ISSN 2044-3145

Continuous Mortality Investigation

Income Protection Committee

WORKING PAPER 48

An overview of the Graduations of Sickness Inception and Termination Rates for the CMI Individual Income Protection Experience for 1991-98 of Males, Occupation Class 1

This paper forms part of a series of papers. It provides an overview of the work contained in the five other papers in the series (CMI Working Papers 5, 6, 7, 46 and 47) covering the analysis and graduation of Sickness Inception and Termination rates.

July 2010

Cheapside House, 138 Cheapside, London EC2V 6BW
Tel: 020 7776 3820 Fax: 020 7776 3810
www.cmib.org.uk info@cmib.org.uk

EXECUTIVE SUMMARY

This paper provides an overview of a large body of work, presented in five inter-related CMI Working Papers, covering the analysis and graduation of Sickness Inception and Termination experience for the CMI Individual Income Protection (IP) dataset for 1991-98. The resulting graduations of the experience of Males in Occupation Class 1 are referred to as IPM 1991-98.

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.

The new graduations use the multiple state model approach described in CMIR 12 (which set out the previous IP graduations, SM1975-78). 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.

The IPM 1991-98 graduations are based on a larger data volume than SM1975-78 and so reflect slightly more complex features in the data. Overall the Claim Inception rates are similar, or lower, than the previous graduations for the shorter DPs, but significantly higher for longer DPs. However, the Termination rates are substantially lower (except for the first few weeks of Sickness), reflecting the significant deterioration in IP experience between 1975-78 and 1991-98, particularly for the longer DPs. More recent data shows some subsequent improvement in experience through to 2006.

As the graduations are derived from only a subset of the data - Males in Occupation Class 1 - the experience of other Occupation Classes and of Females has been compared against them. Claim Inception rates rise steeply through Occupation Classes 1 to 4, and are significantly higher for Females than Males (ratios of 120% for DP 1 week, 165% for DP 4 weeks and around 190% for longer DPs). By contrast, Claim Termination rates show relatively little variation by Sex and Occupation Class.

The CMI IP Committee intends next to produce an analysis of the experience for 1999-2006, calculating expected Claim Inceptions and Terminations on the basis of the IPM 1991-98 graduations, for publication as a CMI Working Paper in the Autumn of 2010.

No formal consultation process is planned on these graduations, and no specific questions are posed within this paper, but the Committee would be pleased to receive any further comments on these graduations. 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. The Committee would be pleased to receive any comments on these papers by 30 November 2010.

An overview of the Graduations of Sickness Inception and Termination Rates for the CMI Individual Income Protection Experience for 1991-98 of Males, Occupation Class 1

CONTENTS

1. INTRODUCTION

The CMI Income Protection (IP) Committee has been working to produce new graduations of Individual IP experience using the multiple state model approach described in CMIR 12 (which set out graduations of the 1975-78 Individual Standard Male experience, referred to as the SM1975-78 graduations).

The new analysis is focussed on the CMI Individual IP experience of Males, Occupation Class 1, for 1991-98. We refer to the resulting graduations as IPM 1991-98. 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. As a result, the work has been spread over a number of years and the results, including graduated Sickness Inception and Termination rates, have been presented through the five inter-related CMI Working Papers listed below:

CMI Working Paper 5 (2004):
The Graduation of Claim Recovery and Mortality Intensities for the Individual IP experience for 1991-98 of Males, Occupation Class 1.

CMI Working Paper 6 (2004):
Date-Related Features of Individual Income Protection Claims 1975-1998.

CMI Working Paper 7 (2004):
The Claim Termination Experience of Income Protection Business, 1991-98, for Other Male Occupations, Females and Group.

CMI Working Paper 46 (2010):
Background papers on the analysis of CMI Individual Income Protection Claim records.

CMI Working Paper 47 (2010):
The Graduation of Sickness Rates for the CMI Individual Income Protection experience for 1991-98 of Males, Occupation Class 1.

All these papers may be accessed via the CMI pages on the UK Actuarial Profession's website: http://www.actuaries.org.uk/research-and-resources/pages/continuous-mortality-investigation-working-papers.

These Working Papers total nearly 300 pages. To help practitioners benefit from this large body of work, and more easily access what they need from it, this paper provides a high-level overview of the content of the Working Papers, summarising both the methodology and the key features of the graduations and experience. Some additional material is also provided to set the new graduations in context: a brief resume of the multiple state model; a comparison of the SM1975-78 and IPM 1991-98 graduated rates, together with a high-level summary of CMI IP experience over 1975 to 2006; and an outline of the Committee's planned next steps.

It is hoped that this overview paper will meet the needs of many IP 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.

2. THE STRUCTURE OF THIS PAPER

IPM 1991-98 is the second complete set of graduations of Income Protection experience produced by the CMI using the multiple state model described in CMIR 12. The structure of the model is outlined in Section 3 of this paper together with a summary of the features observed, and built into the graduated rates, when the approach was applied to the Individual IP Standard Male experience for 1975-78.

The dataset used for this current round of investigations and graduation is the CMI Individual IP data for the years 1991-98. A summary of the data and of the initial processing considerations, including the identification of Duplicate records, is given in Section 4.

The central Sections of this paper provide an overview of the graduation process and results. A summary of the methodology is provided in Section 5, whilst Sections 6, 7 and 8 cover specific considerations for the analysis and graduation of recovery, mortality (from Sick) and Sickness Inceptions experience, respectively. Note that mortality experience is considered only in respect of IP claimants - that is, only for lives who are already Sick (in IP terms).

The analysis and graduation process is complex, particularly for Sickness Inceptions. It is hoped the overview of methodology presented here will give the reader a useful framework in which to view the more complex parts of the modelling set out in the other Working Papers.

In addition, Sections 6, 7 and 8 also contain a summary of the features of the experience and the resulting graduations, IPM 1991-98, highlighting differences in comparison to SM1975-78. For ease of reference the final graduation formulae are set out in Appendix A, together with the resulting table of Claim Inception rates by age and Deferred Period.

The new graduations are derived from the experience of Males in Occupation Class 1. In Section 9 we summarise the experience of other Occupation Classes and of Females, measured against IPM 1991-98.

A comparison of the IPM 1991-98 and the SM1975-78 graduated rates is presented in Section 10 and set in context of a high-level summary of the CMI Individual IP experience, by quadrennium, over the period 1975 to 2006.

Section 11 contains brief comments on the form in which the graduations are presented and on computational procedures for using the IPM 1991-98 graduations.

The Individual IP dataset and analysis methodology have both been significantly developed since the publication of CMIR 12 in 1991. Although the overall effect of the changes is small relative to the inherent uncertainty of IP experience, an awareness of the changes may be useful to those using the results and reports issued by the CMI IP Committee. The changes are summarised in Appendix B.

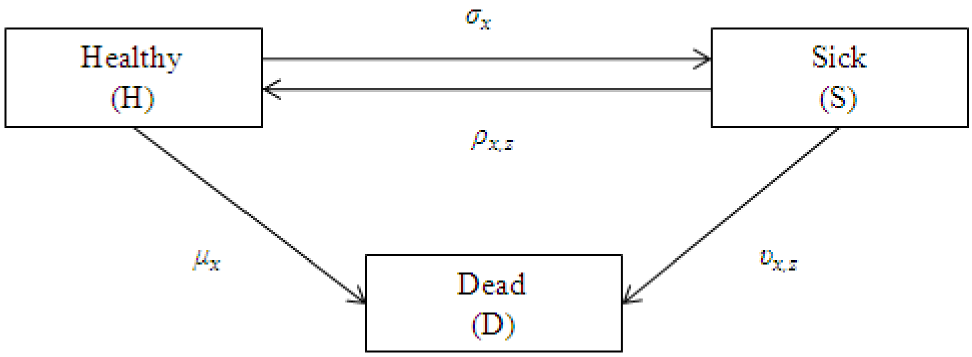
Finally, planned and potential future work for the CMI IP Committee is outlined in Section 12.

3. MODEL

3.1 *Multiple state model for IP business*

We start by defining a mathematical model to provide a clear basis for the statistical analysis of the IP experience. This model was introduced in CMIR 12 (1991) and is illustrated in Figure 1.

Figure 1: A diagrammatic representation of the model for Sickness.



We assume lives enter the risk pool in state H ('Healthy') and are then subject to the risks of falling 'Sick' (transferring to state S) or dying (transferring to state D). The transition intensities, or forces of decrement in an older terminology, for these two transitions are denoted σ_x and μ_x and are assumed to depend only on attained age x (in particular, we assume they do not depend on policy duration).

Note that throughout this paper we use the term 'Sick' to mean being unable to work as a result of illness or injury (as defined for the underlying IP policies). However the definition of disability or incapacity may vary between policies. The CMI IP Committee expects that the great majority of policies and claims will be subject to an "Own Occupation" definition, but anticipates that some will be subject to a tighter definition, such as "Activities of Daily Working".

Lives may leave state S by recovering (transferring back to state H) or dying (transferring to state D). The transition intensities for these transitions are denoted $\rho_{x,z}$ and $\nu_{x,z}$ respectively and are assumed to depend only on the age, x, at which the life fell Sick and the duration, z, of the current Sickness. Collectively we term transitions from state S 'Sickness Terminations'. Note that it is assumed that those who recover from Sickness and re-enter the Healthy state have the same future rates of Sickness and mortality as those that have never been Sick.

An immediate practical problem arises in that the data held by insurers relates to IP Claims rather than directly to Sickness. An IP Claim can only arise once the insured life has been Sick throughout the Deferred Period. Our data therefore does not allow us to observe transitions during the Deferred Period between states H and S, in either direction, nor from S to D.

This raises a question: would it be better to replace states H and S with 'Not Claiming' and 'Claiming' which we could observe directly? First, we note that the cover under IP policies is for Sicknesses that start while the policy is in force, and so it is natural for pricing to consider the future cost of Claims arising from Sicknesses starting at the date of exposure. It is also natural to measure the duration of Sickness rather than the duration of Claim. Thus the transition from H to S is of importance. Second, as the state 'Not Claiming' would include both Healthy and Sick (but not yet Claiming) lives, the resulting model would necessarily yield transition rates from that state which would depend on policy duration. Such durational effects would be a function of the underlying Sickness transition intensity, σ_x, and the Deferred Period, and would arise even where σ_x is not itself dependent on policy duration. This would be an unwelcome complication and was a significant motivator for establishing the CMIR 12 model. Finally, building a model based on the underlying state of Sickness, rather than 'Claiming', offers, in principle, the prospect of comparing Sickness experiences across all the different Deferred Periods (although such comparisons should be treated with some caution since they require assumptions regarding Sickness Termination rates within the Deferred Period and these are not directly observable).

