil Bayliss, David Leach, Johann Du Toit, Dave Grimshaw* and Neil Reynolds

Middle row: Gavin Jones, Caroline Instance (CEO of the Institute of Actuaries), Jonathan Lawlor, John Ellam, Steven Richards, Eugene Hertzman, Paul Seymour, Chinu Patel, Rajeev Shah*, Iain Currie (Heriot-Watt University), Neil Robjohns, Joanne Wells, Howard Waters and Andrew Howe

Front row (L to R): Richard Willets, Tony Leandro*, Gordon Sharp, Angus Macdonald, Brian Ridsdale, David Heeney, Graham Clark, Mike Pomery and Brian Wilson.

* Members of the CMI Secretariat

The CMI and universities

Parts B and C contain a number of references to the interaction between the CMI and universities; for example, see 'A CMI statistical model for PHI' in Section B4.

At the beginning of the period covered in this part of the book, 2000, Heriot-Watt university was closely involved in the CMI's activities; in particular, four professors were represented on CMI committees:

- John McCutcheon was Chair of the Mortality Committee and a member of the Executive and Management Committees;
- Angus Macdonald was a member of the Mortality Committee and would succeed John as its Chair in 2001;
- Howard Waters was a member of both the PHI Committee and the CI Committee; and
- David Wilkie was also a member of the PHI Committee, having previously been a member of the Executive Committee from 1964 to 1994; as Chair from 1983 to 1994, and the AIDS Sub-Committee.

This involvement resulted in a number of projects undertaken by researchers at Heriot-Watt using CMI datasets, as listed in Appendix 8, and was recognised by an annual grant[262]. Howard Waters recalls that:

> "For many years the CMI would contact relevant universities and ask us to submit a list of completed research relevant to the CMI's aims, i.e. mortality and morbidity research. The CMI would then make a grant to each university in recognition of this work. This payment was not for work carried out as a member of a CMI Committee, e.g. my work on CMIR 12, but for work, like Isabel's[263], that was relevant but not central to the CMI."

The provision of grants ceased in 2011 and was initially replaced by the CMI setting aside budget and inviting researchers to apply in advance for a grant to help them undertake research projects relevant to the CMI's work. This approach was consistent with a more focussed approach to research being followed by the IFoA itself. In practice, no such grants were made.

CMI's engagement with universities has changed markedly subsequently, with only one academic on a CMI committee at the time of writing (Gerry Kennedy from Southampton University is a member of the IP Committee). This shift has occurred for many reasons, including:

- The CMI has become more focused on pragmatic research, and producing tools that are valuable to subscribers. This is perhaps best illustrated by the simplifications in methodology for the IP investigation, from one based on sickness to one based on claims inceptions.
- The restrictions on access to CMI's outputs may make involvement less suited to academics' attention.

The CMI and Ireland

Although its work is focused on the UK, the CMI has had relationships with many overseas organisations over the years; often being approached for information and support.

More recently, the Mortality Projections Committee has been keen to test the CMI Mortality Projections Model on other countries data; in particular, a collaboration with the Society of Actuaries in the USA is noted in Section C7.

However the longest-standing and most complex of the CMI's relationships is that with Ireland!

Historically, the CMI collected data for Ireland[264] and produced results based on Irish data. This position may have been a consequence of much of the business being written by subsidiaries or branches of UK offices (the notable exception being Irish Life). The Irish data was not included in the main CMI mortality tables, though, and no Irish-specific tables were produced[265].

At that time, there was no separate professional body in Ireland. As noted on the Society of Actuaries in Ireland's website: "The Society of Actuaries in Ireland was founded … on Wednesday, 3rd May 1972. At that time there were seventeen actuaries, all Fellows of the Institute of Actuaries or of the Faculty of Actuaries, resident in Ireland… As the profession grew in size, the scope of the Society's activities widened considerably. In response to this, the Society was formally incorporated in 1988."

The CMI's last results for Ireland were those for mortality under permanent assurances in 1999-2002 issued in CMIR 21, which notes:

> "As was reported in C.M.I.R. 19, the number of offices contributing to the Irish experiences in recent years has declined and the exposed to risk has been falling steadily. The situation is

[262] A grant was also paid to City University. My recollection is that these were the same amount when I joined the Management Committee but we later agreed to pay more to Heriot-Watt, recognising their greater involvement.
[263] Howard is referring to Isabel Cordeiro, whose PhD thesis is noted in Appendix 8.
[264] The specimen data submission form in Appendix 5 includes a 'territory' field, with 1 = UK and 2 = Ireland.
[265] Irish tables were considered – see, for example, 'The first graduations of female data and a possible graduation of Irish data' in Section B2.

> exacerbated by the fact that most business written in Ireland is now on a unit-linked basis for which the CMI does not currently run an investigation. The viability of this investigation is now questionable."

The Society of Actuaries in Ireland (SAI) undertook a separate Irish critical illness investigation for the years 1995-1999, for which CMI did the data processing and produced individual office and 'all offices' results on an outsourced basis. The CMI's involvement avoided any need for the SAI volunteers to have access to the data and results of individual companies. The results were included in an SAI paper presented on 3 November 2003[266]. Subsequently, there was a second study (for the years 2001-2003) that the CMI also supported[267].

Around 2009, the SAI began to consider establishing a body to undertake its own investigations. The Executive Committee agreed in March 2010 that it would be happy for the CMI to share technical expertise with such a body, but it should not incur any costs or any liability for its work. The new entity was named 'SIDE' ('Studies in Irish Demography Experience') and extensive work was undertaken to set it up, including issuing a Request for Proposals and a decision to appoint Barnett Waddingham to undertake the data processing but, ultimately, this didn't proceed. (From memory, several of the Irish insurers – who would have been needed to provide data and funding – were up for sale, or in the process of being sold, at that time so the SAI couldn't gather the necessary support.)

There was then little interaction between the CMI and the SAI until 2019 when Matthew Edwards (then Deputy Chair of the Executive Committee) spoke at an SAI event on the CMI's recent work[268]. This led to a collaborative project on applying the CMI Mortality Projections Model to Irish population data, which was published as WP 141 in October 2020. The paper was written by two members of the SAI Demography Committee, Sinéad Carty and Karl Murray, and reviewed by the CMI's Mortality Projections Committee.

Further collaboration has since been considered, whereby the CMI would collect and process assurances data on behalf of the SAI, as described in Part D2.

[266] 'Irish Critical Illness Experience 1995-2000'.
[267] The paper 'Irish Critical Illness Experience 2001-2003' is available at: https://web.actuaries.ie/sites/default/files/event/2009/10/070529_critical_illness_update-1.pdf.
[268] This may have been initiated by Caroline Twomey, who at that time was both Chair of the SAI Demography Committee and a member of the CMI Annuities Committee. Matthew describes this in Appendix 10: 'Chairing the CMI during the pandemic'.

Part D: Into the future, 2024 and beyond

D1. Introduction to Part D

The core aims for which the CMI was set up, just over 100 years ago[269] include:

- "To collect statistics relating to the mortality of various classes of insured lives, annuitants and pensioners",
- "To construct tables of mortality" and
- "To make estimates of future developments in mortality".

It is remarkable that these remain central to its work despite all of the changes in the industry and, indeed, society as a whole during the intervening years.

The resounding success of the CMI Review, which concluded with substantive changes to the CMI's structure and operations from 1 March 2013, left the CMI in a very strong position; evidenced by, for example, the widespread adoption of the CMI Mortality Projections Model and the broadened subscription base.

This position of strength has perhaps been jarred by the COVID-19 pandemic. At an early stage in the pandemic, Stuart McDonald (then acting as the CMI's CRO) referred to it as an 'existential threat' to the CMI – if it undermined the perception (held for the preceding 100 years!) that past experience is valuable in understanding the future, then the basis of the CMI's work would be undermined. It is perhaps too early to be wholly confident that this threat has passed; the CMI's actions over the coming years, in analysing the impact of the pandemic and its aftermath, will be vital to ensuring it maintains its long-held reputation as a trusted, highly-valued source of independent analyses. However the CMI has weathered the storm sufficiently that we can look further ahead.

Whilst I have been very happy to document the CMI's past, I thought it better to ask the CMI to contemplate its future. Specifically, I asked Jonathan Hughes and Stuart McDonald, Chair and Deputy Chair of the Executive Committee, respectively, to consider what the future holds over a timespan of ten years and I am grateful to them for setting out their thoughts, drawing on input from the five committees: Annuities, Assurances, Income Protection, Mortality Projections and SAPS. These are contained in Section D2.

[269] These are set out in the "CONSTITUTION AND RULES OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU" in Part A2.

D2. The CMI's view of its future

Serving the CMI's current and future stakeholders

The CMI currently serves a wide range of subscribers: from the largest life insurers, reinsurers, and advisers to pension schemes in the UK to individual sole-trader consultants. It also serves the wider actuarial profession and contributes trusted analysis and insight to public debate in the areas of its expertise. We hope and expect the CMI's outputs to remain relevant for all these stakeholders in future years, collaborating increasingly with adjacent professionals such as demographers and health scientists, with whom we have had increasing interaction, particularly during the pandemic.

To achieve this, the CMI will need to do two things:

1. Evolve its outputs to fit the changing needs of stakeholders; and
2. Maintain (and in areas strengthen) the three critical ingredients to the CMI's outputs: data contributions, financial support from subscribers and professional volunteers.

Neither of these are straightforward, with increasing challenges including data confidentiality, commercial sensitivity and rapid technological developments. But we take great confidence from the past successes of our predecessors in overcoming the challenges they faced, leaving the CMI in such a strong position today.

1. Evolving the CMI's output

Forecasting what the CMI will look like over the next hundred years is too ambitious a target to achieve reliably but there are several areas that we confidently expect to be a focus over at least the next decade:

- Adapting existing analyses;
- Exploring new analyses; and
- Embracing a changing environment.

Adapting existing analyses

The CMI's outputs have not been static during our 100 years. They have always been adapted to best fit their users' needs and we can extrapolate from some of the recent changes to understand what might come next:

- **Market coverage**: Analysing data that represents a large proportion of a particular market ensures that results are representative and reduces the risk of 'data dominance' (where one office is overly-represented in particular segments of the results). We will strive to ensure that the CMI datasets have as wide a market coverage as possible, ensuring that offices which contribute data receive valuable and relevant insights in return. Increased market coverage is especially helpful for more granular analyses, such as cause of death and rated lives investigations.
- **Outward focus**: While the CMI's first priority remains the needs of its subscribers, the COVID-19 pandemic showed that the CMI can serve the wider profession and public interest by reaching a broader audience with timely and objective mortality analysis. This in turn has led to greater interest and useful engagement from non-actuarial professionals in related fields. We have been building on this, working more closely with external organisations such as the Office for National Statistics to share expertise and give the CMI more visibility of, and influence on, decisions related to the production and analysis of national mortality data and statistics. We are grateful to these organisations for their engagement to date and look forward to collaborating further in the future.
- **IMD deciles**. Each of the CMI's investigations now receives a high proportion of data that includes Index of Multiple Deprivation (IMD) deciles. This is an example of where the CMI can add value to even the largest insurers and one that we expect will yield particular insights and assist subscribers in benchmarking and further developing their own understanding.

- **Interactive outputs**: The formats of the CMI's outputs have evolved, and the majority of our outputs are currently a combination of PDF (e.g. working papers) and spreadsheets. But data visualisation and manipulation practices continue to change (not just in our industry), so we will need to ensure our output formats keep pace with subscriber expectations and with regard to the needs of all our stakeholders.

Exploring new analyses

Each investigation committee regularly considers what other analyses might be of value to subscribers, using either existing datasets or where needed seeking out new data sources. The Executive Committee also considers the wider landscape to assess the need for broader analyses which do not easily 'fit' within an existing investigation.

As with adapting existing analyses, we can consider recent changes and how these in turn point to the future:

- **Range of investigations**. The earlier parts of this book illustrate how the areas of CMI's work have evolved as products have changed. This will undoubtedly continue; for example, the Annuities Committee's enhanced annuities analyses are now integral to that Committee's work and we hope that further analysis of equity release mortgages will be possible soon. More widely, the CMI's hosting of MRSC's cause of death dataset[270] has been favourably received by subscribers and may prove to be a pioneer of similar future collaborations to produce common datasets of value to the profession.
- **Ireland**. The CMI has recently assisted in collecting and processing data for analysis of term assurances from Irish companies and the Assurances Committee will collaborate with the Demography Committee of the Society of Actuaries in Ireland to produce 'all offices' results and a CMI working paper. The CMI's infrastructure that enables us to securely and confidentially process datasets will continue to be in demand beyond the UK, so we will carefully consider subscribers' interests when overseas opportunities arise.
- **Working parties**: From time to time the CMI establishes working parties to investigate particular topics of interest and value to subscribers[271]. These operate outside the standard committee structure and tend to be temporary with a narrow focus. Given the increasing pace of change in our environment, we expect to use this model of agile working parties in the future.