To apply the model, we recognise the state of 'Claiming' as a subset of state S and equate the two once the duration of Sickness, z, is beyond the end of the Deferred Period (and beyond any relevant "run-in" period [see Section 3.2 below]). Although the process is not straightforward, it is then possible to use the available data to estimate all the required transition intensities, except the 'healthy life' mortality, μ_x, which we cannot observe at all in the CMI data. [Unless additional benefits are payable on death, μ_x is generally not a critical assumption for the pricing or valuation of IP business; see CMIR 12, pages 97-98 for further discussion, including approaches for estimating μ_x.]

Although strictly speaking the model deals with transition intensities we often use the shorter term "rates" in the remainder of this paper and in the associated Working Papers.

3.2 *CMIR 12: Graduation of Individual IP experience for 1975-78*

CMIR 12 presents an application of this model to CMI Individual IP experience for 1975-78 leading to graduated rates for Sickness Inceptions and Terminations.

The model is computationally complex. As well as the need to overcome the gaps in observations, the model also presents further challenges, in particular through the bi-variate nature of the transitions from state S, with rates depending on both the Age at falling Sick and on the Sickness duration, and through the scale and rapidity of changes in those Sickness Termination rates in the early durations of Sickness. CMIR 12 sets out at length the initial solutions to these problems.

The data subset chosen for analysis and graduation was the 'Standard' data for Males. At that time, Occupation Class was not recorded in the CMI data, but the Standard dataset excluded all policies which were marked as having an 'Occupational Rating'. Analysis was restricted to Deferred Periods (DPs) 1, 4, 13 and 26 weeks. The resulting graduated rates are collectively referred to as the SM1975-78 tables.

The key features observed in the Sickness recovery experience, and built into the graduated rates, were:

(a) The influences of Age at falling Sick and of Sickness duration were found to be largely independent of each other and broadly multiplicative in effect.

(b) The dominant factor was the duration of Sickness, with recovery rates falling very rapidly over the early weeks and months of Sickness.
(c) A single bi-variate ‘table’ of graduated recovery rates was found to be an acceptable fit to the data for all the Deferred Periods for most durations of Sickness.
(d) Some modifications to ‘core’ recovery rates were required to reflect a ‘run-in’ period of significantly lower Claim recovery rates for DP 4, 13 and 26 week business.

The run-in period adjustments arose from the observation that Claim recovery rates (for DPs 4, 13 and 26) during the four weeks immediately following the end of the Deferred Period were unreasonably low compared to the general trend by Sickness duration. It was thought that such effects cannot be plausibly attributed to natural differences in the Sickness characteristics of Claimants with different Deferred Periods. It was thought likely that many insured lives whose Sickness extends only a short way beyond the Deferred Period do not make a Claim, and so their imminent recoveries are not observed in the experience.

The key features observed in the Sickness mortality experience, and built into the graduated rates, were:
(a) The rate of mortality from Sick tends to rise from the start of Sickness to a peak after about 4 months, after which it declines fairly rapidly.
(b) The rate of mortality from Sick rises with age attained but, again, the dominant factor, for at least the first few years of Sickness, is duration of Sickness. Age becomes dominant at longer durations, where mortality from Sick could be broadly equated to typical insured life mortality plus a constant addition of the order of 20 per mille p.a..
(c) A single bi-variate ‘table’ of graduated mortality rates was found to be an acceptable fit to the data for all the Deferred Periods (albeit based on a relatively small number of observed deaths).
(d) There was no statistically significant evidence of a ‘run-in’ period similar to that observed for Claim recovery rates (although it is quite plausible that one exists).

Sickness Inception rates were also derived along with the corresponding Claim Inception rates (allowing for recoveries and deaths during the Deferred Period). The key features observed in the Claim Inceptions experience, and built into the graduated rates, were:
(a) Separate Sickness rates were required to fit the data for each Deferred Period, with Sickness rates falling as the Deferred Period lengthened.
(b) The inferred Sickness rates were ‘U’-shaped by age, with a minimum around age 50.
(c) Claim Inception rates increased with age but considerably less quickly than aggregate (all causes) mortality rates.

Overall the resulting models showed some commonality and some differences between the Sickness experiences for the different Deferred Periods.
(i) It was reasonable, and not inconsistent with the data, to ‘borrow strength’ across the Deferred Periods in graduating the Terminations experience, so that the recovery rates (ignoring the run-in period) and the mortality from Sick were the same for each Deferred Period.
(ii) However the Sickness Inception rates were different for each Deferred Period. This is not an unexpected result as separate groups of policyholders, differentiated by employment circumstances and Income Protection priorities, tend to opt for different Deferred Periods. [Note that the derived Sickness rates depend crucially on the assumption made for Sickness Termination rates within the Deferred Period (so in this case, the assumption that such termination rates do not vary by Deferred Period).]

4. DATA FOR 1991-98

The dataset used for the current round of investigations and graduations is the CMI Individual IP data for the years 1991-98. The experience was analysed for evidence of clear time trends and it was considered that the data for the octennium as a whole was sufficiently homogeneous to be combined. The much larger data volume, compared to 1975-78, is a distinct advantage and, inter alia, allows us to add DP52 to the list of Deferred Periods for investigation. Note that there is little data outside the age range 25-64.

The subset of data used for the graduations is Standard* ('Standard Star') for Males, Occupation Class 1. With the introduction of Occupation Class to the CMI IP dataset for 1991 onwards, the 'Standard' data subset was replaced by Standard* which includes all Occupation Classes and cases with an 'Occupational Rating' (now fewer in number). For the graduations we restrict ourselves to the Occupation Class 1 data for Males, which represents around half of the whole dataset. We then review the experiences of Females and of other Occupation Classes against this benchmark (the results are summarised in Section 9 of this paper), rather than attempting to build a multi-variate model which would need to include additional factors for Sex and Occupation.

A summary of the data is provided in Table 1.

Table 1: Summary of eligible exposure and Claim events in the In force and Claims files
CMI Individual IP, 1991-98

	Policy Exposure (policy years)	**Claims** including Duplicates	**Claims** excluding Duplicates	**Inceptions** excluding Duplicates	**Recoveries** excluding Duplicates	**Deaths** excluding Duplicates
Males, Occ Class 1	1,381,793	65,653	34,932	14,777	11,553	689
Other Occ Classes and Females	1,958,773	51,652	46,793	15,536	9,404	627
Total	**3,340,565**	**117,305**	**81,725**	**30,313**	**20,957**	**1,316**

The data is collected on a Calendar year basis and contains records for each policy in force, at the beginning and end of the calendar year, together with records for each Claim in payment at any point during the year. The two columns headed 'Claims' in Table 1 show the number of Claim records in the file, simply summing the totals for each of the eight Calendar years: where IP benefits are paid to a policyholder over 2 (or n) years, that would result in 2 (or n) Claim records. [The reference to 'Duplicates' is covered later in this Section.]

The dataset is somewhat limited in its form and this complicates some elements of the analysis. One aspect of the current investigations which has taken considerable time has been a reappraisal of the data and how to deal with some of its weaknesses.

Particular constraints are that:
- there are no unique life or policy identifiers in the data;
- only partial details, such as month and year but not day, are recorded for dates of birth (particularly, but also some other dates);
- the data relate to each calendar year separately, often with discontinuities between years as offices enter or leave the investigation.

Changes to the Coding Guide for CMI IP data have been agreed so that many of the issues will be removed for new data once contributors are able to adopt the latest Guide (published July 2009).

Some records have to be rejected because the data is invalid or internally inconsistent. The algorithm applied to identify and exclude unacceptable records has been revised: details are set out in CMI Working Paper 46 (Part A: *Note on Exclusions and some other features of the Claims data*).

It is important to identify and remove Duplicate records within the data as their inclusion would undermine the statistical model and risk introducing bias to the graduations by affecting the 'weight' given to observations in each data cell. Duplicate records typically occur when a policyholder buys additional cover of the same 'type', so that the dataset contains a number of separate records with sufficiently similar conditions for it to be better to treat them as one policy / Claim rather than as several.

We can identify Duplicates within the Claims records with reasonable confidence, but cannot identify Duplicates in the In force. The algorithm applied to identify Duplicate Claim records has been revised: details are set out in CMI Working Paper 46 (Part B: *The Identification of Duplicates*).

Overall, there are 38 Duplicate records for every 100 'original' Claims records. Further investigation has shown that:

(a) There were no statistically significant differences in the Claims Terminations experience of various categories of 'original' and Duplicate records. Our analysis is set out in CMI Working Paper 46 (Part C: *The Experience of Singletons and Duplicates*).

(b) The prevalence of Duplicates varies by Occupation Class, Deferred Period, Age and Sex, all factors for which we would naturally subdivide the data anyway, but not for any other factors available in the data (after aggregation across Offices). Further information is also given in CMI Working Paper 46 (Part D: *An Analysis of the Distribution of Duplicates*).

Some of the revisions to the identification of 'exclusions' and Duplicates occurred between the work on Termination rates and that on Inception rates, resulting in small differences in the final dataset used for each part of this work. Further details of the differences are provided in Appendix B of this paper.

Some further commentary on the data is provided in Section 1 of CMI Working Paper 5 (for Claim Terminations experience) and Section 2 of CMI Working Paper 47 (for Claim Inceptions experience). In addition CMI Working Paper 6 reports on our investigation into date-related features of the Claims data, including analysis of the distribution of Sickness start and end dates by days of the week or month, and showing the imperfect relationship between the Sickness start date, the Deferred Period, and the first payment date.

5. METHODOLOGY

We now give an overview of the methodology adopted for the investigation and graduation of the 1991-98 CMI IP data, noting that some of the solutions to the problems posed in applying the multiple state model differ from those set out in CMIR 12.

To apply the model we must first examine the Claim Terminations experience and derive the Sickness Termination rates (separately for recoveries and deaths from Sick).

We start with counting the number of events (recoveries and deaths from in-Claim) and the central exposure (life years in Claim). In performing these calculations we sub-divide the data to produce two-dimensional arrays by Age (last birthday at Commencement of Sickness) and duration Sick (in very short time intervals at least for the early durations of Sickness) for each combination of Sex, Occupation Class and Deferred Period.

These basic calculations provide us with inputs required either for the graduation (Males, Occupation Class 1) or for an 'Actual over Expected' analysis (for example to compare the experiences of Females and of other Occupation Classes against the graduated rates).

The graduation process then follows the usual, albeit complex in this case, process of developing a Termination rate formula to represent the statistically significant features of the observed experience. We start by calculating crude transition rates by dividing the observed number of events by the exposure. We also start from the premise that features of the experience are shared across the Deferred Periods, but divert from this position where the data supports additional variation in the formula.

We fit the graduation formula by the method of maximum likelihood. A general explanation of this method is given in *"On graduation by mathematical formula"* by Forfar, McCutcheon and Wilkie (1988; *J.I.A.* 115). In practice, a number of alternative formulae will be trialled in this way, testing the goodness-of-fit of each one and the statistical significance of the value of each extra parameter. We look overall for a balance between the fit and the complexity of the formula. We are guided in this by the results of a range of standard statistical tests and by more general considerations, including whether the formula produces 'sensible' values outside the range of the given data.

The results of this exercise for Sickness Termination rates are summarised in Sections 6 (recoveries) and 7 (deaths from Sick) of this paper.

Having settled on a graduation of Termination rates, we have a basis for filling in one of the gaps in our observations, that is estimating the transition rates from 'Sick but not Claiming'. We proceed by using observations on the shorter Deferred Period business to infer the pattern of Termination rates for pre-Claim Sickness for longer Deferred Period business, and by extrapolating the graduation formulae back to Sickness duration zero. This gives us a complete set of estimated Sickness Termination rates for all durations Sick.

Now we are ready to examine the Claim Inceptions experience and use it to derive both Sickness Inception and Claim Inception rates. We cannot directly observe Sickness Inceptions but we can count the number of Claim Inceptions and also calculate the central exposure period (life years) from the In force. In performing these calculations we sub-divide the data by Age (last birthday at Commencement of Sickness or at the In force date), Sex, Occupation Class and Deferred Period.

The expected number of Sickness Inceptions is given by $R.\sigma$ where R is the exposed-to-risk and σ is the Sickness Inception rate (ignoring age subscripts). Sicknesses are not observed unless and until a Claim starts, so we must allow for the probability of a Sickness continuing to the end of the Deferred Period, π, and the probability that a Claim is then made, η. [As noted in Section 3.2, it is thought that many insured lives whose Sickness extends only a short way beyond the Deferred Period do not make a Claim.] Combining these, the expected number of Claim Inceptions is given by $R.\sigma.\pi.\eta$.

If R, π and η are known (or can be estimated) and the observed number of Claim Inceptions is I, then the maximum likelihood estimator of σ is $I/(R.\pi.\eta)$. We can estimate π and η from the graduated Sickness Termination rates (hence the need to examine the Terminations experience before the Inceptions). We also use these Termination rates for some of the required adjustments to the crude exposed-to-risk to calculate R (see Section 8 of this paper.)

We then have the inputs required and proceed with the graduation (for Males, Occupation Class 1), using the same general graduation techniques as discussed above, and 'Actual over Expected' analysis (to compare the experiences of Females and other Occupation Classes).

Finally, we derive Claim Inceptions rates $i = \sigma.\pi.\eta$. We note that, although estimation uncertainty in π and η will directly affect our estimate of σ, those factors are 'reversed out' of the equation in moving from Sickness to Claim Inception rates, so that there is much less uncertainty in the graduated Claim Inception rates and they correspond well to the observed crude Claim Inception rates, I/R.

The results of this exercise for Sickness and Claim Inception rates are summarised in Section 8 of this paper.

The output of the graduations work summarised in this paper is a set of rates for Sickness and Claim Inceptions and Terminations. The graduations are presented as formulae for the intensities, together with sample values. A table of Claim Inception Rates is included in Appendix A but a full 'table' of Termination rates would be very large, as the rates vary by Age at falling Sick, Sickness duration and Deferred Period, and so only the formulae are provided. Computational procedures for the multiple state IP model, for example to calculate annual rates from the intensities, or to generate a projection of future Sicknesses from an initial ('Healthy') population, were set out in Parts D, E and F of CMIR 12 and are not considered further in this paper.

6. GRADUATION OF SICKNESS RECOVERY RATES

For the Sickness Terminations investigation we only require the Claims records and so are able to work directly with a data file with Duplicates removed.

Following the process just outlined in Section 5, there are then no particular issues in counting the Claim recoveries and the central exposure, other than in setting appropriate time intervals for subdividing the counts by Sickness duration. The following intervals, giving a practical balance between accurately reflecting the pattern of rates (especially where recovery rates vary rapidly with changing duration Sick) and computation timescales, were adopted:

- single days, for the first 28 days of Sickness;
- weeks of 7 days (with a final week of 8 days) for the remainder of the first year;
- lunar months of 28 days (with a final month of 29 days) for the next four years; and
- single years of 365 days, for Sickness periods of greater than 5 years.

The resulting array of crude Claim recovery rates was then examined to identify the key features of the experience, and an ad hoc graduation formula developed. With larger data volumes used for the 1991-98 graduations than for the 1975-78 work in CMIR12, there is greater resolution in the observed experience and this has led to a more complex graduation formula.

The key features observed in the Sickness recovery experience 1991-98, and built into the graduated rates, were:

(a) The influences of Age at falling Sick and of Sickness duration were again found to be largely independent of each other and broadly multiplicative in effect.

(b) The dominant factor is again the duration of Sickness, with recovery rates falling very rapidly over the early weeks and months of Sickness. The pattern of recovery rates is quite complex so that an ad hoc graduation formula needed to be developed with three distinct elements to reflect the patterns of experience in the first four weeks of Sickness, from weeks 4 to 26, and from week 26 onwards, respectively.

(c) Although a single bi-variate 'table' of graduated recovery rates (adding an 'Age at falling Sick' component to the formula by Sickness duration) was found to be an acceptable fit to the 'shape' of recovery rates across the Deferred Periods at most durations, variations in the overall level of rates needed to be recognised. A multiplicative factor has been introduced to reflect this variation by Deferred Period: taking the level of recovery rates for DP1 as 100%, multipliers are 132% for DP4, 99% for DP13, 84% for DP26 and 59% for DP52. The factors apply equally for all durations of Sickness, so that the modelled 'core' recovery rates are highest for DP4 and lowest for DP52 at every Sickness duration.

(d) Some modifications to 'core' recovery rates were again required to reflect a 'run-in' period of significantly lower Claim recovery rates for DP4 and DP13 business (but not this time for DP26). There is clear evidence of an initial 4-week run-in period for both DP4 and DP13; in addition the observed rates for DP4 continue to run low, relative to the pattern observed for DP1, until week 16, so that a further (but shallower) adjustment was required for DP4 over weeks 8 to 16.

Where the patterns of experience diverge between DP1 and DP4 over the first 16 weeks of Sickness, DP1 has been taken to be the 'base model' for the pattern of experience as a whole, not least because of the need to place confidence in the DP1 rates (as the DP covering the earliest durations of Sickness) for extrapolating the graduated Sickness Termination rates back to zero duration (as required for the Inceptions analysis).

Some features of the observed experience have been ignored in the graduations. In particular:

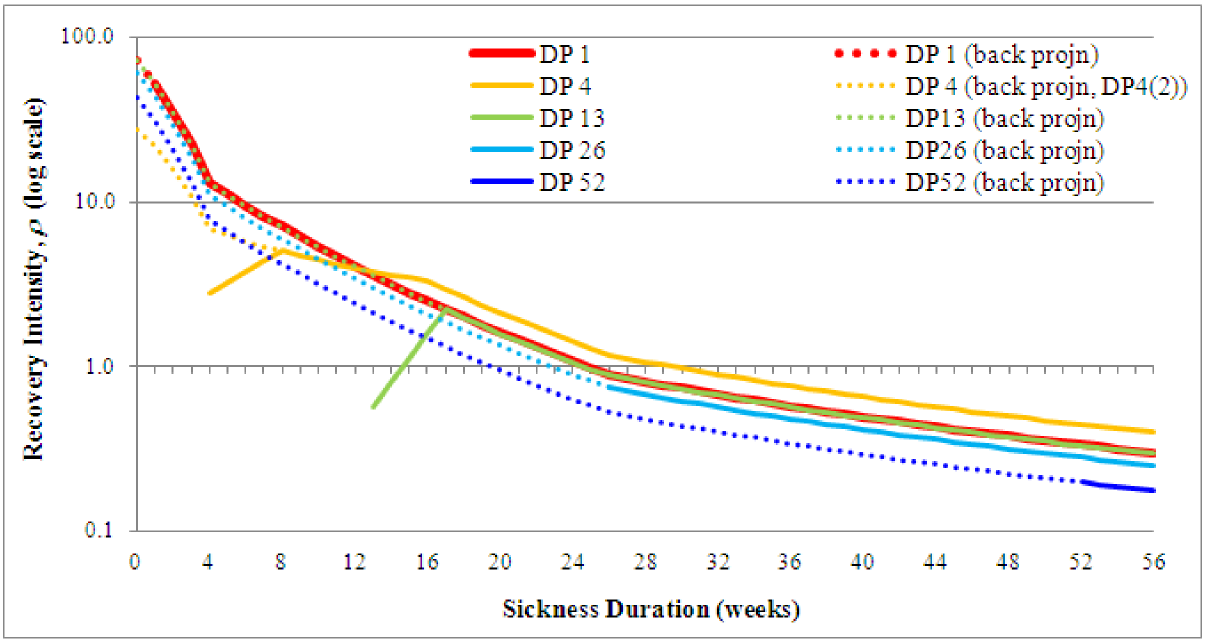
(e) Observed recovery rates generally declined with increasing age but appeared to level off or rise for ages 60+. This feature was considered unreliable, and was thought possibly to be the result of some policy expiries being coded as Claim recoveries, and so the data for ages 60+ was excluded (and rates for those ages estimated by extrapolating the fitted graduation formula).