Embracing a changing environment

As the CMI's own investigations evolve, the wider environment continues to change and at an ever-increasing pace. To illustrate this, we consider below a few of the key themes currently of most salience to the Executive Committee and how they might impact the CMI's future work.

- **COVID-19**: The immediate implications of the heavily-impacted years (2020, 2021 and 2022) are already considered in CMI outputs such as our Mortality Projections Model and pooled experience analyses. But over the coming years, we will need to determine how to make best use of these data for graduated tables and to continue to produce analyses that provide subscribers with a picture of how post-pandemic experience is evolving. Specifically:
  - Both the Annuities and Assurances Committees will assess the need for new tables derived from mortality (and critical illness) experience post-pandemic, potentially leading to "24" Series tables based on data for 2023-2026.
  - The original CMI Model was based on the principle that recent experience is a good guide to the short-term future. The Mortality Projections Committee will continue to assess whether the pandemic affects this principle, to ensure that the Model remains useful and relevant to subscribers.
  - The CMI has yet to assess the impact of the COVID-19 pandemic on Income Protection experience. Having recently concluded its work on revising claim inception

[270] The Mortality Research Steering Committee of the IFoA; this initiative is noted under 'The impact of COVID-19' in Section C7.
[271] The work of three recent working parties is described in Section C8.

methodology[272], the IP Committee is looking to capture data for the more recent years to enhance understanding of how COVID-19 has affected claim inceptions and terminations.

- **AI**: The CMI is already exploring how it might benefit from developments in Artificial Intelligence (AI). This will be an ongoing priority, as is the case for technological developments in general. The CMI's unique datasets could present equally unique opportunities for analysis (as long as appropriate care and attention is paid to matters such as data confidentiality, the commercial considerations of data contributors and the value of such analyses to subscribers). AI is likely to contribute to the CMI's operational efficiency too, such as in administering and documenting committee meetings.
- **Diversity**: Ensuring diversity among volunteers has been a CMI priority for some time[273] and indeed having a broad range of skillsets and organisations within each committee is critical to delivering useful, high-quality outputs. We will continue our efforts to ensure that the CMI committees represent the actuarial profession as a whole, and welcome other professions' involvement where they can add value.

2. The key ingredients to CMI outputs

Three things are crucial to producing the CMI's outputs: data contributions, financial support for its operation and professional volunteers. We need to maintain and where possible strengthen each of these to meet our subscribers' evolving future needs.

Data

The CMI uses a large amount of data contributed by insurers and advisers to pension schemes; these cover a significant proportion of many markets of core interest to subscribers. In addition, the CMI uses public data from national bodies such as the ONS, in particular for assessing features such as mortality trends for the general population.

Data contributors would not be willing to submit data without the CMI's robust data collection and processing infrastructure. This is provided by the Secretariat, currently outsourced to Barnett Waddingham. Having this separate data processing capability maintains the confidentiality of individual office and pension scheme submissions and ensures that the data is held and processed in a secure environment. Using a contracted provider (rather than solely relying on volunteers) also enables more timely release of outputs through agreed service levels and KPIs[274], as well as the application of consistent quality assurance controls.

We expect this infrastructure to remain in place for the foreseeable future, as it is integral to the operations of the CMI. Future developments will likely relate to the technologies deployed to analyse this data and the safeguards needed to maintain security and confidentiality, as well as regular reviews of the outsourced provider to ensure the best fit with the CMI's objectives.

Financial support

The outsourced Secretariat model requires sustainable funding, hence the creation of the CMI subscriber paywall ten years ago[275]. Combined with making the CMI a wholly-owned subsidiary of the IFoA, this allows the CMI to operate with specific governance and dedicated resources. Despite the subscriber paywall, outputs are released publicly where they have wider public interest (such as our regular Mortality Monitors, analysing population mortality).

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[272] These changes are described, alongside results for 2017-2020, in WP 193, issued in 2024.
[273] I was a guest attendee at the CMI Committee Member Forum in September 2024 and it struck me that the attendees were considerably more diverse (at least with regard to observable attributes) than when I first became involved. It is certainly more diverse with regard to gender than in the early years, described in Part A, in which I think the only women are those employed to process data! The CMI has had several female committee chairs in the last fifteen years and now has its second female CMI Secretary … hopefully it won't be too long before it has the first female Chair of the Executive Committee!
[274] Key Performance Indicators.
[275] This is described under 'Review of the CMI' in Section C9.

Given the criticality of the outsourced Secretariat model and the success of that model to date, we would not expect the overall funding structure to change significantly in the next few years. However, we do (and will continue to) review the balance of funding between the different types and sizes of subscribers to the CMI. This has recently resulted in introducing a modest discount for subscribers who are also data contributors. We firmly believe that the CMI's outputs represent value for money, but recognise that this will only persist for as long as we keep producing analyses of relevance to subscribers.

Professional volunteers

While the Secretariat provides the confidential data processing and often output drafting, the outputs are overseen and reviewed by volunteers who staff the CMI's committees. Our volunteers are typically actuaries whose daily work has relevance to CMI outputs.

Throughout our hundred years, the CMI has benefited from such volunteers and we are grateful to them and to their employers, who allow them to use some time for the CMI. We hope they also benefit: the individuals by having an opportunity to apply their actuarial talents in unique ways, and the employers by having a voice at the table within the CMI committees.

This volunteer base is as critical to the future success of the CMI as it has been to the past. We are fortunate that our regular requests for volunteers attract strong candidates and are often heavily over-subscribed. Our future efforts will be focused on ensuring that access to these opportunities is as open as possible, so the CMI can benefit from the experience of a diverse range of volunteers in its committees.

A future 'thank you'

Many people have helped the CMI deliver outputs over its hundred years. Their contributions have been in many different ways: providing data, supporting the CMI financially or offering their time and expertise. These people have helped make the CMI the unique and respected organisation that it is today.

So we would like to end our 'thoughts on the future of the CMI' with a pre-emptive 'thank you' to all those who will contribute to the CMI's future achievements: we wish you every success in overcoming the challenges that will inevitably arise in producing the high-quality impartial analysis for subscribers and the wider profession, and hope that you will feel as much pride as we do in being a part of the CMI's history.

Despite the inevitable challenges that the future will bring, we are optimistic that the CMI will rise to those challenges and continue to be a 'Jewel in the Crown' of the UK actuarial profession for many years to come.

Appendix 1 CMI Chairs, Secretaries and Committee Chairs

Chairs of the CMI

The full list of Chairs of the CMI to date is:

Sir W. P. Elderton	1923-1948
R. Ll. Gwilt	1948-1961
F. M. Redington	1961-1968
J. M. Denholm	1968-1974
E. B. O. Sherlock	1974-1983
A.D. Wilkie	1983-1994
C.G. Kirkwood	1994-1999
P.J. Nowell	1999-2004
B.P. Ridsdale	2004-2008
A.G. Sharp	2008-2013
T.J. Gordon	2013-2017
J.M. Tait	2017-2020
M.F.J. Edwards	2020-2023
J.E. Hughes	2023-

Note that the holders were initially titled 'Chairman of the CMI' until CMI Limited was formed, in 2013, when it was amended to 'Chairman of the Executive Committee'. 'Chairman' was shortened to the gender-neutral 'Chair' for all CMI committees in 2017.

Deputy Chairs of the CMI[276]

Angus Macdonald	2008-2013
James Tait	2013-2017
Matthew Edwards	2017-2020
Jonathan Hughes	2020-2023
Stuart McDonald MBE	2023-

To my knowledge, there was no Deputy Chair prior to Angus. Angus's role was not well-defined; more recently, Deputy Chairs have, effectively, been 'Chairs in waiting'.

CMI Secretaries

The full list of CMI Secretaries to date is:

Roland Clarke	1950-1972
Rodney Barnett	1972-1990
Jillian Evans	1990-1998
Tony Leandro	1998-2006
Dave Grimshaw	2006-2021
Viv Maclure	2021-

[276] In recent years, it has been the norm within CMI to use forenames, rather than initials, and I have used this approach in the remainder of this appendix.

Investigation Committees

The investigation committees are set out below, in the order in which they were formed. The dates applicable to each chair are based on CMI Reports for the years to 2000. From CMIR 8, these listed the members of each committee but do not include dates; consequently, where there was a gap of several years between CMIRs, the years shown below may be inaccurate, by a year or two.

The CMI has had a range of working parties and other groups over the years; these are less well-documented and I have not included them here. I have also not included the Management Committee, which has been chaired by the chair of the Executive Committee throughout.

PHI / IP Committee

Jo Hamilton-Jones	1973-1979
Jim Cairns	1979-1982
Bob Plumb	1982-1995
Graham Clark	1995-2009
Paul Murray	2009-2010
David Richardson	2010-2011
Joan Coverson	2011-2018
Duncan Heald	2018-2021
Toby Hester	2022-2023[277]
Zoe Woodroffe	2023-

Impaired Lives Committee

Hugh Jarvis	1991[278]-1991
Spencer Leigh	1991-1998
Dave Grimshaw	1998-1999

Mortality / Life Office Mortality / Annuities Committee

Colin Kirkwood	1991[279]-1995
John McCutcheon	1995-2001
Angus Macdonald	2001-2011
Kevin Armstrong	2011-2015
Jonathan Hughes	2015-2020
Jamie Funnell	2020-

AIDS Committee

John Lockyer	1993-1999

[277] Toby acted as Interim Chair, due to Duncan's ill-health. Sadly, Duncan passed away early in 2024.
[278] CMIR 11 notes that "The Bureau set up an investigation into assured impaired lives in 1982 under another Sub-Committee, which is now chaired by Hugh Jarvis." This suggests there was an earlier chair than Hugh, but I have been unable to identify who this was; in any event, it is likely that Hugh took office before the date shown.
[279] This may appear surprisingly late, given the CMI started operations in 1924 but I understand that earlier work was undertaken by the Executive Committee.

Critical Illness / Assurances Committee

Dave Grimshaw	1999-2006
Dave Heeney	2006-2012
James Tait	2012-2017
Hamish Wilson	2017-2022
Chris Reynolds	2022-

SAPS Mortality Committee

Brian Wilson	2006-2009
Deborah Cooper	2009-2017
Matt Fletcher[280]	2017-

Projections Library Committee / Mortality Projections Committee

Gordon Sharp	2007-2013
Tim Gordon	2013-2019
Cobus Daneel	2019-

Technical Committee[281]

Howard Waters	2010-2011
Angus Macdonald	2011-2015

[280] Matt stood down in 2024, and was replaced as chair by Susan Hanlon.
[281] This was initially established as the Technical Working Party, chaired by Howard, in October 2006.

Appendix 2 Extract from 'The Institute of Actuaries 1848-1948'

Note: This appendix contains the 'MORTALITY AND OTHER INVESTIGATIONS' section of the book 'The Institute of Actuaries 1848-1948: An Account of The Institute of Actuaries during its First One Hundred Years' by R. C Simmonds, published in 1948. Much of this section describes work prior to the formation of the CMI itself. It should also be noted that it is a history of the Institute; consequently, it does not seek to document matters from the perspective of the Scottish body, the Faculty.

MORTALITY AND OTHER INVESTIGATIONS

Although this book is not the place in which the history should be recorded of the various important investigations with which the Institute has been concerned, some references must be made, especially with regard to the part played by the Council as the administrator of Institute affairs.

Early in l849, a Scottish member wrote in advocacy of some plan 'for collecting correct returns from year to year of the mortality among insured lives' (perhaps, there was a hint of a continuous investigation, not adopted till many years had passed). He sent, later, a 'Resolution of Managers of Scotch Life Offices'. It was 'agreed to consider the recommendation on a future day'. In November 1850, the Council decided (as was mentioned in Chapter III[282]) that, as an experience 'taken some years hence will be so much more valuable than if obtained at the present time, it does not seem expedient to make the proposed investigation now'. Instead, the Council turned its attention to the 'so much more urgent' matter of the mortality of 'persons residing in places abroad, or who have at any time incurred foreign risk'. Forms for this purpose were drawn up and issued to all the Offices, but only fifty-two responded. Details were obtained of 6,154 cases and Charles Jellicoe, in 1857, contributed a short account (].I.A. VII, 131). The following extract shows the obvious general difficulty that was met in trying to extract anything useful from the material:

> If, on the one hand, the conditions of the risk were kept within limits sufficiently restricted, the numbers in each class were all but insignificant; and if, on the other, attempts were made to remedy this last inconvenience, the groups comprised risks which were altogether heterogeneous.

A handsome tribute was paid, in a footnote, to Edward Cheshire, described as 'the then Secretary of the Institute', for superintending the work, which 'was executed with all the care and minute accuracy which, it is so well known, that gentleman brought to bear upon such undertakings'.