(f) The observations suggest a roughly cyclical pattern of peaks and troughs (approximately monthly peak-to-peak) in recovery rates for the first 6 months of Sickness with a particular peak at the end of that period. It is possible this relates to a practice by offices of reviewing Claims-in-payment at certain durations. However, the graduations have not been adjusted and so 'smooth over' these features.

Sections 3 and 4 of CMI Working Paper 5 provide further details of the investigation and graduation respectively, including sample values of the graduated recovery rates (Tables 1(a) to 1(e)). For ease of reference, full details of the graduation formula are also shown in Appendix A of this paper.

The graduated recovery rates are illustrated in Figure 2. The solid lines show the values of Claim recovery rates by duration of Sickness, for each Deferred Period, for an individual aged 40 exact at the date of falling Sick. The run-in periods for DP4 and DP13 are clearly visible. (The dotted lines show the projection of Sickness recovery rates back to duration 0, ignoring run-in effects, as explained in Section 8 of this paper.) The rates show a similar pattern for other ages but their overall level generally decreases with advancing age.

Figure 2: Graduated recovery intensities for Sicknesses starting at exact age 40, by Sickness duration, for each Deferred Period.
Solid lines show Claim recovery rates, including the run-in periods;
Dotted lines show the projection back to duration 0, ignoring run-in effects.



7. GRADUATION OF SICKNESS MORTALITY RATES

The data preparation work and methodology considerations for the analysis of in-Claim mortality rates are the same as those just summarised in Section 6, for the analysis of recovery rates. The resulting ad hoc graduation formula is somewhat simpler than that required for the Claim recovery rates, but again the greater resolution in the observed experience has led to some refinement compared to the formula developed in CMIR 12.

The key features observed in the Sickness mortality experience 1991-98, and built into the graduated rates, were:

(a) The rate of mortality from Sick again tends to rise from the start of Sickness to a peak after 4 or 5 months, after which it declines fairly rapidly.

(b) The rate of mortality from Sick rises with age attained but, again, the dominant factor, for at least the first few years of Sickness, is duration of Sickness. Age becomes dominant at longer durations, where mortality from Sick could be broadly equated to typical insured life mortality plus a constant addition of the order of 10 per mille p.a. (a significantly lower ‘constant’ differential than observed for 1975-78).

(c) Although a single bi-variate ‘table’ of graduated mortality rates was again found to be an acceptable fit to the ‘shape’ of mortality rates across the Deferred Periods, variations in the overall level of rates needed to be recognised, resulting in the rates for DP1 being set at 74% of the graduated mortality rates for all other Deferred Periods combined.

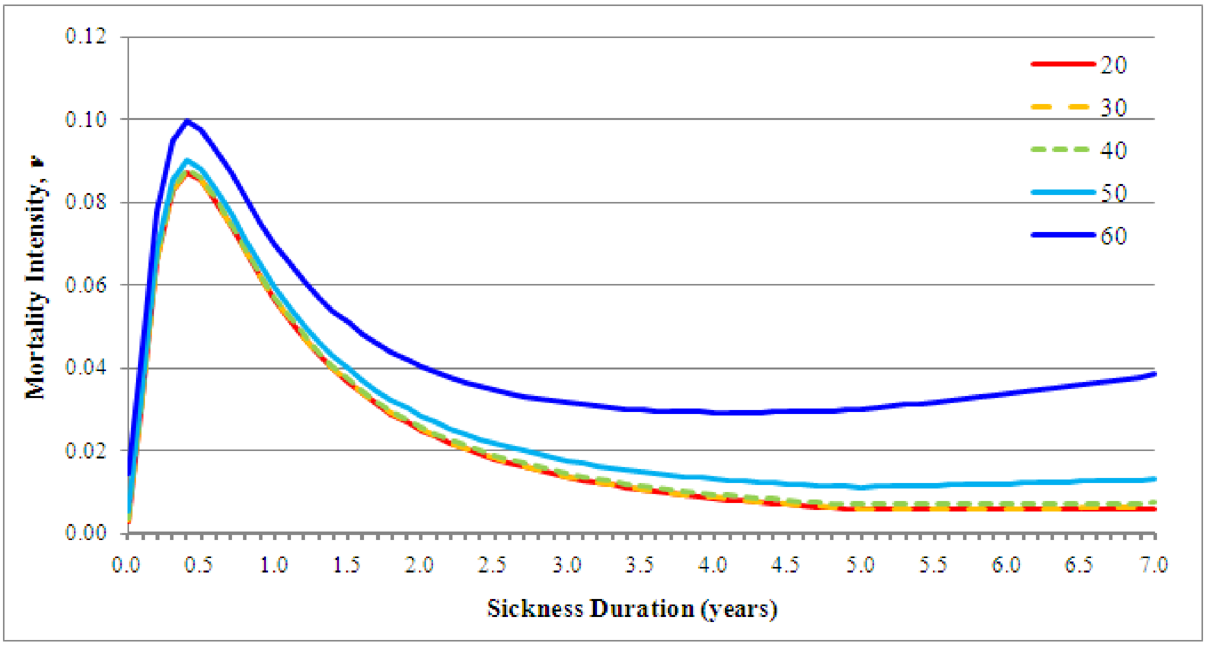
(d) There was again no statistically significant evidence of a ‘run-in’ period similar to that observed for Claim recovery rates.

Sections 5 and 6 of CMI Working Paper 5 provide further details of the investigation and graduation respectively, including sample values of the graduated mortality rates (Tables 2(a) and 2(b)).

For ease of reference, full details of the graduation formula are also shown in Appendix A of this paper.

Graduated mortality rates for sample ages are shown in Figure 3. (The lines also show the projection of mortality rates back to Sickness duration 0 as explained in Section 8 of this paper.)

Figure 3: Graduated mortality intensities by Sickness duration
for Sicknesses starting at selected exact ages; all Deferred Periods except DP1.



8. GRADUATION OF SICKNESS INCEPTION RATES

The investigation and graduation of Sickness Inception rates follows the process outlined in Section 5 of this paper, and in particular uses the graduated Sickness Termination rates (extended back to duration zero) where required to overcome the gaps in our observations (Sicknesses which did not become Claims and so were not recorded).

We require both the Claim records and the In force files for exposure calculations. As we cannot identify Duplicates in the In force data we calculate exposure using the files including Duplicates, and then scale the result down by the ratio of the Claim Inceptions count excluding Duplicates to the Claim Inceptions count including Duplicates. We do this separately for each 'cell' (defined as a unique combination of Age, Sex, Deferred Period and Occupation Class).

Although this may seem a crude approximation as regards the exposure in each cell, we note that the scaling does not alter the observed crude Claim Inception rates but does broadly 'correct' the weight given to each cell in the graduation process.

The calculation of exposure, R, is rather more complex than for a typical mortality investigation. In line with our statistical model, we need to estimate the exposure for 'healthy lives': that is, only the time spent in state H during the investigation period. We need to work through a number of calculation steps:

(i) Before commencing the calculations, note the need to adjust for the timing of observed Claim Inceptions relative to the underlying Sickness Inceptions: a Claim Inception we observe at time T relates to Sickness which started at time $T - d$, where d is the Deferred Period. We must therefore use data relating to calendar year Y to estimate the exposure (to falling Sick) for year '$Y - d$' for each Deferred Period.

(ii) First we calculate policy-years of (central) exposure using a modified census method. Given the known In force at the start and end of each year, Y, we use interpolation (and backwards extrapolation) to estimate the exposure for the year '$Y - d$'. For this we assume exponential, rather than linear, change over time in the In force.

(iii) Next we make the initial step in adjusting from an 'all lives' to a 'healthy lives' basis by deducting the total time spent Claiming during the investigation period. We can calculate this for each year Y directly from the Claims records, and then make the timing adjustment noted in (i), to obtain figures for year '$Y - d$', by using 'growth factors' consistent with those calculated for the In force in step (ii).

(iv) To complete the restriction to 'healthy lives', we then estimate and deduct the total time spent Sick but not Claiming during the investigation period. We calculate this in three parts:

- for known Claims, the Deferred Period;
- for policies where Sickness has not lasted the duration of the Deferred Period, an estimate of the time spent sick;
- for policies where Sickness lasted beyond the duration of the Deferred Period but for which no Claim was made, the Deferred Period *plus* an estimate of the time spent Sick during the run-in period.

(v) We also make an estimated adjustment to remove exposure within a Deferred Period of policy expiry as no Claims could arise from Sickness starting that late in the term.

(vi) Finally, we scale the exposure down for Duplicates, as discussed above, for comparison with the observed Claim Inceptions, I (excluding Duplicates).

As noted in Section 5, to complete our calculations we also need to estimate both π, the probability of a Sickness continuing to the end of the Deferred Period, and η, the probability that a Claim is then made. For this, and for the second and third elements of stage (iii) of the exposure calculation, we use the graduated Sickness Termination rates.

In particular we use estimates of the early duration Termination rates, during the Deferred Period and any run-in period. We take the fitted graduation formula, subject to the modifications described below, and assume (in the absence of other observations) the values it gives for Termination rates at early Sickness durations are reasonable. Thus, in essence, we apply the graduation formula to 'extrapolate' the rates back to duration zero.

The run-in period adjustments to recovery rates (for DP4 and DP13) represent the difference between the observed experience of Claims and the inferred experience of Sicknesses. To estimate π, η, and the exposure adjustments, we need to consider Sicknesses and so we require estimates of early duration Termination rates with the allowance for run-in effects removed.

For DP13 it is sufficient to remove the run-in feature part of the graduation formula before 'extrapolating' back to duration zero. However, for DP4 the run-in feature is more complex and so alternative approaches to the adjustment were discussed in CMI Working Paper 47; only that referred to as "DP4(2)", removing only the allowance for an initial 4-week run-in, is considered in this paper. Although these variants produced markedly different estimates of the Sickness intensities, the estimates of Claim Inception rates for DP4 are close together except at the extreme ages. This confirms the more general point that, although the need to estimate π and η does introduce uncertainty into the graduated Sickness rates, little of that extra uncertainty flows through to the estimates of Claim Inception rates. The Committee plans to use only the DP4(2) variant in its future work.

Estimated values for recovery rates projected back to Sickness duration zero, removing the allowance for run-in effects, are shown by the dotted lines in Figure 2. Similarly, estimated values for mortality rates projected back to duration zero are shown in Figure 3: the extrapolation is simpler than for recoveries as the graduated mortality rates do not have the complication of run-in effects.

Combining the results of all these steps, we calculate crude Sickness Inception rates as $I/(R.\pi.\eta)$ for each cell. The graduation follows the principles set out in Section 5 and, in contrast to the ad hoc formulae required for Termination rates, graduation formulae of the relatively simple form $\sigma(x) = \exp\{ a_0 + a_1.x + a_2.x^2 + a_3.x^3 \}$ proved appropriate for Sickness Inception rates.

As noted earlier, once we have satisfactory graduations of σ, we can also produce Claim Inception rates $i = \sigma.\pi.\eta$.

The key features observed in the Claim Inceptions experience 1991-98, and built into the graduated Sickness and Claim Inception rates, were:

(a) Separate Sickness rates were again required to fit the data for each Deferred Period, with Sickness rates generally falling as the Deferred Period lengthened. However, the two estimates for DP4 are far apart and do not fit this pattern.
(b) There were no strong and consistent features to the pattern of inferred Sickness rates by age, in contrast to the 'U'-shaped feature of the Sickness rates for 1975-78.

(c) Claim Inception rates for DP1 vary little with age over the age range 30 to 60, but are lower for younger ages and higher for older ages.
(d) In contrast, Claim Inception rates for DP4 to DP52 increase steadily with age (apart from an initial fall from age 20 to 30). The rate of increase in Claim Inception rates with age is greater for the longer Deferred Periods, but even then is again considerably less quick than for aggregate (all causes) mortality rates.

These observations are broadly consistent with the results which would be obtained from a model assuming Sickness Inception rates were roughly constant with age and Termination rates declined with increasing age. However, note that the absolute level of both Sickness Inception and Termination rates does vary by Deferred Period.

The graduated values of the Sickness and Claim Inception rates are shown by age, for each Deferred Period, in Figures 4 and 5 respectively.

CMI Working Paper 47 provides further details of the graduation of Sickness and Claim Inception Rates, including full details of the graduation formulae and tables of sample rates (and the corresponding values of π and η). For ease of reference, the graduation formulae and the table of Claim Inception rates are also shown in Appendix A of this paper.

The detail of the calculation in CMI Working Paper 47 is necessarily long and complex. It is hoped that this overview will give the reader a better context in which to see each step, and against which to judge the significance of potential approximation errors.

Finally we note that the larger volume of observed data for 1991-98 compared to 1975-78 has resulted in some further differences between the Sickness models for the different Deferred Periods. Although it remains reasonable, and not inconsistent with the data, to assume some commonality of patterns and features in Terminations experience, the graduations now reflect different levels of Sickness Inception and Termination rates by Deferred Period.

Figure 4: Graduated Sickness Inception intensities, $\sigma(x)$,
by age and Deferred Period.
[Note: The rates shown as DP4 are the DP4(2) variant in CMI Working Paper 47.]

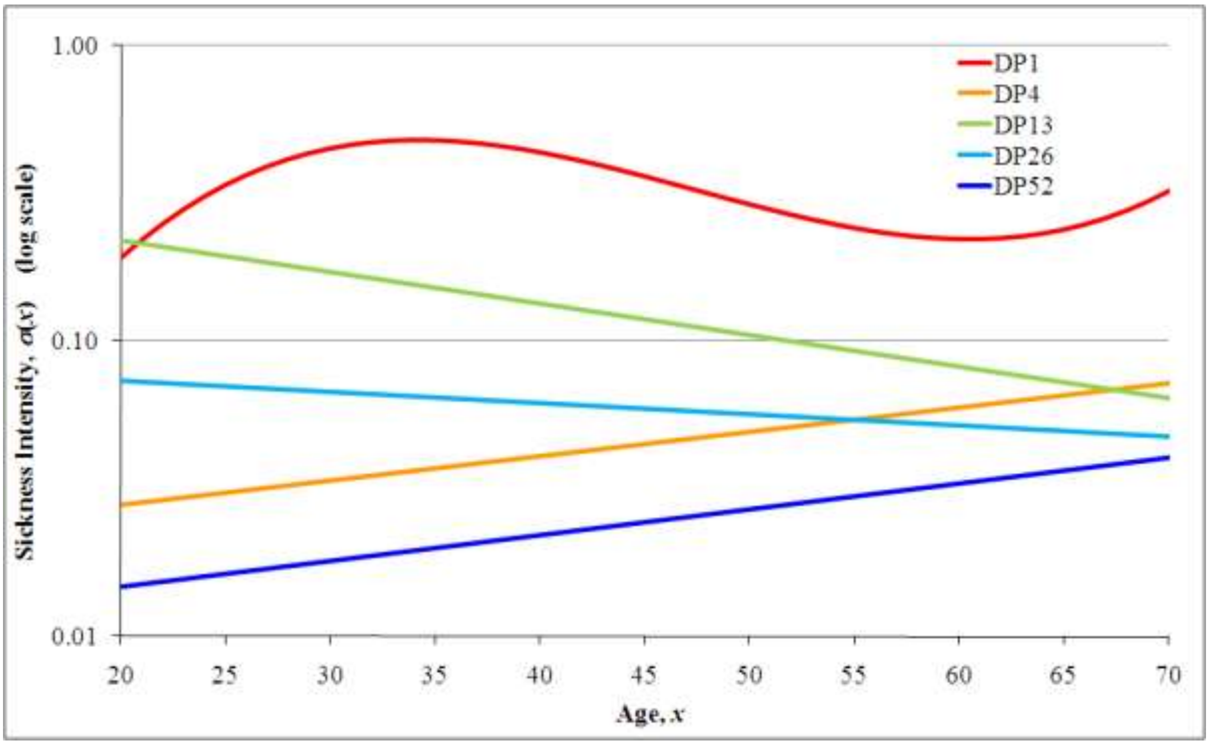
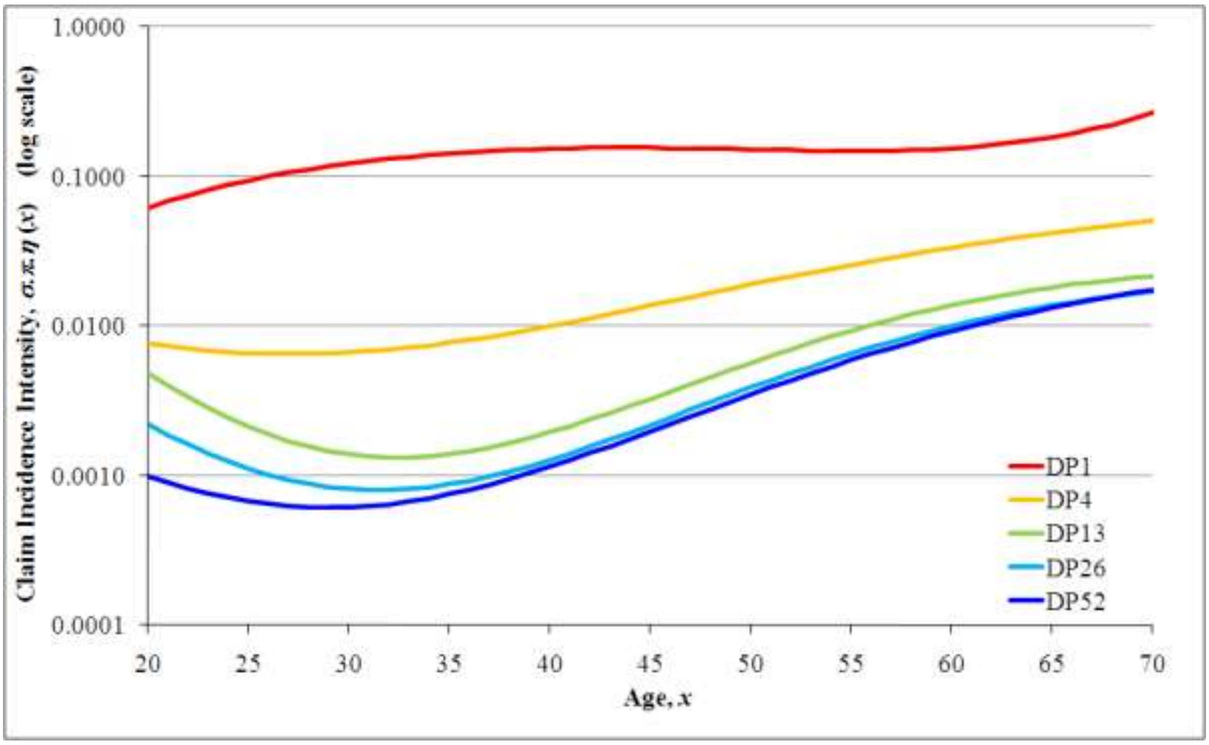


Figure 5: Graduated Claim Inception intensities, $\sigma(x).\pi(x,d).\eta(x,d)$,
by age and Deferred Period.



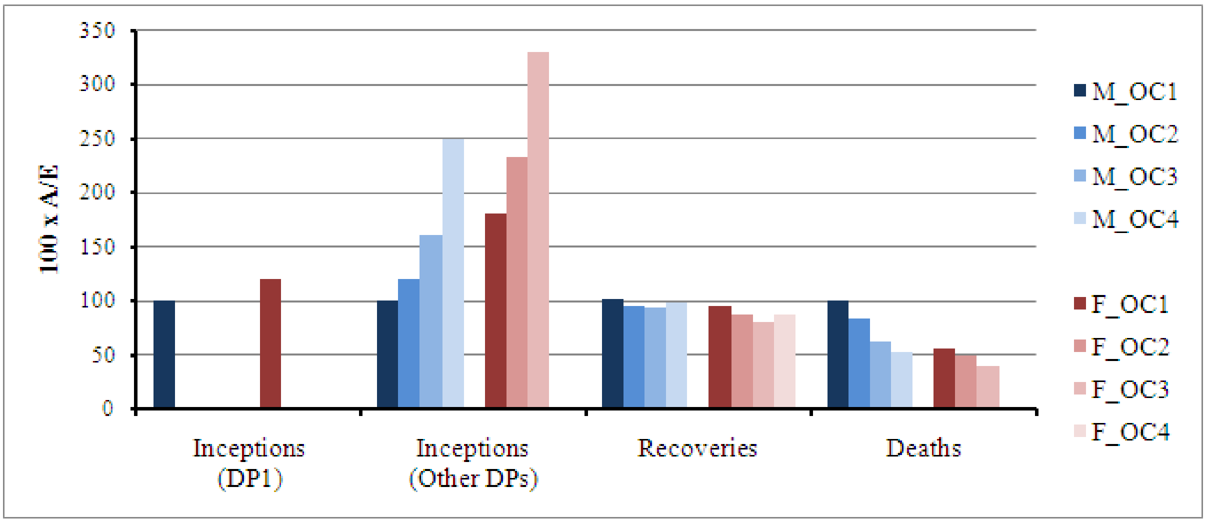
9. OTHER EXPERIENCES FOR 1991-98

The new graduations are derived from the experience of Males in Occupation Class 1 (OC1). In this Section we summarise the experience of other Occupation Classes and of Females; a more detailed analysis is set out in CMI Working Paper 7 (for Claim Terminations) and in Section 10 of CMI Working Paper 47 (for Claim Inceptions).