The Council, in these early days, was also interested in, and was consulted specifically about, the question of the proper rates of contribution for Benefit Societies.

In January l862, the H^M, first of the really important investigations, was launched. It was resolved:

[282] Chapter III of the book by R. C Simmonds, which is not included here.

That it is very desirable to collect and combine, as far as possible, the experience of the Life Assurance Companies of the United Kingdom, to the present time.

That a Committee be appointed to report on the best means of collecting such experience, with power to communicate with any other Committee, or Actuaries and Managers of Companies, who may be disposed to assist in obtaining the required information.

The Committee reported, in May 1862, giving draft circular letters and a schedule showing the data that the Offices were to be requested to provide. The recommendations were approved, with slight amendments, and the circulars and schedule were ordered to be 'printed and issued to the Life Assurance Companies'. In January 1863, the Honorary Secretaries were requested 'to take immediate steps for carrying out the resolutions' adopted in the previous May. The reasons are not apparent, either of the delay that had occurred, or of the rather urgent tone of the instructions. It may be, however, that the Council feared competition from the Actuaries' Club, in the shape of independent publication of material that it had collected. The Minutes of the Club state that, in January 1860, considerable progress had been made in 'extracting the mortality experience of the Offices of the Club' and that, in February l862, Samuel Brown had sent the following letter to a member of the Club:

It has been decided by the Council of the Institute of Actuaries to endeavour to collect and combine the experience of the Life Assurance Companies of Gt. Britain to the present time. With this view a Committee has been appointed empowered to communicate with any other Committee or individual willing to aid in this useful object. Understanding that the Actuaries' Club have already collected the experience of some important Companies, and that you are a member of their Committee, I have been requested by our Committee to ask the favor of being furnished with the forms you have adopted, the names of the Companies and such other information as to the total number and nature of the facts collected as you can give us. The object will be to save the trouble of applying to Companies which have already completed the work and to collect the fresh experience, as far as possible, in such a form as will allow both collections of facts being compared or combined with each other hereafter. We shall feel obliged if you will have the goodness to bring this question before your Committee and let us know the result.

The reply of the Club, on 4 March 1862, was in these terms:

Mr Hendriks has brought under the notice of the Actuaries' Club the letter you were good enough to address to him relative to the proposed collection of the Mortality Experience of Assurance Offices, and I am desired to express the best thanks of the Club for the communication.

The one fact of great interest to all those who seek for information bearing on the subject of vital statistics vizt.: the rate of mortality experienced by the Offices, is of course kept in view by each

of the contributing Companies, but the method pursued to attain that end has not in its details been so uniform as to permit the Club to comply with all your requests, otherwise they would most cheerfully do so; and some Offices have pursued enquiries collateral to the main one.

All the Offices have, it is assumed, adopted methods that permit of the results being combined so as to arrive at an accurate result of the whole mass of experience and several of them have taken out their facts on the only form that I possess and this, in the shape of the enclosed card and instructions relating thereto, the Actuaries' Club have great pleasure in furnishing to you.

Our work is in such a state of forwardness that it is hoped the practical deductions from it may appear at an early date and I beg to assure you that, quite appreciating the labors made by others in a like direction with ourselves, we shall have great satisfaction in seeing it combined with the results of your investigation whenever the two shall be in a proper state for being brought together, although the Club prefer in the first instance completing as a separate work that which they have so long had in hand.

On 5 April 1862, the Club 'resolved to collect without delay, from members so far prepared, the numbers living and dying at each age, distinguishing males from females and British from Irish, and that a form of card should be at once got ready for that purpose'.

But the Club itself was in no continuing state of hurry, for, in April 1865, 'some conversation ensued as to what progress had been made in the collection of the mortality experience which was commenced about 7 years ago'.

To return to the activity of the Institute – contact was established with the Faculty of Actuaries, the Committee of which intimated, in February 1864, that cards had been adopted 'similar to those proposed for use in England'.

By the end of 1866, the investigation was well in hand. Mr Hopkinson was engaged by the Experience Committee 'to arrange the cards', at a salary of £2 a week, and was awarded 20 guineas 'for work already done'. Substantial sums, amounting to £1,142. 5*s*., were collected from the Offices for defrayal of expenses. An interim account, presented in 1868, showed that computing had cost £432. 0*s*. 8*d*.; carpenters' work, £19. 10*s*. and carriage of parcels, £2. 7*s*. 6*d*.

The volume of Tables, prepared under the supervision of Peter Gray, was ordered, in April 1872, to be issued at a price of 10*s*. 6*d*. 'to members at the rooms' and of £1. 1*s*. 'to the general public at the publisher's'.

The investigation attracted foreign interest – in April 1868, Herr Lazarus of Hamburg asked for and was given copies of the forms, etc. used by the Institute for the Experience.

The H^M and its associated Tables provided for Life Assurance a standard and an equipment that remained in general use for more than 30 years.

After these heavy labours, a considerable period elapsed before anything further was done. In October 1892, a well-known doctor

suggested a collective mortality experience of lives with consumptive family history, but the Council 'was not at present prepared to take up the matter'.

But, in December 1892, the second great task was contemplated – the O^M Investigation of Assured Lives and the O^a Experience of Annuitants. At the Council Meeting of that month:

The President gave notice that he would place it on the Agenda for the next Council meeting to consider the question of a new Collective Mortality Experience of Assured Lives and Annuity Nominees, and the appointment of a Committee to consider the question and report.

In January 1893, it was resolved unanimously:

That a preliminary Committee be appointed to consider the desirability or otherwise of collecting and combining the mortality experience of assured lives and annuity nominees of the Life Assurance Companies of the United Kingdom.

The Report of the Preliminary Committee being favourable, a Committee was chosen in February 1893 'to report on the best means of collecting such experience, with powers to communicate with any other Committee of Actuaries or Managers of Companies who may be disposed to assist in obtaining the required information'. The co-operation of the Faculty of Actuaries was sought immediately and secured: a Joint Committee of the Faculty of Actuaries and of the 'Scottish Managers' Association' was formed to keep contact with the Committee of the Institute.

The scope of the investigation was fixed soon afterwards, on the basis that an effort be made to embrace the whole of the data for the 30 years 1863-92 both inclusive.

A draft joint preliminary circular was approved in November 1893 for issue by the Institute and the Faculty of Actuaries. A satisfactory response came from the Offices and the plans were pressed forward: the Mortality Committee was able, in March 1894, to report at length regarding the form of card and the general requirements. It was arranged that the Scottish Committee should supervise the printing of cards (identical with those to be issued in England) for the Scottish Offices.

The very large mass of data to be prepared, and the detailed instructions to be followed, involved not only considerable delay before the cards could be ready for the technical work of the investigation, but also numerous queries. In March 1895, it was proposed to issue a circular dealing with the points so raised.

Some reorganization of control appears to have been made in June 1895, for 'it was decided not to reappoint the late Mortality Committee'. Instead, an 'Organizing Committee' was chosen 'to report direct to the Council'.

In January 1896, it was noted that only nineteen Offices out of forty-seven concerned had sent in their Life Assurance cards and that, of five Offices that had been asked and had agreed to furnish only

Annuity cards, four had done so: information was to be sought about the position in Scotland. A month later, Scotland having reported 'favourably as to progress' there, further steps were taken, particularly to accelerate the arrival of the Annuity cards. As if enough work were not already in hand, a proposal was made, at a meeting of the Life Offices' Association, that the mortality should be investigated of Life Tenants in reversionary transactions. 'It was agreed to defer consideration of the matter until progress with the Life Assurance and Annuity Cards had been more clearly ascertained.'

Meanwhile, a loud but belated echo of the H^M Experience was heard; in May 1896, the details were settled of the forthcoming volume of Sprague's Select Life Tables for which he had placed material at the disposal of the Institute.

In October 1896, an advance of £250 was ordered to be made, on account of the new investigation, the sum to be drawn in two amounts of £150 and £100, 'the cheque for the latter amount to be dated 14 days hence'. At the same meeting, the Committee recommended that 'official letters of reminder be sent in respect of the whole of the Scottish experience, and the two English and one Irish Offices whose cards have not yet been sent in'.

The position of affairs had to be considered again a few months later, when it was resolved that a Joint Conference in London be arranged at once, 'between delegates of the Institute Committee and an equal number of delegates from the Faculty Committee, in order to discuss and arrange a method of procedure'. A Permanent Committee, with wide powers, was formed soon afterwards.

Shelves were 'to be erected round the Classroom, according to a design submitted, for the purpose of accommodating the boxes containing the Mortality Experience Cards, at a cost not exceeding £ 35'.

Large sums were received from the Offices: over £5,000 were in hand in December 1897. The Council felt that the Institute should receive at least housekeeping expenses – in March 1898, the Joint Mortality Committee was ordered to be informed 'that the Finance Committee have ascertained that the charge to be made against the former Committee, up to date, for housekeeping expenses (without, of course, any cost for the use of the rooms) is £41; and that a reasonable charge to be made for the same purpose in future would be £60 p.a.'

And then, there is a long silent interval in the Minutes, during which, of course, the Joint Committee and its helpers were busily at work.

In December 1900, George King was granted permission to publish in the *Journal* 'certain Tables deduced from the Assurance Experience recently issued by the Joint Committee'. In view of this consent, it is rather strange to find that, a year later, a member, asking to be allowed to use the new Tables in an Insurance Institute paper, was told that the Council 'had no power to grant the required permission'. The applicant was referred to the Joint Mortality Experience Committee.

In February 1905, the Committee 'had declared its functions to be concluded'. The terms of the Resolutions passed at the final meeting on 31 January 1905 were:

1. That the Committee now declare their functions to be at an end, and the undertaking committed to them, with the Assets and Liabilities as at 31st Dec. 1904, and the whole property under their control, including the stereotyped plates and stock of bound and unbound sheets in the hands of Messrs C. & E. Layton, the Abstract of Data, and their Summary Cards, the Minute Books, Manuscripts, printed records and correspondence of this Committee, and of the Sectional Committees in London and Edinburgh to be, as from the said date, vested in and at the disposal of the Institute of Actuaries, and the Faculty of Actuaries m Scotland.

2. That a suitable Cabinet be ordered, at the discretion of the Honorary Secretary, and, at the suggestion of the. Scottish Members, it was decided to recommend that, provided the Institute of Actuaries were willing to favour it with houseroom, the Cabinet containing the Cards be kept at Staple Inn Hall.

The Council agreed to accommodate in Staple Inn Hall 'the proposed Cabinet to contain the Abstract of Data and Summary Cards' and passed unanimously a cordial vote of thanks to the members of the London Section of the Committee.

Only a few matters remained to be settled. One was the division, between the Institute and the Faculty of Actuaries, of the proceeds of sales of books of Tables – it was agreed to share equally. Another was the preparation of a volume of Valuation Tables. It is interesting to note that some private members compiled further books – 'Baker and Raisin' and 'Austin and Symmons' are cases in point, and a later example of individual initiative was provided by T. Bradshaw of Toronto.

Meanwhile, the Council had rejected a suggestion that the statistics of Widows' Funds be collected.

The O^M and O^a investigation was a very great, a wearing and a most lengthy task, in which, as the memorial volume *Principles and Methods* showed, the data were sieved 'to the gritted last' in a quest for the elimination of duplicates, for the removal of individual errors and for the testing of the comparative accuracy of various possible assumptions about ages and durations. T. G. Ackland and his associates did an almost incredible amount of work and a brilliant graduation was made by G. F. Hardy. But this last massive product (in its restricted sphere) of a spacious age was not to be repeated in other times. When occasion arose for further inquiry directed to similar ends, criticism prevailed of method, delay and general obsolescence of result.

At this point, it is permissible to place on record the fact, at least indirectly germane to any history of the Institute, that, throughout the years reviewed, many members have contributed, for the general benefit, the results of investigations made individually or in concert.

The new age was to usher in approximation and continuity. Speculation is possible, but fruitless, on the question whether a different method, developed from the old procedure, might have found acceptance had the modern facilities been recognizably available whereby punched cards can be prepared most readily and rapid sorting and tabulation accomplished. In 1912, the Council was informed that the Council of the Faculty of Actuaries, stimulated at least partly by a paper read in Edinburgh by Mr L. P. Orr, had agreed 'that the establishment of a bureau for Research was desirable'.

The Committee appointed to consider this proposal was sympathetic with the idea, but considered that too heavy a burden would be thrown on Offices if they were asked to provide data for a long period already passed. Moreover, it was felt that changes in conditions, meanwhile, made such data of little real value. It was suggested, therefore, that a continuous investigation should be set in train of the future mortality experience of the Offices, and that special aspects should be dealt with, such as the effects of climate, family history and personal record. Stress was laid also on the need for a new table of Annuitant Mortality, and the general view was expressed that there should be a permanent process conducted on simple and economical lines.