Figure 6 shows a high-level comparison of the experience by Sex and Occupation Class. The results are expressed as 100 × *A*/*E*, with actual events, *A*, and exposure counted for each subset of the data, and expected events, *E*, calculated using IPM 1991-98 and so reflecting the transition rates observed for Males in OC1. The experiences have been combined across all ages, durations Sick and Deferred Periods (all factors taken directly into account in the graduated rates), except that Claim Inceptions experience is shown separately for DP1.

The results for Males in OC1 are all very close to 100 as expected. The chart then shows considerably more variation in Claim Inceptions experience by Sex and Occupation Class than in Claim Terminations experience.

Figure 6: Variation in Experience for 1991-98 by Sex and Occupation Class,
100 × *A*/*E* measured against IPM 1991-98,
All ages, durations Sick and Deferred Periods combined.



[Note that result bars have been omitted where data volumes are too small to yield useful estimates. This applies to Females in OC4, and to OCs 2, 3 and 4 for DP1 business.]

We observe very significant variations in Claim Inceptions experience by Occupation Class. Ignoring DP1 business (which is almost exclusively OC1), the 100 × *A*/*E* ratios are around 120 for Class 2, 160 for Class 3, and 250 for Class 4, for Males, with a similar pattern of relativities for Females. There is no clear pattern within this by Deferred Period, but further analysis shows that the variation in experience by Occupation Class does have an age component such that within each subset (by OC and DP) the *A*/*E* ratios are generally higher at younger ages (below age 43 or so) than at older ages.

In addition, we observe significantly higher Claim Inception rates for Females than for Males. The differential appears to vary by Deferred Period: for DP1 the 100 × *A*/*E* ratio for Females is around 120% of that for Males; for DP4 it is around 165%; it is around 190% for

DP13 and perhaps a little higher for longer DPs. Although there may be an age component to these differentials, the observed pattern by age varies by Deferred Period and no further analysis has been undertaken as part of this investigation.

In contrast, Claim recovery rates appear to vary relatively little by Occupation Class or by Sex. The bars in the chart do look a little lower for Females than Males, but data is relatively sparse for Females, particularly outside of OC1. Given this limited variation by Occupation Class, the $100 \times A/E$ ratios for all Classes combined are of interest: these are 101 for Males and 96 for Females. For the largest subgroup for Females (OC1, DP1) the all durations $100 \times A/E$ is 91, but the ratios are above 100 for Sickness durations beyond 8 weeks.

There are many fewer deaths in the experience than recoveries, and so the observed pattern of results for mortality in Sickness by Occupation Class is not statistically significant. We do however note that the $100 \times A/E$ for all Classes combined for Males is only 88. Mortality rates for Females are markedly lower with a $100 \times A/E$ of 57 for all Classes combined, around ⅔ of the level of rates for Males (so the ratio of Female to Male mortality rates in Sickness is broadly similar to that observed for all-cause mortality).

Such high-level comparisons as these inevitably gloss over more subtle issues within the experience, data and methodology. In particular, it should be noted that:

(i) The mix of definitions of disability or incapacity applied to each policy and claim may vary by Occupation Class.

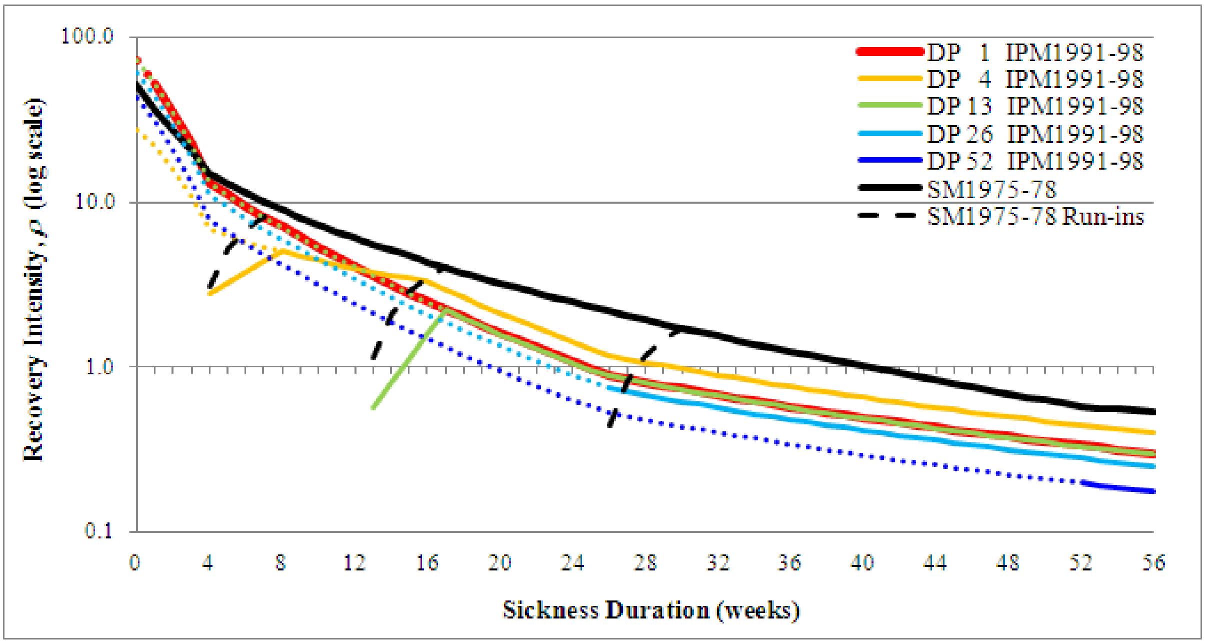
(ii) The comparison of Claim Inceptions experience is imperfect as the calculation of expected Claims requires assumptions on Termination rates (for example, for some of the adjustments to the exposure). Strictly we should use Termination rates applicable to the relevant Sex and Occupation Class, but we only have graduated rates for Males in OC1. However, the distortion of results is small compared to the observed differences in Claim Inceptions experience.

(iii) Further information on the variation in results by Deferred Periods, ages and durations Sick is available through the more detailed analysis set out in CMI Working Paper 7 (for Claim Terminations) and in Section 10 of CMI Working Paper 47 (for Claim Inceptions).

10. Comparison of IPM 1991-98 against SM1975-78

Graphical comparisons of the IPM 1991-98 and SM1975-78 graduated rates for recoveries, deaths from Sick and Claim Inceptions are shown in Figures 7, 8 and 9 respectively.

Figure 7: Graduated recovery intensities for Sicknesses starting at exact age 40, by Sickness duration, for each Deferred Period, for the experience of 1991-98 (IPM 1991-98) and 1975-78 (SM1975-78).



The coloured lines in Figure 7 (for IPM 1991-98) are the same as those shown in Figure 2. The solid black line shows the graduated Sickness recovery rates for SM1975-78; these did not vary by Deferred Period except for the run-in effects (for DP4, DP13 and DP26, which are shown by the dotted black lines).

Comparing the graduated recovery rates for DP1, we see the IPM 1991-98 rates are higher for the first few weeks of Sickness, but fall more sharply relative to the 1975-78 rates as duration Sick increases so that, after about 4 weeks, they are always lower. At 26 weeks Sickness, the ratio of IPM 1991-98 to SM1975-78 recovery rates reaches a low point of around 40%, but it then climbs a little to settle at 55% or so for the longer durations Sick.

As already noted in Section 6 of this paper, the 1991-98 graduations introduced significant differentials in recovery rates by Deferred Period, and also reflect different observations for the run-in periods for DP4 (more complex than SM1975-78) and DP26 (no longer present).

The graduated mortality rates for the 1991-98 experience are significantly lower than those for 1975-78. Ignoring DP1, the ratio of IPM 1991-98 to SM1975-78 mortality rates is around 70% at the peak of mortality at Sickness duration 20 weeks, rises to around 80% after the first year of Sickness, and then falls to around 30% for Sickness durations of 5 years and longer. The new graduations also introduced separate, even lower mortality rates for DP1 (see Section 7 of this paper).

Figure 8: Graduated mortality intensities for Sicknesses starting at exact age 40,
by Sickness duration,
for the experience of 1991-98 (IPM 1991-98) and 1975-78 (SM1975-78).