The matter must have been bruited abroad, to some extent, for, in May 1912, an offer was received from a non-member of his services in connexion with any Bureau that might be established.

An informal conference having been held between the 'Research' Committees of the Institute and the Faculty of Actuaries, the Council, in June 1912, accepted the ideas generally, subject to the framing of a simple scheme that should be welcomed and supported by the majority of the Offices. A long explanatory letter was issued to the English Offices early in 1913: the Scottish Offices had given conditional approval already. The following are extracts from the Institute's letter:

The operations of life offices have, hitherto, been based on mortality tables which have been the result of special investigations at long intervals. These investigations have been very expensive, the work in connexion with them of a most prolonged description and the delays in getting out the final results have always been a source of regret to the actuarial profession. It is thought, too, that before long the life insurance companies will be calling for a fresh experience, as conditions of life have been changing so rapidly during the last generation that the results of the last investigation are already obsolete to some degree. This is certainly the case as regards life annuitants.

The executive staff would consist of a salaried actuary with clerical assistants.

As to the expense of the scheme to the contributing companies, it is impossible to give anything more than a very rough idea, but it is thought that if Offices generally support it, a contribution of £25 for every million of life assurance and annuity funds should prove amply sufficient.

The Faculty of Actuaries suggested, in June 1913, that the time had arrived for the appointment of a Joint Provisional Committee to consider details. Representatives of the Institute were named to confer with those of the Faculty.

A further letter was sent to the Offices at the end of June 1914, the basis of the investigation to be 'policies' and not 'lives'. An analysis of the replies came before the Council in October 1914, when the melancholy but inevitable decision was made 'that consideration of the matter be deferred until after the conclusion of the War'.

In November 1920, following a suggestion by G.J. Lidstone that a new Annuitant Experience should be taken out, a Committee was appointed. A year later, the Council was informed of progress and that the Faculty of Actuaries had agreed to co-operate, not only in the specific matter of the new experience, but also with regard to a continuous investigation. The completion of the work, as regards deduction of mortality rates, was announced early in 1923, and the Council agreed to proposals to limit the 'period of selection' to 1 year, to adopt 'the principle of exterpolation for obtaining a basis for new annuity-values' and to 'the basis of exterpolation suggested'.

A few months later, the Council expressed its unanimous opinion that a fresh investigation into the mortality of assured lives should be made. A report was accepted, in May 1924, whereby a continuous investigation would be set up, the work to be done 'on broad lines' without any 'refinements' and not to include for the present any examination of special risks. [283]

The matter was put in train, but nothing further was reported until December 1930, when the Council was informed

> That arrangements were being made to print the data for the first three years 1924, 1925 and 1926 ... also ... that work on the data for 1927, 1928 and 1929 was in hand.

Soon afterwards, the Faculty of Actuaries proposed that steps should be taken to provide a basis for research into the selection of lives. The question was referred to the Mortality Investigation Committee, of which the constitution was cast into its present form, whereby the Councils of the Institute and the Faculty have placed the ordinary mortality investigation and any special investigation in the hands of a small Joint Committee of the two Bodies, which is empowered to act 'without interim discussions with the Councils of both Bodies or any large Committee'. The President of each Body is a member of the Joint Committee, which is expected to report to its principals from time to time.

Although the instructions to the Offices had been framed on simple lines, the Presidents of the Institute and the Faculty of Actuaries had the very unpleasant duty of stating, at the respective Annual General Meetings in 1934, that certain errors in the returns had been discovered which, though not seriously affecting the monetary functions, were described as indefensible.

[283] This report is included in Appendix 6.

A separate investigation of the mortality under Temporary Assurances was carried out by an individual member of the Faculty of Actuaries.

Other possible work was mooted, but the War of 1939-45 broke out, and all that could be done was to maintain, as far as possible, the progress of the continuous general investigations already in being. Apart from elaborate volumes of Tables based on the data for the years 1924-9, various other results have been and are being issued.

During the war, arrangements were made to collect statistics of 'War Deaths', but, for 'security' reasons, no general release of the results was permissible.

In 1944, a request was received for inquiry into the mortality experienced under policies for large amounts. The matter had to be deferred until a more convenient season.

For many years, the main burden of the work has rested on the Chairman of the Joint Committee, Sir William Elderton, who was assisted, specially and untiringly, in London, by H. J. P. Oakley. None but these two distinguished actuaries could attempt to measure their enormous labours. A small staff of computers was obtained – it is not possible to say 'gathered' – for they worked in all sorts of places, until, in 1945, accommodation was found for them in No. 2, Staple Inn.

Appendix 3 History of the computerization of the CMI

Editor's note: This appendix contains an excerpt from CMIR 8, published in 1986.

THE C.M.I. BUREAU: A NOTE ON THE HISTORY OF THE COMPUTERIZATION OF THE WORK OF THE BUREAU AND THE DEVELOPMENT OF IMPROVED SERVICES TO CONTRIBUTING OFFICES

ONE of the prime functions of the C.M.I. Bureau, under the direction of the Executive Committee, is the production of standard tables for use by the actuarial profession. Allied to this is the continuous monitoring of experience to determine whether new tables are necessary and whether forecasts made are being borne out. The Committee is conscious of the tremendous contribution of the participating offices to this enterprise over the years. In the early days the constraints of the computational process itself made it difficult to perform much in the way of analysis other than on an All-Offices basis, although, for whole-life and endowment assurances only, some limited individual office results were laboriously produced annually. The advent of modern data processing techniques has, in recent years, made it possible to begin to offer some more specific return to the contributing offices in consideration for their assistance. This note traces the development of the service that can be offered to offices. It is the hope of the Committee that participation by offices in the work of the Bureau can now be regarded in terms of a partnership rather than merely as a tiresome duty undertaken for the benefit of the profession and the insurance and pensions industry as a whole.

For just over 50 years all collation and calculation within the Bureau was done manually. A small staff checked in the data from the contributing offices and collated it on to schedules in order to produce All-Offices totals. They then calculated the exposed to risk and the expected deaths on the bases required by the Committee. Once this process was completed, the results were prepared for printing and distribution to the offices – schedules showing the in force and deaths for the investigation year in question, together with a comparison of actual and expected deaths in broad age groups as well as by duration.

The staff involved saw the whole process through from beginning to end. They were in direct contact with the offices and could therefore liaise easily with them and, working directly on the data, were in a position to pick up at an early stage any detectable irregularities which may have crept in. The system worked quietly and unobtrusively and served the Committee well for over half a century.

Data year 1975 saw major changes in the way the Bureau operated; computerization had arrived! The services of a computer bureau[284] had been retained and a suite of programmes commissioned to take over the tasks of collation and analysis previously done manually. This, of course, relieved the staff of many hours of scheduling and calculation and their role changed. They now checked in the data, sent in on specially designed punching documents, punched cards or computer listings, maintaining detailed records of what had been returned. The data was then stored until all the expected returns for a given

[284] Pension and Insurance Computing Services, often referred to as 'PICS'.

year were in, at which point it was sent to the computer bureau in one large batch for punching, vetting and all further processing.

As well as relieving the staff of the hard grind of manual calculation, computerization meant that the analyses of results distributed to the contributing offices could be expanded. The All-Offices results were shown in detail and certain statistical tests were added. For certain investigations results were shown on more than one comparison basis where it was felt that offices might find this useful. Also, for the first time, offices received an analysis of their own experience for every investigation to which they contributed. In addition the Committee has been able to add new investigations in response to market changes much more quickly and without straining the resources of the Bureau.

Following initial teething problems (a familiar song to anyone who has ever been involved in a computerization exercise!) the system settled down and has so far produced eight sets of annual results plus two sets of quadrennial analyses. It has proved robust and secure and has fulfilled well the functions expected of it. However, solving the computational problem almost inevitably led to difficulties in other areas which required attention and considerations of this nature have led to further changes in the Bureau's *modus operandi*.

As described already, following computerization, the Bureau staff checked in all data and stored it until the returns for the year were complete when it was sent in one large batch to the computer bureau. However, the Bureau currently runs 12 different sets of investigations with two more starting as from data year 1985. Further, each investigation is run separately for males and females, several of the assurance investigations are classified by medical type, while the annuity and pensioner investigations are run on both lives and amounts bases. With over 50 offices contributing data, well over 2,000 data schedules a year come into the Bureau, the majority on manually completed forms. This meant that complex data control systems had to be set up to ensure that all data sent to the computer bureau from the C.M.I.B. was accounted for, punched, vetted and agreed. Data queries thrown up at the punching or vetting stage were routed from the computer bureau via the C.M.I.B. to the offices and back again – a lengthy process requiring control at every stage. The practice of storing the data until the last returns were in and then processing in one large batch often meant that the Bureau was raising queries on material that had originally been submitted many months before. Even where there were no queries (and it is only fair to point out that the vast majority of schedules go through with no problems at all) offices which had submitted their returns early had to wait a significant time before receiving any results at all. These considerations prompted the Committee to look at ways in which the service to offices provided by the C.M.I.B. might be improved.

The main difficulties arose at the data vetting stage, as returns were being put on file during what are known as the 'Front End' procedures. Once 'clean' files had been achieved, further processing normally ran through without any major problems. Accordingly, the Committee requested the firm of consulting Actuaries in whose offices the C.M.I.B. is located[285] to design a new 'Front End' system by means of which office returns could be punched and vetted as they came in and from which 'clean' files could be built up which would then

[285] Rodney Barnett & Co.

be transferred to magnetic tape and passed to the computer bureau for the remaining processing procedures and the results runs.

Under the new system, first used for experience year 1983, the data comprising an office return is checked in on arrival and immediately logged into a comprehensive housekeeping procedure designed to keep track of all material which comes into the Bureau. It is then punched and checked as soon as possible after receipt. Any queries arising at this stage can easily be taken up directly with the office concerned and, usually, quickly sorted out. As the system is 'on line;' putting through amendments received after the submission of the original schedules is a simple task.

At the request of the Committee, a further system was developed to produce an analysis of the experience of an individual office which would be returned to it shortly after its data had been received in the Bureau rather than having to wait until all the expected office returns were in as had been the case previously. At the same time, offices were given the option of requesting analyses on comparison bases other than those recommended by the Committee for the All-Offices experience and some have availed themselves of this facility. It was hoped that the faster turn-round of data returns and the additional facilities offered would prove useful to offices and, in the event, the changes have been generally welcomed.

It goes without saying that the All-Offices results can only be produced as quickly as the slowest of the contributing offices. In order to produce the results timeously, the Bureau has now instituted a procedure under which a closing date is imposed each year, after which data received will not be included in the All-Offices analyses for the year in question.

When designing the Individual Office Results system the opportunity was taken to build in certain statistical tests on the data, year on year. The first is a simple consistency test based on the premise that the 'In-Force' at age x+l, duration, t+1 at the end of the year should not normally be greater than the 'In-Force' at age x, duration t at the start of the year. The second is the Kolmogorov-Smirnov test. This is designed to test whether two distributions could have been drawn from the same parent population. A description of its basic features, with a resume of its application to C.M.I. data, is given as an appendix to this note[286].

The area of data testing is a relatively new one for the Bureau and the effectiveness of the results in picking up errors is being kept under review. The Bureau would welcome comments on the tests used as well as further suggestions as to how this activity might be extended. All this is not to imply that erroneous returns are a serious problem in the Bureau. It is quite clear that the vast majority of schedules are carefully and accurately compiled. It has to be recognized, however, that in an enterprise of this size and complexity errors will creep in from time to time. It is in the interest of everybody that such errors are isolated at the earliest opportunity before they become embedded in the system where they are more difficult to detect and, once detected, are expensive and time consuming to sort out.

The new 'Front End' procedures allied to the subsequent service supplied by the computer bureau provide an overall system which makes the best use of the hardware available in the separate parts. The Committee is confident that,

[286] This appendix is not included here.

with the systems at its disposal, the Bureau is now able to offer a real service to contributing offices.

Note: The systems described in this note apply only to the Assurance, Annuitant and Pensioner mortality investigations undertaken by the Bureau. The Impaired lives investigation, for which no individual office results are produced, is run under the old system whereby data is checked into the Bureau and is sent in one large batch to the computer bureau for processing. The P.H.I. investigation, which has been fully computerized from the start, has always been operated by the computer bureau which, under the auspices of the P.H.I. Sub-committee, deals directly with the contributing offices.

Appendix 4 The 75th Anniversary booklet

Note: This appendix contains the text from a booklet 'The Continuous Mortality Investigation Bureau: 75th Anniversary' that was written by Rodney Barnett and (I think) sent to all contributing offices after the event at Staple Inn[287]. Much of this describes work in the first 50 years of the CMI, and therefore overlaps with the history published in CMIR 1, but I have included it in its entirety. The list of Contributing offices in 1924/29 was included on the inside front cover of the booklet, and the list from 1999 on the inside rear cover.