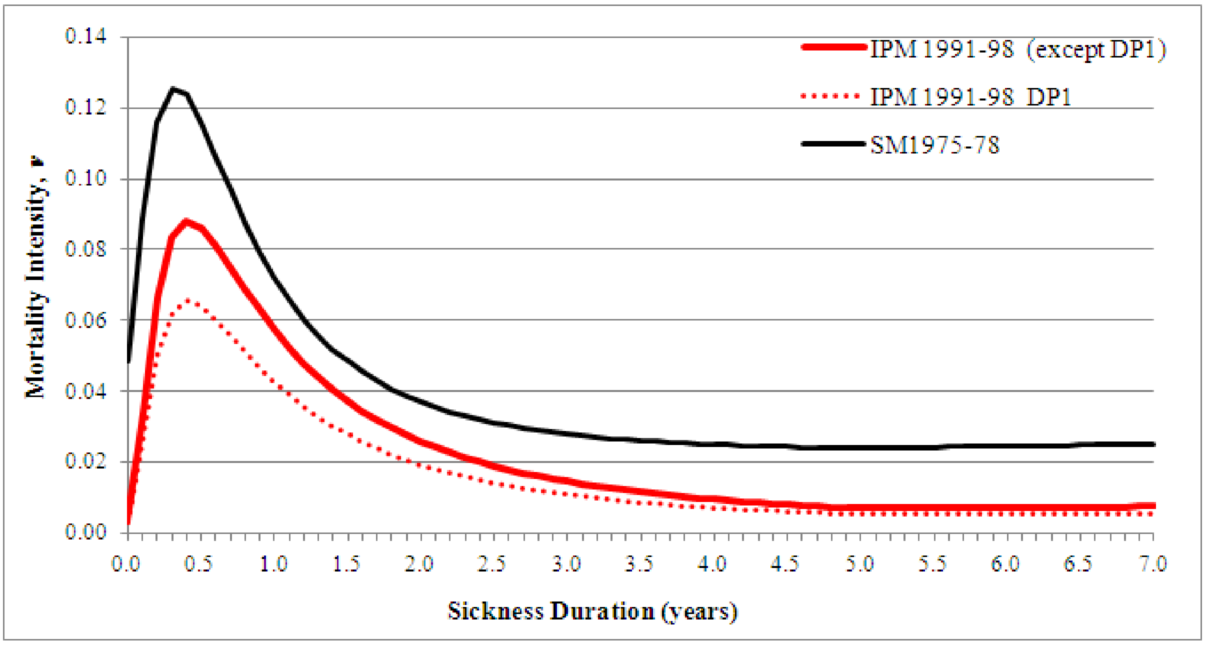
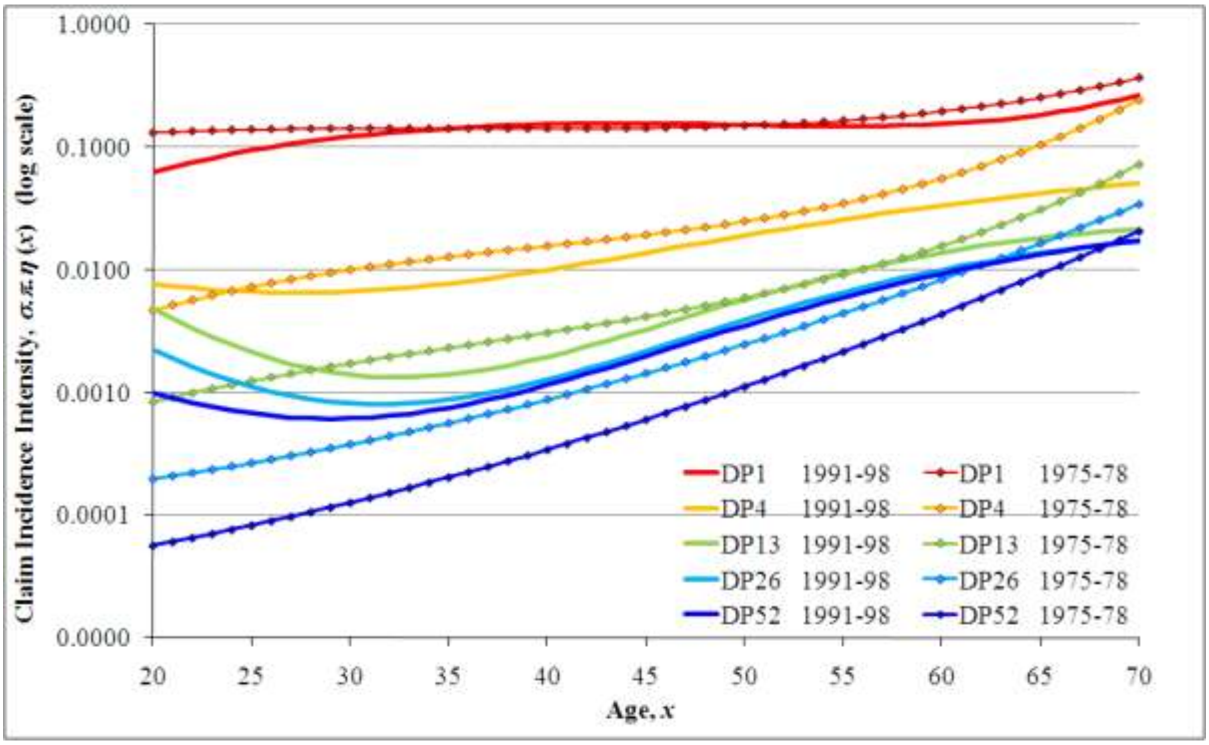


Figure 9: Graduated Claim Inception intensities by age and Deferred Period,
for the experience of 1991-98 (IPM 1991-98) and 1975-78 (SM1975-78).



[Note: The Claim Inception rates shown in Figure 9 have been derived from the graduated Sickness Inception and Termination rates using identical methodology for both SM1975-78 and IPM 1991-98, so that the comparison shown is on a like-for-like basis as regards the underlying experience. The SM1975-78 rates have been adjusted from those published in CMIR 12 for changes in the assumed Deferred Period (in particular to reflect the current view, informed by practitioners, that the effective Deferred Period for DP1 is 6 days not 7) and require some additional assumptions for DP52 for which no formal basis was published for SM1975-78.]

The ratio of the Claim Inception rates based on IPM 1991-98 and SM1975-78 varies significantly by Deferred Period. For DP1 the Claim Inception rates are reasonably similar (after aligning the assumed Deferred Period at 6 days) over the age range 30 to 55, with the new rates being lower at the extreme ages. For DP4 the new rates are around 30% lower at most ages, but are higher at younger ages. For DP13 the comparison is similar to DP4 at most ages, but with greater divergence at younger ages. For DP26 the 1991-98 rates are around 50% higher at most ages (and rather more at younger ages). For DP52, the 1991-98 rates are substantially higher at almost every age, and much closer to the DP26 rates than was the case for the 1975-78 rates. The typical shape of the rates with age, for most Deferred Periods, has changed so that, in general terms, the new rates rise relative to the 1975-78 rates (and in absolute terms) below age 30, and tail down relative to the 1975-78 rates above age 55.

Further information, including a comparison of graduated Sickness Inception rates, is given in Section 8 of CMI Working Paper 47.

To show the context for the movement in graduated rates, Table 2 presents a high-level summary of the CMI Individual IP experience, by quadrennium, over the period 1975 to 2006. Experience deteriorated sharply between 1979-82 and 1991-94, with recovery rates falling and Claim Inception rates rising, especially for the longer Deferred Periods and durations Sick. More recently, experience has improved markedly between 1995-98 and 2003-06; in particular, Claim Inception rates have fallen for each Deferred Period.

Table 2: Summary of CMI Individual IP, 1975 to 2006, by Quadrennium;
100 × A/E relative to SM1975-78;
Males, Occupation Class 1; all ages and durations Sick combined.

	75-78	79-82	83-86	87-90	91-94	91-94	95-98	99-02	03-06
	Standard, Males					Standard*, Males, Occ Class 1			
Inceptions									
DP 1	97	80	93	109	97	98	92	81	70
DP 4	102	73	70	81	75	72	69	52	48
DP 13	99	84	105	98	101	97	86	71	52
DP 26	95	77	116	137	139	141	152	127	98
DP 52	100	133	183	221	272	276	321	269	174
Recoveries									
DP 1	100	109	101	95	100	100	101	96	99
DP 4	100	102	74	63	61	61	53	52	59
DP 13	97	96	67	66	58	49	44	41	56
DP 26	96	77	59	56	48	43	41	42	57
DP 52	75	73	35	64	47	31	29	41	51
Deaths									
All DPs	100	97	77	71	64	63	52	41	52

11. USE OF THE IPM 1991-98 GRADUATIONS

The IPM 1991-98 graduations have been published as formulae for the Sickness Inception and Termination transition intensities. Sample values of the intensities and other key values derived from the graduations have also been presented:

- The table of Claim Inception intensities applicable for 'healthy' lives. (Appendix D of CMI Working Paper 47, repeated as Table A4 in Appendix A of this paper).
- Sample values of the graduated recovery intensities and mortality in Sickness intensities (Tables 1(a) to 1(e), and Tables 2(a) and 2(b), respectively, in CMI Working Paper 5).
- Sample 'continuation tables' (double decrement tables of Claim Terminations showing the proportion of lives remaining Sick at sample Sickness durations for sample ages at falling Sick (Tables 5(a) to 5(e) of CMI Working Paper 5).

The Committee is aware of a number of approaches to the modelling of IP business in use in the UK, including: forms of the multiple state model; Claim Inception rates combined with disability annuities; and elements of a Manchester-Unity style approach. As a result, it is not clear to the Committee which, if any, additional sample values or calculation tools would be of material benefit to practitioners.

Computational procedures for the multiple state IP model were set out in Parts D, E and F of CMIR 12. In particular, they include the derivation of select tables of Claim Inception rates applicable to the full insured population (both Healthy and Sick lives) on two bases:

- Type (a) - Sicknesses commencing between ages $x - d$ and $x + 1 - d$
- Type (b) - Sicknesses commencing between ages x and $x + 1$.

Whilst annual rates of Claim Inceptions for Healthy lives can be derived easily from the Claim Inception intensities, using the same techniques as are used to derive mortality rates from mortality intensities, deriving rates applicable to the full insured population (both Healthy and Sick lives) requires a projection of the multiple state model. Type (a) and Type (b) Claim Inception rates are described further in CMIR12 Part D Section 5. The calculation of these rates is described in CMIR12 Part E Section 5. Type (b) Inception rates are the rates most commonly used for calculation purposes. In practice, it is easier first to calculate Type (a) rates, and then to derive Type (b) rates from them using a relatively simple weighting / interpolation calculation.

The Committee is happy to consider requests to provide additional access to rates or sample calculations, perhaps in spreadsheet form.

12. PLANNED AND POTENTIAL FURTHER WORK

The CMI IP Committee intends next to produce an analysis of the experience for 1999-2006, calculating expected Claim Inceptions and Terminations on the basis of the IPM 1991-98 graduations. It is hoped the results will be published as a CMI Working Paper in the Autumn of 2010.

A report on the experience for 1999-2002 was published in CMIR 22 in November 2005 and an analysis of experience for 2003-06 was issued to CMI member offices in April 2010, but in both cases the basis of comparison was SM1975-78. The new paper will therefore complete the publication of experience for 2003-06, and enable practitioners to study the CMI IP experience of the two most recent quadrennia against the IPM 1991-98 graduations. The paper will therefore be an important step in helping practitioners gain full value from the new graduations.