The Continuous Mortality Investigation Bureau

75th Anniversary

Contributing offices 1924/29

Alliance Assurance
Atlas Assurance
Australian Mutual Provident
Beacon Insurance
Britannic Assurance
British Equitable
Caledonian Insurance
Canada Life
Clerical, Medical & General
Colonial Mutual
Commercial Union
Co-operative Insurance
Eagle, Star & British Dominions
Edinburgh Assurance
Equitable Life
Equity & Law
Friends' Provident
General Accident
General Life
Gresham Life
Guardian Assurance
Law Union & Rock
Legal & General
Life Association of Scotland
Liverpool & London & Globe
London Assurance
London Life
London & Manchester
London & Scottish
Marine & General Mutual
Mutual Life & Citizens'
National Farmers' Union
National Mutual
NPI
North British & Mercantile
Northern Assurance
Norwich Union
Pearl
Phoenix Assurance
Provident Mutual
Prudential
Refuge Assurance
Royal Exchange Assurance
Royal Insurance
Royal London Mutual
Scottish Amicable
Scottish Equitable
Scottish Life
Scottish Provident
Scottish Union & National
Scottish Widows
Standard Life
Sun Life
Sun Life of Canada
United Kingdom Provident
University Life
Wesleyan & General
Yorkshire Insurance

[287] See 'CMI 75' in Section B6.

C.M.I. BUREAU AND EXECUTIVE COMMITTEE

circa 1924 —1999 and beyond

Introduction

If you glance at the list of Committees appointed by the Institute and Faculty Councils, you will see many concerned with administration, legislation or professional guidance but, apart from those dealing with education or research, only one which directly uses the science of the profession. Perhaps this is why members of the C.M.I. Executive Committee become dedicated and often remain for a long time; there have been but seven Chairmen in 75 years.

Genesis

No one knows exactly when the Executive Committee first met. It had a long period of gestation, as the early moves towards its inception were interrupted by World War I. Its first meeting was probably in 1923, although no formal minutes were kept until 1948. But it is a known fact that the Bureau started to function as from 1 January 1924, and the purpose of this leaflet is to look forward by looking back over the past 75 years, regarding the 75th anniversary as having fallen on 1 January 1999.

Numbers

Originally the only investigations for which the offices contributed data to the Bureau were for whole of life and endowment assurances (subdivided between medically examined and non-medical data, and also between with-profit and non-profit business), and for immediate annuities without a guaranteed period. The assurance investigation was confined to males accepted at normal rates, while for the annuities, males and females were investigated separately. The offices submitted the numbers in force at the beginning of each year, and the number of deaths in the year, by age and duration. Full details of the investigations and subdivisions which have come and gone (according to demand) up to 1973 are given in *C.M.I.R.* **1**, and subsequent changes are recorded in later numbers of *C.M.I.R.*

These changes include the start of the life office pensioners' investigation (lives from 1948, amounts from 1958), an investigation *ab initio* into retirement annuities effected under the 1956 Finance Act, a separate investigation into the mortality of female assured lives (started in 1973) and a very recent subdivision of assured lives between smokers (at the time of proposal) and non-smokers. The annuitants' investigation now includes cases with a guaranteed period.

Chronicles

After World War II there was a period of consolidation, the only innovations before the 1960s being the investigations into life office pensioners and retirement annuities. Starting in 1964 the assured lives' deaths were investigated by cause, a venture which was discontinued after 1994. The PHI Sub-Committee was inaugurated in 1970, and started to collect sickness data from 1972. Mortality data relating to lives accepted with certain known impairments started to be collected from 1982. And recently an investigation was inaugurated into policies under which the sum assured became payable in the event of critical illness, but with insufficient data hitherto for a detailed report. For the first 50 years any papers prepared by the Committee were printed in *J.I.A.* and *T.F.A.*, but from 1973 the Committee's reports have appeared in *C.M.I.R*.

Acts

Still looking back, the investigations from 1924 started with great enthusiasm on the part of the offices submitting data, and an entente developed between the offices and the Bureau, no doubt due to the novelty of the project. Latterly much of that enthusiasm has worn off, and one wonders whether in some offices the data-processing departments have become somewhat remote from the Bureau, perhaps not realising the uses to which their products are put. A similar enthusiasm greeted the inauguration of the PHI investigation, and this still continues. To a lesser extent (as fewer offices are involved) this is also true of the impaired lives investigation, which was mooted for decades, but did not get off the ground until the Life Underwriters' Association made loud requests for it, and were told the Bureau could do nothing without data; about 20 offices responded with commendable alacrity.

Lamentations

A similar enthusiasm extended to the cause of death investigation, but gradually waned; the offices were permitted to record 'cause unknown', this latitude being necessary because some foreign or consular certificates do not show cause of death, and because sometimes deaths of well-known persons are reported in the press with no record of the cause. But the manual nature of the task gave rise to difficulties, resulting in many offices failing to record the causes even when the information was available. Praise is due to those offices who succeeded in providing complete data; but with a considerable number of offices reporting the causes in a mere 30% to 50% of deaths, it became doubtful whether the good data could be regarded as representative of the whole, and the Committee regarded discontinuance as the only practical option. It will now be more difficult to estimate the effect on mortality of a medical breakthrough over a major cause of death; it will be impossible to analyse deaths among impaired lives according to whether or not the death was due to the known impairment; the Bureau will no longer be able to identify duplicates (both within offices and between offices) among the deaths — and the distribution of duplicates observed in the past will not necessarily remain similar in the future; and there will no longer be an independent check on each office's deaths in its main returns — which were not infrequently found to be incorrect.

Revelation

So, to the future. Some offices are still submitting high quality data, but by no means all. Mention has already been made of the remoteness of some data-processing departments. Theoretically, it must be the responsibility of Appointed Actuaries to see that these departments know the purposes of their products. In practice the Appointed Actuary, who knows these purposes, is far too busy to ensure the quality of the data produced, and he or she should delegate appropriately to ensure the quality and integrity of the data submitted. Surely the fact that the Bureau produces mortality and other tables which have a statutory purpose[288] and which benefit both the profession and the assurance industry, should mean that the delegated person is aware of the responsibilities involved.

[288] This reference to 'statutory' is curious as I think the statutory use of CMI's tables was limited; for example the a(55) table was used to calculate the capital element of annuities for tax purposes. CMI tables were often referred to as 'standard tables' but were not usually mandated.

Prophecy?

Be warned. Sooner or later statutory tables for Medical Expenses Insurance may be required. Perhaps also mortality tables for self-administered pension funds, and tables of claim rates under critical illness policies. Hitherto there has been insufficient interest for the collection of data. If your cheeks are burning, then 'the bell tolls ... for thee'.

H A R Barnett
24 June 1999

Rodney Barnett *has been involved with the C.M.I. Bureau since 1952. From 1955 until May 1990 he was responsible for the data collection side of the Bureau's work. For the last 18 years of this period he was Secretary of the Bureau, having succeeded Roland Clarke in 1972. On his retirement as Secretary he was immediately appointed to the Executive Committee of the Bureau, a position he still holds. Rodney was awarded the first Institute of Actuaries Finlaison medal[289] in 1985 for his services to the profession and, in particular, his work in the sphere of mortality investigations.*

[289] The Institute's Silver Medal was redesignated the 'Finlaison Medal' from 1985, named after John Finlaison (1783-1860), the Institute's first President from 1848 to 1860. Roland Clarke was the last to receive the Silver Medal in 1980 (see Section A3) and Rodney Barnett was the first to receive the Finlaison Medal.

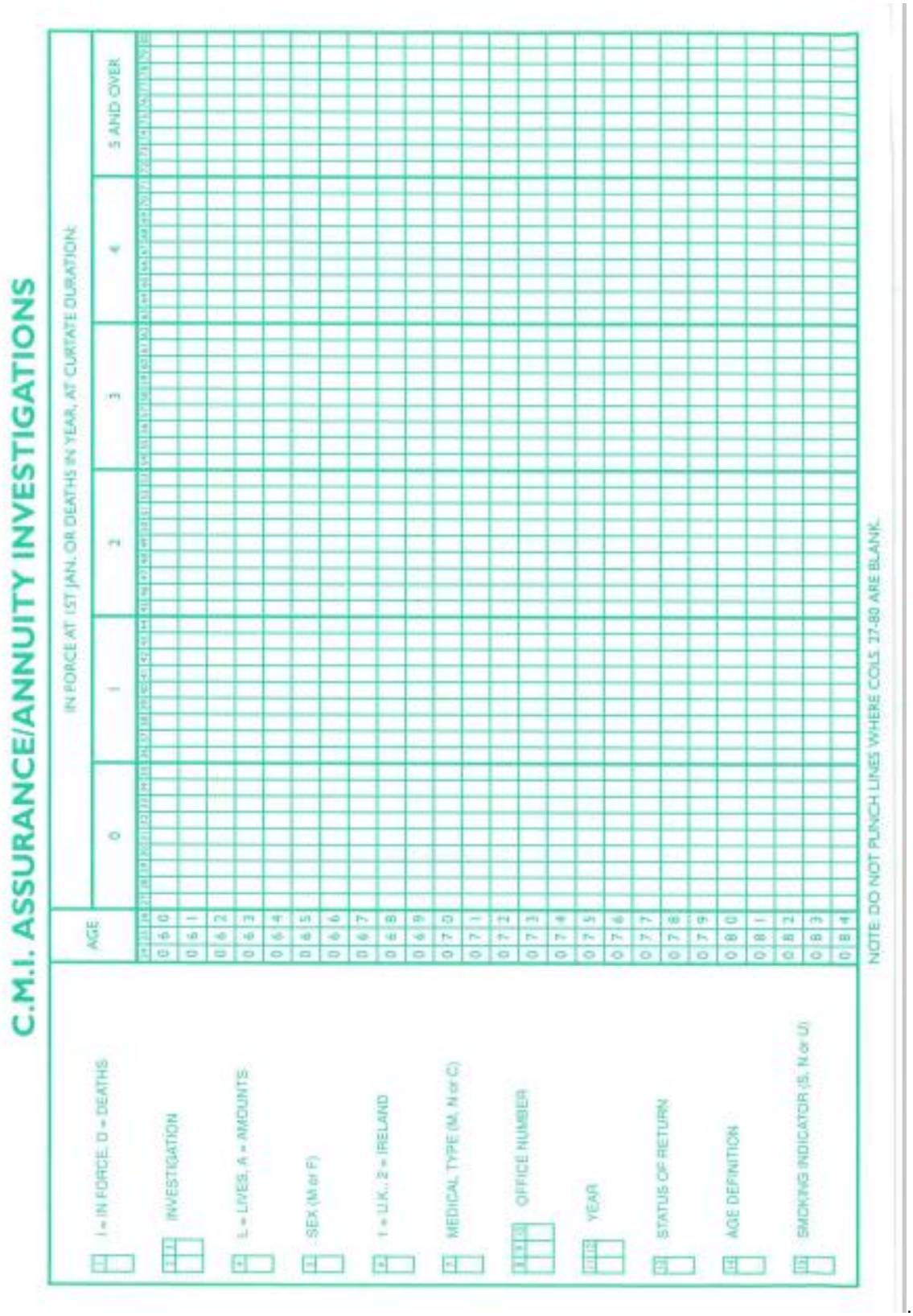
Contributing offices 1999[290]

Abbey National
Australian Mutual Provident
AXA Sun Life
Britannic Assurance
BUPA
Canada Life
Century Life
CGU
Clerical Medical
Colonial Mutual
Cologne Re
Co-operative Insurance
Eagle Star
Equitable Life
Friends' Provident
Gerling
Guardian
Hannover Life Re
Legal and General
Life Association of Scotland
London and Manchester
London Life
M&G Re
Medical Sickness
MGM Assurance
Munich Re
National Mutual
NFU Mutual
Norwich Union
Pearl
Permanent Insurance
Premium Life
Prudential
Reliance Mutual
Royal & Sun Alliance
Royal London Mutual
Save and Prosper
SCOR Vie
Scottish Amicable
Scottish Equitable
Scottish Life
Scottish Mutual
Scottish Provident
Scottish Widows
Standard Life
Sun Life of Canada
Swiss Re
Teachers Assurance
TSB Life
Tunbridge Wells
United Friendly
UNUM
Wesleyan
Worldwide Re
Zurich Life

[290] This list appears to be financial contributors, rather than data contributors, as it includes several reinsurers.

Appendix 5 A specimen data submission form

Note: This appendix contains a form for ages 60-84 and could be used for assurances or annuities data and for in force or deaths.



Note: Different forms applied for the pensioners investigation.

Appendix 6 Report to Council in May 1924

Preliminary Report to the Council of the Institute of Actuaries by the Committee considering investigation of mortality of assured lives

The Committee has met on several occasions and has examined various possible arrangements. It has become increasingly clear that there would be much difficulty in getting adequate information from past mortality in reasonable time and we recommend:-

1. that the offices be approached and asked to furnish information on the same lines as those of the continuous annuity investigation from 1st January 1924 for business then on the books and new business thereafter.

2. that foreign business (Board of Trade definition), cases accepted on special terms, female lives, reassurances, duplicate policies effected simultaneously in same office or in same class of business, should be excluded so far as possible in respect of existing business.

3. that returns should be made for

(a)	whole life	-	with profits
(b)	"	-	without profits
(c)	endt.assurances		with profits
(d)	"		without profits

4. that for new business the cases indicated in 2. be excluded and that an attempt be made to measure mortality of cases accepted in future without medical examination.

5. that the details be left to the Committee with power to act and with the understanding that the investigation will be made on broad lines and will not attempt refinements.

6. that for the present no attempt be made to obtain information from the offices with the intention of examining the mortality of special risks (e.g. overweight) until it is seen that such action is warranted by the continuous investigation now suggested or is required by the offices.

W. Palin Elderton
Chairman.

1st May 1924

Appendix 7 History and Development to 1983

Note: This appendix is reproduced from CMIR 6, issued in 1983, and follows on from that in CMIR 1 (reproduced in Section A2). As with the earlier extract, I have tried to reproduce this in its original font to clearly distinguish the historical material from my commentary.

HISTORY AND DEVELOPMENT

A PAPER with the above title appeared in C.M.I.R. **1**, as an opening to the C.M.I.R. publications which have now reached their sixth number. The purpose of the present paper is to bring the history up to date, without repeating any items which have little bearing on current or on possible future practice. Relevant items are repeated as C.M.I.R. **1** is now out of print, although reference to it can of course be made in the Institute and Faculty Libraries[291].

CHAIRMEN

The earlier paper outlined the system whereby prior to 1923 various investigations were undertaken by *ad hoc* Committees. Since the formation of the Joint Mortality Investigation Committee the following have served as Chairmen:

Sir W. P. Elderton	1923-48
R. Ll. Gwilt	1948-61
F. M. Redington	1961-68
J. M. Denholm	1968-74
E. B. O. Sherlock	1974-83

It will be seen[292] that the alternation of Institute and Faculty representatives as Chairmen of the Committee has been maintained throughout.

ADMINISTRATION

Formal minutes were not kept before the end of World War II, when F. L. Bradshaw was appointed the first Superintending Actuary. There was no Secretary to the Committee until July 1950 when R. D. Clarke was appointed. The clerical work of the Bureau was carried out by a small staff, paid by the hour. At the end of 1955 F. L. Bradshaw was succeeded by H. A. R. Barnett.

When R. D. Clarke retired as Secretary in September 1972 the position of Superintending Actuary disappeared; H. A. R. Barnett became Secretary with R. E. Hayward as Assistant Secretary. At the same time R. E. Hayward became Secretary to the (then new) P.H.I. Sub-Committee to whom R. D. Clarke had acted as Secretary during its opening stages.

Since the work became computerized, *c*. 1975, Mrs J. V. Evans has been responsible for routine liaison with the computer company and may perhaps be regarded as having resuscitated the position of Superintending Actuary. There is still a small clerical staff responsible for dealing with queries from contributing offices, circulating letters, output, questionnaires, etc., to the offices and the Committee, coding cause-of-death sheets and, occasionally, making calculations if the Committee request additional information for which it would be uneconomic to order a computerized re-run of data.

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[291] At the time of writing, CMI Reports are accessible online at: https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-reports.

[292] It is not obvious to me how this could be seen, but my understanding is that Elderton, Redington and Sherlock were Institute representatives and Gwilt and Denholm were Faculty representatives.

STATISTICS

Statistics are submitted in a form suitable for the use of the 'Census Method', that is to say the offices submit particulars of policies in force on I January each year (a different date can be substituted if more convenient to the office) and of policies becoming claims by death notified during the year. Statistics are usually submitted according to age nearest birthday, but for some offices a different age classification is more convenient, and in these cases the Bureau makes appropriate adjustments to the figures to approximate to an age nearest birthday classification. For some investigations there are also subdivisions according to curtate duration of policy, all durations beyond the select period being combined. Data are received from about sixty offices, some who have joined recently cancelling out numerically some who have lost their separate identities through mergers.

Originally, female lives were excluded from the assured lives investigation but offices were permitted to include them if exclusion was difficult and if they were only a small proportion of the total. Since a separate investigation was started for female assured lives it is believed there are now very few, if any, female lives still included in the male investigation.

Mention has been made of 'policies' and this word was used deliberately. The investigations have generally been on the basis of policies rather than of lives, although in the assured lives' experience 'concurrent duplicates' have been excluded, so that a batch of policies effected at the same time on the same life would only be counted as one. Where possible all duplicates in the assured lives over age 80 have also been excluded, and the Bureau has recently asked those offices who can do so to make similar exclusions from annuity data.

The effect of duplicate policies was investigated by the Committee who invited the contributing offices to analyse the death claims in 1954 showing the number of lives at each age having 1, 2, 3… policies. The returns were of duplicates within offices, no attempt being made to trace duplicates on the same life in several offices. The purpose of this investigation was to ascertain whether it would be possible to improve the estimates of the standard deviations needed to test the differences between actual and expected deaths; it was based on statistics for durations 3 and over.

INVESTIGATIONS

Whole Life and Endowment Assurances – Males

The assured lives' experience was originally subdivided into eight sections according to whether the policies were whole life or endowment assurance, with or without profits, and effected with or without medical examination. Policies effected at higher than normal rates were excluded, and similar exclusions have subsequently been made in all assured lives' investigations except that into impaired assured lives. However, when standard tables were prepared based on the experiences of 1924-29 and 1949-52, it was found that the Whole Life section was insufficient to give reliable results at young ages and the Endowment Assurance section was insufficient at the older ages. Furthermore, the Non-profit Whole Life section was insufficient at the older ages. Variations between individual offices were found to be more significant than variations between the different types of policy and consequently the A 1924-29 and A 1949-52 tables were constructed from the whole of the data. After the publication of the A 1924-

29 table, the experience was subdivided into offices exhibiting the lightest and heaviest mortality and 'Light' and 'Heavy' tables were constructed; similar tables were not prepared from the 1949-52 experience.

Despite the knowledge that variations between types of policy were of little significance, the subdivisions of the data in this way continued up to and including 1958, after which the only division (apart from age and duration and, later, sex) has been between medical business and business accepted without medical examination.

For convenience, the A 1924-29 tables were based on a three-year select period even though data had been collected on a five-year select basis. The A 1949-52 and A 1967-70 tables were based on a two-year select period, but when the latter were compiled a further table, A 1967 70(5) was compiled with a five-year select period. Details of the graduation methods employed are described in the official publications.

Periodical reports, at first published in the *Journal of the Institute* and in the *Transactions of the Faculty* but since 1972 in *Continuous Mortality Investigation Reports*, have included comparisons of trends with those of the national mortality; these were originally published as separate reports but are now incorporated with the main reports on whole life and endowment assurances.

Although comparisons with national mortality can show overall differences, they cannot analyse these differences in detail, and accordingly from 1964 a subsidiary investigation has been undertaken according to cause of death, which is described in a later section.

Children's Deferred Assurances

From 1924 to 1960 there was a separate investigation into mortality under Children's Deferred Assurances. Interest in the experience under this class of policy declined and the investigation was closed.

Immediate Annuitants

The other investigation which has been continuing ever since the Bureau was set up is that on immediate annuitants. Data for males and females are kept separate and there has generally been a five-year select period; however, periodical scrutiny of the results in the preparation of reports indicated that from 1957 onwards there appeared to be some change in the class of lives effecting immediate annuities, possibly arising from the effects of the 1956 Finance Act, and accordingly from 1963 onwards the select period was extended by one year every year up to and including 1968. The select period has now reverted to five years, but pre-1957 business has been kept separate from post-1956. The pre-1957 business remaining on offices' books now relates only to lives at very advanced ages, and the collection of data in respect of these annuities has been discontinued from 1982.

From 1960 the offices were asked to submit, in the case of immediate annuitants, lists of deaths notified in the first half of a year which had taken place in the previous year. This enabled the 'in force' figures to be adjusted, in order to cut down systematic distortion which can otherwise be quite serious at the advanced ages which figure prominently in this class of business. Since the returns have been computerized by the Bureau, those offices who can do so have been waiting until the middle of the following year to make up a year's immediate annuitant statistics, so that in effect most of the offices now make the adjustments themselves.

From 1975 statistics have been collected by 'amounts' as well as by 'lives'.

A standard table was prepared on the basis of the 1947-48 experience, projected to give rates which might be expected to apply to lives purchasing annuities in 1955. A 'forecast' generation table was also prepared on a projection based on expected improvements in mortality which, in the event, did not materialize.

A further standard table was prepared on the basis of the 1967-70 'lives; experience and, by taking note of earlier experiences, projected to give rates applicable to the year of experience 1990 and therefore suitable for use in the 1980s. The projection was devised in such a way that a fixed year of progression in time was equated to a fixed deduction from age, and the publication included a double entry table of mortality rates by age and calendar year of birth, as well as a table of mortality functions applicable to lives born in the calendar year 1925.

Annuities payable for a term certain and life thereafter

In 1948 a separate investigation was started into the experience of this type of annuity. This was concluded in 1957.

Pensioners under Life Office Pension Schemes

Also in 1948, collection of data was started for pensioners under life office pension schemes. Originally this investigation was based on lives, but since 1958 particulars based on amounts have been submitted. and the two sets of data are still being collected.

A standard table was prepared similar to the latest table for immediate annuitants, but based on 'amounts' experiences. As in the case of the annuitants' table, experiences up to 1967-70 were projected to 1990 so that the table would he suitable for use in the 1980s; a similar projection was made, and the table also included mortality rates according to age and calendar year of birth, and mortality functions applicable to lives born in 1925.

Between 1965 and 1974 separate data were submitted by five offices based on 'Works' pension schemes, these also being included in the main pensioners' data; this separate investigation is now discontinued, having been virtually superseded by the 'amounts' investigation.

Since 1976 data have been collected subdivided by duration, based on a ten-year select period since retirement.

Retirement Annuities

Retirement annuities effected under the 1956 Finance Act have been the subject of an *ab initio* investigation, both during the period of deferment and after retirement, and will therefore form the basis of the only investigation into which all possible data will have been collected, apart from the fact that there are some offices who write this business but do not submit data.

Group Life Schemes

A special investigation based on seven offices and three years only (1958-60) was undertaken into mortality under group life assurance schemes. This was carried out on a 'policy year' basis, and the results were presented according to both lives and amounts. The returns of policies in force were by age nearest birthday on the scheme anniversary which occurred in the calendar year for which the return was being made. Deaths and withdrawals were tabulated by age nearest birthday on the scheme anniversary prior to death or withdrawal no matter in what calendar year the exit took place. New entrants and increments, where they took

place at dates other than the scheme anniversary, were tabulated by age nearest birthday on the scheme anniversary prior to entry.

Whole Life and Endowment Assurances-Republic of Ireland

From 1970 a separate investigation into the mortality of male lives covered by whole life or endowment assurances issued in the Republic of Ireland was started. From 1982 a similar investigation into the mortality of female lives is being made. At present thirteen Irish offices, or offices with Irish branches, are contributing data. The select period is five years.

Temporary Assurances

Also from 1970, a new investigation was started into the mortality of male lives under certain temporary assurances, with a similar investigation into female lives starting from 1982. Level and decreasing policies are kept separate, and again the select period is five years.

Female Lives (Whole Life and Endowment Assurances)

The first investigation into the mortality of female assured lives was started in 1973, and related to lives assured under whole life and endowment assurances issued in the United Kingdom. The select period is five years, and the Committee have just completed a graduation of the latest experience, relating to the years 1975-78.

Linked Life Assurances

From 1976 an investigation was started into the mortality experience under linked life assurances. Data for both male and female lives are submitted, and there is a select period of five years. Offices were asked to submit data for the medical and non-medical sections separately, with the option of submitting all their data as 'combined' if they could not separate the two sections; in the event most offices have taken up this option, so that there are very few policies recorded in the separate medical and non-medical sections. From 1982 the Irish offices are also contributing data under this class of assurance issued in the Republic of Ireland.

Joint-Life-First-Death

From 1983 a new investigation has been started into the mortality of lives assured under joint-life-first-death policies. Similar policies where one or both lives are impaired are included in the Impaired Assured Lives Investigation (see later), the data for which should thus be substantially increased. In order to keep an independent check that, when a claim occurs on a first death, the second life is removed from the in-force data, this new class has been limited to policies on one male and one female life, so that the in-force for any office at any time should consist of equal total numbers from each sex.

Whole Life and Endowment Assurances without selection

Also from 1983 a new investigation has been inaugurated into the mortality of lives accepted without any medical evidence whatsoever, under whole life and endowment assurances completed in connexion with mortgages. Such non-selection cases should not be confused with the non-medical data in the main investigation, where the proposal forms include certain questions of a medical nature.

Cause of Death

From 1964 the mortality experience of male lives under whole life and endowment assurances issued in the U.K. have been analysed according to cause of death. Following a discussion on an Institute paper in 1976, the causes of death among immediate annuitants and pensioners are also being investigated from 1979 to enable comparisons to be made between these classes and the lives covered by whole life and endowment assurances. To make these comparisons complete, causes of death are also being analysed in the experience of whole life and endowment assurances on female lives, also from 1979.

From 1982 the cause of death investigations are being extended to include temporary assurances, linked life assurances and assurances issued in the Republic of Ireland, in order to have a complete 'control' for the Impaired Assured Lives Investigation described in the next section.

Impaired Assured Lives

From 1982 an investigation has been started into the mortality of assured lives known, at the time of effecting a policy, to be suffering from certain impairments. There is an extensive impairment coding list, each impairment being recorded at the outset as a separate investigation. It is expected that the volume of data relating to some of the impairments will be small, but until a number of years' statistics have been collected the Committee are unable to determine which impairments will need to be grouped to avoid fragmentation of the data. The classes of assurance included are the same as those in the main assured lives investigations.

Permanent Health Insurance

In 1970 a sub-committee was set up to plan and conduct an investigation into sickness rates under permanent health insurance policies. Data were collected from 1972, and separate investigations have been made into experiences under individual policies and group policies. Development is described in the relevant papers listed in the bibliography which follows.

CONFIDENTIALITY

It should be mentioned that strict anonymity of offices is preserved in all data and statistics. Each contributing office is allocated a number, and the name of the office does not appear on any data sheets.

GENERAL

The historical note in C.M.I.R. 1 included three Appendices. The first showed the Constitution and Rules of the C.M.I. Bureau; these are not repeated in the present paper as the only change has been the alteration of the financial year, which now runs from 1 March to 28 or 29 February. The second gave the Consolidated Rules of the investigations, as issued to offices; these are now in loose-leaf form which is not suitable for reprinting as an appendix, but anyone wishing for a copy may obtain one on request to the Bureau subject to payment; many items from the Rules have been incorporated in the above historical outline. The third appendix was a bibliography, to which an addendum is given below[293].

[293] As noted in Part A1, I chose not to include the corresponding appendix to CMIR 1 and, similarly, have not included the supplement here.

Appendix 8 Papers by Heriot-Watt researchers using CMI data

1) Isabel Cordeiro, PhD thesis: *A Stochastic Model for the Analysis of Permanent Health Insurance Claims by Cause of Disability*, 1998.

2) Athol Korabinski and Howard Waters:

   PHI claim inception rates: modelling the experience of individual companies in the United Kingdom, Transactions of the 26th International Congress of Actuaries, 1998.

   An analysis of the PHI experience of individual companies in the United Kingdom I: Claim inception rates, CMIR 18, 2000.

   An analysis of the PHI experience of individual companies in the United Kingdom II: Claim termination rates, CMIR 18, 2000.

3) Cristina Gutierrez Delgado, PhD thesis: *Impact of Initial Selection on Claim Inception Rates for Individual Income Protection Insurance*, 2000.

4) SingYee Ling, Howard Waters and David Wilkie:

   Modelling Income Protection Insurance claim termination rates by cause of sickness I: Recoveries, The Annals of Actuarial Science, 2009.

   Modelling Income Protection Insurance claim termination rates by cause of sickness II: Mortality of assured lives, The Annals of Actuarial Science, 2009.

   Modelling Income Protection Insurance claim termination rates by cause of sickness III: Mortality, The Annals of Actuarial Science, 2009.

5) Erengul Ozkok, George Streftaris, Howard Waters and David Wilkie:

   Bayesian modelling of the time delay between diagnosis and settlement for Critical Illness Insurance using a Burr generalised-linear-type model, Insurance: Mathematics and Economics, 2012.

   Modelling Critical Illness claim diagnosis rates I: Methodology, Scandinavian Actuarial Journal, 2014.

   Modelling Critical Illness claim diagnosis rates II: Results, Scandinavian Actuarial Journal, 2014.

6) Erengul Ozkok, George Streftaris, Howard Waters and Andrew Stott: *The effect of model uncertainty on the pricing of Critical Illness Insurance*, The Annals of Actuarial Science, 2015.

Appendix 9 Note issued alongside Working Paper 1

Editor's note: This note was issued alongside WP 1 to explain the intended role of working papers.

CMI Working Papers

On occasions, the CMI needs to quickly report developments in the experiences it monitors or to report on work in progress. The Executive Committee of the CMI now intends that this should be done via "Working Papers". Working Papers will not necessarily be published in a CMIR. Nor will any tables they contain necessarily become Standard Tables of the profession. However, readers can assume that work done for a Working Paper will be of the same standard as that required for a Blue Book and will have been carefully considered by the sponsoring sub-committee.

Some of the benefits of publishing Working Papers will be:

1. They will allow information to be disseminated quickly without the need to wait for a CMIR or for long projects to be completed. As in the case of the recent cohort report, it may be felt necessary to disclose interim results whilst a project is still under way.

2. The implied longer consultation periods would allow a more robust peer review of the work being undertaken by the CMI.

3. The CMI would be able to expose possible new tables, improvement rates or other information without it immediately acquiring the status of one of the profession's Standard Tables.

4. Whilst projects are still ongoing, the profession and others will have the opportunity to help the CMI in its approach to analysing and interpreting information. The CMI will welcome feedback on its working papers.

5. They can be used to inform offices of the CMI's plans thereby allowing offices to better plan their implementation of anticipated new information.

Working Papers will be published on the CMI section of the profession's website and will be public documents. They may also be distributed to CMI offices and others who need the information.

December 2002

Appendix 10 Chairing the CMI during the pandemic

Note: This appendix was written by Matthew Edwards who was the Chair of the CMI Executive Committee from 2020 to 2023. I have added some comments in footnotes.

I started as Chair on 1 March 2020, and my three years coincided almost 'perfectly' with the pandemic – its start in the UK, its temporary dominion over most of our lives, and then the start of the 'post-pandemic' period.

All of these phases posed challenges for the CMI, and these challenges were somewhat different across the committees, in addition to the broader organisational challenges.

Early 2020: pandemic stirrings

My first thoughts about the coronavirus news coming from the Orient were along the lines of "let's hope it ends up like SARS" – in other words, quickly contained, with a relatively small morbidity / mortality impact in a small geographical area.

My views changed quickly towards the end of February, in large part thanks to my close following of the emerging dire situation in Italy (for personal reasons as my wife is Italian), but also thanks to a presentation by Adrian Pinington at a protection writers' forum in late February. This led to my thinking we could see potentially a doubling of UK mortality for a large part of 2020.

At the outset of my period as Chair, I was therefore expecting a fraught year. Looking back at my CMI emails of early March, the bulk of them related to various elements of the pandemic (as in fact did most of my 'day job' emails). However, the CMI's remit (which exists principally for the benefit of the subscribers who finance the CMI's work) effectively precluded it from 'conjectural' views as to the likely impacts of the pandemic. As the pandemic progressed, we sought to provide our subscribers and wider stakeholders with the most assistance we could from an analytical perspective, but doing so within our remit.

This constraint worked well for the CMI, giving us a clearer view of what we could do or could not do, and I think it worked well for the wider profession also by clarifying what areas outside the CMI's remit needed to be dealt with in other ways. This explicit gap led to the creation of the COVID-19 Actuaries Response Group (the 'ARG', https://covidactuaries.org/), with an open remit to provide (largely actuarial) expert opinion on the pandemic as it progressed. For clarity, the ARG was set up outside any IFoA structure, and was then followed shortly afterwards by an IFoA group 'ICAT', the IFoA COVID-19 Action Taskforce, led by Colin Dutkiewicz.

The ARG overlapped heavily with CMI volunteers: Stuart McDonald and I (along with then IFoA President-elect Tan Suee Chieh) created and led the group. Stuart sat on the CMI Executive Committee, acting as our Chief Risk Officer. Matt Fletcher, who led the SAPS Committee, and Adele Groyer (on the Assurances Committee) were also heavily involved in the ARG. We had to be clear as to our roles depending on what we were doing, with each of us having three roles (CMI, ARG, and our normal work responsibilities), and I think this worked well. The need for volunteers to be clear as to 'which hat' was already part of life, given the distinction between CMI volunteer activities and our paid employment, and so was not the problem it might have appeared to be. As the pandemic progressed, the ARG was able to promote through social media those of the CMI's outputs which had a direct bearing on pandemic morbidity and mortality. This helped in particular with promulgation of the excess deaths work (of which more below).

Early-mid 2020: the CMI and the pandemic

There were two primary changes resulting from the pandemic in the initial months of the pandemic. One was operational, the other related to our work on 'excess deaths'.

From an operational perspective, my initial concern was the potential impact of the pandemic on the operation of the Secretariat and also data providers. I asked the Secretariat to provide a monthly update clarifying if any problems were emerging relating to reduced personnel (I had been thinking not so much of direct impacts but of people in the working age range taking time off in respect of

dying or deceased parents), or unusual delays for similar reasons from the firms who provide data. Thankfully, neither of these proved problematic over the pandemic.

Also from an operational perspective, all meetings moved to the virtual world. This proved beneficial in many respects, especially for the many volunteers living some way from London, although it did cause problems with the efficacy of 3-hour meetings. Many of the committees had based their work on a three-hour default, and we found this (or speaking for myself, I found this!) untenable and tried slightly shorter periods[294]. This itself was a useful discipline in tighter agendas and more care on chairing meetings efficiently.

Moving to excess deaths, this was probably the single biggest contribution of the CMI to the 'outside world' (i.e. not just the mortality specialists of the CMI's subscribers) during the pandemic.

The Mortality Projections Committee[295] ('MPC'), the group responsible for the CMI Mortality Projections Model ('the Model'), had for some time produced a quarterly analysis of population mortality changes over the year to date[296], and the implications of these for the latest version of the Model. The MPC realised that increasing the frequency of this to weekly would allow a potentially very useful perspective on what was happening to mortality in the early stages of the pandemic. This became known as the 'excess deaths' work, where the MPC calculated actual deaths and compared these with expected deaths, with expected defined using 2019 population mortality rates (by age and sex, not at overall population level).

This turned out to be incredibly useful for a couple of reasons:

- There were two sets of COVID-19 death figures being produced by the UK government – one based on deaths with COVID-19 mentioned in the death certificate, and one based on deaths where the deceased had had a recent positive COVID-19 test. The two did not reconcile well, particularly in the first few months of the pandemic. The CMI's excess deaths figure felt like a clearer view of the pandemic's mortality impact, also showing indirect pandemic impacts as well as COVID-19 deaths, and was to prove important in the next couple of years.
- The closest analogous calculation done by the ONS was not age/sex standardised (and so changes in population age and sex composition from pre-2020 to 2020 led to a distortion), and was based on an expected deaths figure calculated per average mortality over the previous five years (and hence distorted by general population mortality improvements of the order of a few percent per year). Luckily, these two issues cancelled out to some extent.

Given the degree of public interest in these results, much attention was paid to associated press releases and ensuring our wording in these passed muster. One of my memories of the period was the amount of time spent on video calls with the key MPC members (Cobus Daneel as Chair and Jon Palin as the Secretary, who was the senior calculation 'doer' initially) along with Stuart McDonald (in his capacity as Chief Risk Officer) and the IFoA press officer, Sonia Sequeira.

Mid-end 2020

In the second half of 2020, with sufficient passage of time since the start of the pandemic, it became possible to consider conducting the CMI's normal investigative work on subscriber portfolio mortality. The first analysis was done by the Annuities Committee, looking at pension annuitant mortality over the first half of 2020[297]. As any mortality practitioner will realise, this posed great problems in terms of late reported deaths, and a key part of the analysis was developing late reporting factors to allow for this ('Incurred but not reported', or IBNR, in non-life insurance language). The exposure calculations also had to be done in a somewhat novel way.

[294] The main exception to this was the Management Committee, which had usually operated with shorter, virtual meetings for some years.
[295] The work of the Mortality Projections Committee is described in Section C7.
[296] These 'Mortality Monitors' are noted in Section C7, initially under 'Expanding the work of the committee, 2013-2019'.
[297] This is described under 'Assessing the impact of COVID-19 on pension annuitants' in Section C2.

The working paper (WP 140, published in October 2020) warned subscribers at the start that "The analysis is less rigorous than our usual analyses – both in terms of data validation and the estimation of exposure and deaths – but we hope it will provide valuable input to year-end basis setting". I thought it was an excellent piece of work and showed an extremely pragmatic approach to tackling the objective of providing insight into insurance annuitant portfolio mortality during the first months of the pandemic compared with the previous period.

This period also saw the establishment of the CMI's COVID-19 Working Party[298]. As well as the obvious point that a number of issues were appearing that needed some concentrated thought and consideration, there was a specific prompt from Tim Stedman (at the time on both the CMI Executive Committee and the IFoA Life Board), who noted the Life Board's concerns as to what insurers should do in terms of assumption setting using their 2020 data.

From my email history I see that I started the ball rolling in June on the need for the working party, along with early considerations of scope and thoughts on membership (ideally it would contain one person from each committee), and we then discussed this formally in the Exec Committee meeting of 30th June:

> *"…the current pandemic makes 2020 mortality highly unrepresentative of future mortality and CMI experience investigations post-2020 would therefore need to formulate an approach to allow for this. His proposal is to form a working party with the objective of developing a consistent approach across the four 'experience analysis' committees to allow for the unusual nature of 2020 mortality. Although aiming for consistency, it is recognised that each committee will have different underlying mechanics. The output should also aim to assist subscribers with related issues regarding their own internal post-2020 investigations"*

I had had an earlier conversation with Steve Bale as a possible leader of this Working Party, given his general CMI experience as well as his strong performance as Chair of the High Age Mortality Working Party a few years previously[299]. The Terms of Reference were quickly agreed and the COVID-19 Working Party had its first meeting on July 24. I attended the first call, wanting to both thank the group's members for their participation and enthuse them, and it was a good example of something we all remember from those months – insights into our colleagues' domestic settings! I enjoyed calls with Steve in particular because of his impressive vintage Star Wars adornments combined with a multitude of cats trying to 'assist' on the calls. Although this might sound an inappropriate memory in the serious and semi-catastrophic context we found ourselves in, at the time we were all in need of more human contact and the odd moment of levity.

The Working Party moved quickly to produce WP 139 which was released less than three months later, in October 2020.

2020 and 'non-pandemic' life

The CMI would be a busy and dynamic body in normal times, constantly seeking to improve, and the raging pandemic did not mean we could ignore our general intention to move ahead on various fronts.

We made good progress in 2020 with various initiatives, the main ones from my memory being the 'bedding in' of the Resource Pool, and collaboration with the Society of Actuaries in Ireland[300].

The Resource Pool was something I had proposed a year or so previously (as Deputy Chair), the main rationale being to increase resourcing flexibility away from the formal Committee structure. That structure meant (to my mind) an implicit bias against work that did not sit clearly with any one committee. It also meant committees could be vulnerable to increased workloads given the limited number of volunteers in each committee. And from a wider IFoA perspective, the stringent 'quality control' on new committee members meant it was hard for younger and less-experienced actuaries to get involved in the CMI. Setting up the Resource Pool was a way to overcome each of those

[298] The work of the COVID-19 Working Party is described in Section C8.
[299] The High Age Mortality Working Party is also described in Section C8.
[300] The Resource Pool is described under 'Structure and operations: 2013 to 2023' and the collaboration with the SAI under 'The CMI and Ireland'; both in Section C9.

problems. In 2020 members of the Resource Pool were involved in the COVID-19 Working Party as well as other initiatives including support for the CRO, overseeing the CMI's risk management, and for the development of a cause of death dataset, in collaboration with the MRSC[301].

The collaboration with the Society of Actuaries in Ireland (SAI) was something we had kicked off in early 2019, I think, when I spoke at an SAI event on the CMI's recent work, and then immediately after that event attended a meeting of the SAI's demographic group to discuss possible ways forward.

One outcome of that discussion was an awareness of how fortunate UK actuaries are to have the CMI in its current structure, whereby a 'neutral' secretariat can handle very granular data from a range of data providers. The SAI, not having an equivalent set-up, had been doing its mortality analyses at a much less granular level (e.g. with banded ages) because of totally understandable concerns about the Intellectual Property inherent in their data, and not wanting competitors to see any detailed data. From that discussion grew the collaboration whereby the CMI would provide that confidential third-party data handling role, allowing a granular temporary life mortality analysis (work on this started recently and is underway at time of writing).

A major part of the rationale for supporting the SAI with this (given the costs) was that many of our subscribers on the life insurance side had offices with large portfolios in the Republic of Ireland, quite apart from the interest that reinsurers and consultancies might have in improving the understanding of Irish mortality and longevity.

The other SAI collaboration was a great deal easier to organise, due to lack of Intellectual Property concerns or material budget issues. This was a paper on applying the Model to Irish population data and some of the insights from that; it was published in October 2020 as WP 141, with SAI actuaries Sinéad Carty and Karl Murray heavily involved in writing it.

In addition to the above, we were also working on some other pieces which were more 'behind the scenes' but still warranted attention – for instance, moving to a new way of working with the Secretariat, following a retender which Barnett Waddingham (the long-term previous incumbent) had won. Part of this change also involved preparing for Dave Grimshaw's move away from the CMI as his retirement from Barnett Waddingham approached, and starting to work towards a new Secretary – something which involved a substantial amount of time in interviewing possible contenders.

Another example of sporadically time-consuming work that went on behind the scenes were the regular meetings we had with the CMI's two Directors, both full-time senior staff at the IFoA. I found these to be in principle useful touchpoints to hear views of two 'non mortality' people (as we otherwise all ended up working in something of a mortality bubble much of the time!), and this dimension of our activity was in any case essential from a governance perspective.

Finally, while thinking about other major memories of my first year as Chair, I think we had worked well in improving our communications. This had been a major theme of the previous Chair, James Tait. This year, we put more effort into improving the regular newsletters going out to IFoA members, and being more active on LinkedIn as a way of publicising outputs. The communications 'drive' continued with each working paper coming out with an associated blog on the IFoA thought leadership site (accessible to non-subscribers and hence a useful and 'public spirited' expansion), and a free subscriber webinar. This was an example of small incremental change which I suspect might not have been noticed by many, but across a range of different things over the years everyone in the CMI could be proud we'd helped improve our service to subscribers and the wider public in a material way.

2021 – the pandemic continues

An important and highly valued output of the CMI is the Mortality Projections Model (widely referred to as 'the CMI model' and in this book as 'the Model'). The structure and associated calibration of the Model can have a material impact on pension fund solvency and life insurers' balance sheets (as well as annuity rates for customers). The generally smooth nature of mortality movements from year to

[301] The IFoA's Mortality Research Steering Committee

year before the pandemic had meant that adjustments to the Model were also similarly 'smooth', with generally minor methodological adjustments every few years and a data refresh every year[302].

However, the extraordinary spike in mortality in 2020 meant that the Model could not usefully be updated simply by adding in the 2020 data, nor was there any obvious way to adjust its extrapolative 'mechanics' in a mathematically robust way.

The MPC had put much thought into how to deal with 2020 data in the Model, and ended up proposing a new approach to allow for the Model to be published as usual in early 2021. This approach was to introduce a parameter to weight the influence of each year's data, with the default values set to zero for 2020 and 100% for all other years.

This was regarded in the Exec and (to my knowledge from outside non-CMI conversations) by many users as being a very practical route forward for the first version of the Model to appear in the pandemic, albeit it would obviously need revision as we move into the post-pandemic era.

As many readers will know, the "Long-Term Rate" assumption regarding the long-term future of mortality improvements is input by users and the CMI refrains from making any recommendation about this parameter. This agreed lack of recommendation continued with this Model version, but the COVID-19 Working Party's paper had provided some views as to how the pandemic might affect future mortality.

We were able to do more work on 2020 data in 2021, one example being the Annuities Committee's extension of the H1 2020 work (in WP 140) to the whole of 2020 (compared with 2015-19), published as WP 148.

The Income Protection Committee was busy on a fundamental revamp to the methodology and systems they used and, partly because of this task, the IP Committee during my time as Chair produced less in the way of normal analyses than the other committees (it was to some extent a relief that the pandemic had not messed up their plans). One very interesting piece of work they produced was WP 156, a qualitative look at the impacts of the pandemic on IP business via a survey. This showed results which surprised many (including me), for instance a reduction in claims in 2020 (likely attributable to a combination of furlough, operational claim delays and NHS backlogs).

As the end of 2021 approached, most insurers were starting to think about the extent to which their data (for the previous year, 2020, and the year 2021 once complete) could be used for their own experience investigations. While many firms had 'skipped' 2020, ignoring it somewhat as had been the approach for the CMI Model, the idea of skipping two whole years of data felt undesirable.

The same issue of course was present for the CMI, albeit less urgently (given what has generally been a four-year cycle in using mortality data to prepare tables, as opposed to the more frequent 'Actual v Expected' analyses).

It seemed to me of extreme importance that the CMI communicated its thoughts on how 2020 and 2021 data could be used for mortality investigations, framing our thoughts (which would sit explicitly in a CMI context) so that the issues and recommendations would be as transferable as possible to insurers' own positions.

The central problem of what approach to take was conceptually very simple, and I couldn't see it occupying more than a couple of pages of rationale. It therefore felt inefficient to do as any form of formal working paper, notwithstanding the question of which part of the CMI would own that paper. I worked on a short note with Steve Bale, and (after due internal review) we published this as a 'blog' on the IFoA website (https://blog.actuaries.org.uk/the-cmi-s-approach-to-the-use-of-2020-2021-data/), it also appeared shortly afterwards as an almost identical article in The Actuary magazine.

[302] As noted in Section C7, significant changes to the Model have only been made following consultation.

2022

This final year of my Chairmanship felt refreshingly unexciting after the first two years! 2022 started with further thought and discussion about the next release of the Model, which followed the previous version in allowing a low weighting of the most recent year's population mortality (2021; another unusual year, albeit less so than 2020).

Away from the CMI's core activity of doing analyses and then publishing them, some of my memories of what was going on in 2022 (but including 2021 to some extent) were:

- Assisting with presentations or interventions where the IFoA had been asked to contribute, often on the back of the MPC's excess deaths work – for instance, pandemic-related events organised by the Royal Statistical Society and the International Longevity Centre. The final instance of this was the CMI's contribution to the UK Government's COVID-19 inquiry, situated in the context of Module 3 (item 10): "Deaths caused by the Covid-19 pandemic, in terms of the numbers, classification and recording of deaths, including the impact on specific groups of healthcare workers, for example by reference to ethnic background and geographical location."
- I spent some time in the last few months of my period thinking through what I called 'how to cut up the mortality universe'. The CMI had a tightly prescribed remit focusing on objective analysis of data, while the Mortality Research Steering Committee had effectively taken the implicit gap created by that remit, of looking at whatever might be regarded as more subjective, future-focused or judgemental. This split seemed to work, but it had come about almost by accident and I was concerned that it had never really been thought through or 'approved' within the IFoA. (I noted earlier the separation of activities between CMI and ARG, almost identical to that between CMI and MRSC, but that was a temporary arrangement.) In sessions over that time with the relevant IFoA Practice Boards I went through some of this background and some possible alternatives, but all were happy to keep the 'mortality universe' cut up as it already was, which was a relief to me – I was prompting these discussions in the hope that they would produce agreement on our current approach, not require any reorganisation.

Two final thoughts, one positive and one sad:

- The Deputy Chair at the time, Jonathan Hughes (now Chair) may no doubt be wondering 'what about me?' as he reads the above! I was incredibly lucky to have Jonathan's support, and found him to be an extremely useful 'discussion partner' and sounding board to think through how to approach some of the major challenges emerging – some on the technical side, but even more so on the organisational and 'people side' where I was particularly wary of mis-stepping. Likewise we often brought Stuart (who has since become Deputy Chair) into these conversations, and his inputs were invaluable. The profession is incredibly lucky to have such a number of talented volunteers contributing their time, and doing so without any sense of 'politicking' or, for the most part, conflict of interest with their commercial roles.
- On the sadder side, the CMI is by definition institutionally focused on death, but generally in the abstract. Over my time (and including the subsequent year or so) we had news of several deaths. Two of the 'founding fathers' of the SAPS investigation died during 2020: Brian Wilson, the first SAPS Chair, and Nigel Bodie, a former Watsons colleague and an exceptionally jovial character. Secondly, and more jarring because of her youth, Adele Groyer – an important member of the Assurances Committee, and someone I'd worked with closely at part of the ARG. Finally, Duncan Heald – who had been chairing the IP Committee, took time off as part of his cancer treatment, and then returned to work (although not the CMI) only to find his cancer had returned shortly afterwards. "Time and chance happen to us all."

I am extremely proud, and fortunate, to have been able to serve the profession through chairing the CMI during the period of the pandemic. Looking back, now that I have reverted to being 'outside' the CMI, it does strike me that the CMI is something extraordinary that the profession takes for granted but should not. I am amazed at how much we accomplished during the pandemic.

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