The Committee also intends to put the IPM 1991-98 graduations forward for adoption by the UK Actuarial Profession in due course. Adoption implies that the 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. Note that adoption would not carry any implication that the graduations are appropriate as a standard for any particular purpose and that it is the responsibility of any actuary or other person using a published table to ensure that it is appropriate for the particular purpose to which it is put.

In offering the IPM 1991-98 graduations for adoption, the Committee intends to put forward only the DP4(2) variant for Claim Inception rates for DP4. Similarly, only the DP4(2) variant will be used for the analysis of experience of DP4 business.

Although the work summarised in this paper has been subjected to extensive peer review within the CMI, additional feedback from practitioners would be very welcome. No formal consultation process is planned on these graduations, and no specific questions are posed within the papers, but the Committee would be pleased to receive any further comments on these graduations. The Committee does not intend to propose the IPM 1991-98 graduations for adoption until after the publication of the next Working Paper, comparing the 1999-2006 experience with the new graduations. The Committee would be pleased to receive any comments by 30 November 2010.

The Committee will also consider whether further work in relation to the presentation and accessibility of the graduations would be helpful for practitioners. As a number of approaches to the modelling of IP business are used in the UK, it is not clear to the Committee which, if any, additional sample values or calculation tools would be of material benefit to practitioners, and so it has no fixed plans in this regard. However, the Committee is happy to consider requests to provide additional access to rates or sample calculations, perhaps in spreadsheet form.

Please send any requests and all feedback on the graduations to:

Neil Robjohns, CMI, Cheapside House, 138 Cheapside, London, EC2V 6BW.
Email: ip@cmib.org.uk Tel: 020 7776 3820

APPENDIX A: THE IPM 1991-98 GRADUATION FORMULAE

A.1 *Sickness Recovery Rates*

The formula for the graduated intensity of recovery from Sickness may be summarised in simple symbolic form as follows:

$$\ln\{\rho\,(d, x, z)\} \;=\; s + f + g + h + q + r$$

where

s is a scalar varying by Deferred Period, d;

f is a polynomial for the age-related dependency;

g is a piecewise linear expression for the trend of $\ln(\rho)$ as a function of the duration variable t, where $t = w / (1+ k.w)$; the slope changes after 26 weeks;

h is an adjustment for the first 4 weeks of Sickness;

q applies only to DP4 and is a linear expression over the duration range 8 to 16 weeks only; elsewhere its value is zero; and

r is a linear expression for the 4-week run-in periods for DP4 and DP13 with different parameters for DP4 and DP13. Its value is zero outside the run-in periods.

Full details of the component terms are as follows:

$s = s(d)$ and $d \in$ {DP1, DP4, DP13, DP26, DP52},

$f = a_1.(X/100) + a_2.(X/100)^2 + a_3.(X/100)^3 + a_4.(X/100).t(Z)$,

$g = -b_1.t(Z)$ for $w \leq 26$;

$g = -b_1.t(26) - b_2 .\{t(Z) - t(26)\}$ for $w > 26$,

$h = \{t(4) - t(Z)\}.\{h_0 + h_1.X/100 + h_2 .t(Z)\}$ for $w < 4$;

$h = 0$ for $w \geq 4$,

$q = -r_1.(16 - w) / 8$ for DP4 if $8 \leq w < 16$;

$q = 0$ otherwise,

$r = -r_2.(8 - w) / 4 - r_1$ for DP4 if $4 \leq w < 8$;

$r = -r_3.(17 - w) / 4$ for DP13 if $13 \leq w < 17$;

$r = 0$ otherwise.

In the above expressions:

z = exact duration of Sickness in years;

$Z = z$ for $z \leq 5$;

$Z = 5$ for $z > 5$;

$w = (365 / 7).Z$, i.e. Z translated to units of weeks;

$t = w / (1 + k.w)$.

x = exact age (in years) at Sickness Inception;

$X = x - 50$ for $z \leq 5$;

$X = x - 55 + z$ for $z > 5$.

(It may be noted that for $z > 5$, $X + Z = (x - 55 + z) + 5 = y - 50$, i.e. attained age relative to an origin of 50.)

The parameters $s(d)$, k, a_1, a_2, a_3, a_4, b_1, b_2, h_0, h_1, h_2, r_1, r_2, r_3 are constants.

The parameter values and their estimated standard errors are:

i	Symbol	c(i)	SE(i)
1	$s(1)$	3.036467	0.029720
2	$s(2)$	3.316474	0.045410
3	$s(3)$	3.025743	0.048326
4	$s(4)$	2.856549	0.053863
5	$s(5)$	2.511347	0.077871
6	k	0.016000	0.001285
7	a_1	–3.080944	0.152614
8	a_2	–6.419924	1.445250
9	a_3	20.048953	6.486295
10	a_4	–0.113352	0.009593
11	b_1	0.195291	0.005383
12	b_2	0.108662	0.009402
13	h_0	0.198289	0.012853
14	h_1	–0.724805	0.069255
15	h_2	0.047682	0.009067
16	r_1	0.622543	0.039663
17	r_2	1.197880	0.056345
18	r_3	1.830356	0.120325

A.2 *Mortality in Sickness Rates*

The formula for the graduated intensity of mortality from Sickness is as follows:

$$\nu(x+z,z) = \left(\frac{a.\exp\{-\frac{b}{Z+c}\}}{(Z+c)^2} + \left(\frac{r}{100}\right).\exp\{s.(X+Z)\} \right).q(d)$$

where

$q(d) = q$ for DP1; $q(d) = 1$ for all other Deferred Periods;

and where the parameters a, b, c, r, s, q are constants;

and where X, Z are, as stated before:

z = exact duration of Sickness in years;

$Z = z$ for $z \le 5$;

$Z = 5$ for $z > 5$.

x = exact age (in years) at Sickness Inception;

$X = x - 50$ for $z \le 5$;

$X = x - 55 + z$ for $z > 5$.

The parameter values and their estimated standard errors are:

i	Symbol	c(i)	SE(i)
1	*a*	0.188906	0.017845
2	*b*	1.081708	0.060205
3	*c*	0.132474	0.019228
4	*r*	0.257331	0.089870
5	*s*	0.149466	0.026343
6	*q*	0.744739	0.039118

A.3 *Sickness Inception Rates*

There are separate graduation formulae for each Deferred Period. The general form of the formula for the graduated intensity of Sickness Inceptions is as follows:

$$\sigma(x) \quad = \quad \exp\{\ b_0.C_0(t)\ + b_1.C_1(t)\ + b_2.C_2(t)\ + b_3.C_3(t)\ \}$$

where:

x = exact age at Sickness Inception;

t = $(x - 40) / 25$.

and the $C_i(t)$ are Chebycheff polynomials in t. These are defined by:

$$C_0(t) = 1$$
$$C_1(t) = t$$
$$C_2(t) = 2t^2 - 1$$
$$C_3(t) = 4t^3 - 3t$$

The parameters b_0, b_1, b_2, b_3 are constants with distinct values for each Deferred Period.

The parameter values (zero if not shown) and their estimated standard errors are:

Parameters	DP1	DP4	DP13	DP26	DP52
b_0	–1.416038	–3.200943	–2.008366	–2.786287	–3.816687
SE(b_0)	0.0529	0.0264	0.0487	0.0526	0.0757
b_1	0.238522	0.474149	–0.614523	–0.216186	0.507200
SE(b_1)	0.0996	0.0505	0.0871	0.0917	0.1399
b_2	–0.588151				
SE(b_2)	0.0621				
b_3	0.333549				
SE(b_3)	0.0379				

[Note: The rates shown as DP4 are the DP4(2) variant in CMI Working Paper 47]

Equivalently the formulae can be expressed directly in terms age, x:

$$\sigma(x) \quad = \quad \exp\{\ a_0\ + a_1.x\ + a_2.x^2\ + a_3.x^3\ \}$$

where the parameters a_0, a_1, a_2, a_3 are constants with distinct values for each Deferred Period. The parameter values (zero if not shown) are:

Parameters	DP1	DP4	DP13	DP26	DP52
a	–8.084687	–3.959581	–1.025129	–2.440389	–4.628207
b	0.529947	0.018966	–0.024581	–0.008647	0.020288
c	–0.012129				
d	0.00008539				

A.4 *Table of Claim Inception Intensities* [*graduated values of* $\sigma(x).\pi(x,d).\eta(x,d)$]
for Males, Occupation Class 1, 1991-98, DP1 to DP52,
by exact age at falling Sick.
[*The rates shown as DP4 are the DP4(2) variant in CMI Working Paper 47.*]

Age Exact	DP1	DP4	DP13	DP26	DP52
20	0.061813	0.007585	0.004846	0.002204	0.000981
21	0.068354	0.007313	0.003997	0.001875	0.000893
22	0.074898	0.007080	0.003338	0.001613	0.000820
23	0.081391	0.006888	0.002825	0.001405	0.000760
24	0.087783	0.006736	0.002427	0.001240	0.000711
25	0.094032	0.006624	0.002119	0.001111	0.000674
26	0.100102	0.006551	0.001881	0.001010	0.000645
27	0.105962	0.006518	0.001698	0.000933	0.000626
28	0.111586	0.006525	0.001561	0.000877	0.000614
29	0.116950	0.006571	0.001461	0.000837	0.000611
30	0.122032	0.006658	0.001391	0.000812	0.000614
31	0.126811	0.006786	0.001349	0.000800	0.000625
32	0.131269	0.006955	0.001329	0.000801	0.000644
33	0.135386	0.007168	0.001332	0.000814	0.000671
34	0.139146	0.007425	0.001355	0.000838	0.000706
35	0.142535	0.007728	0.001399	0.000875	0.000751
36	0.145537	0.008079	0.001463	0.000925	0.000805
37	0.148145	0.008481	0.001549	0.000988	0.000871
38	0.150353	0.008933	0.001658	0.001067	0.000949
39	0.152159	0.009440	0.001792	0.001161	0.001041
40	0.153570	0.010003	0.001954	0.001274	0.001149
41	0.154594	0.010623	0.002145	0.001407	0.001273
42	0.155250	0.011302	0.002369	0.001563	0.001416
43	0.155563	0.012042	0.002629	0.001743	0.001581
44	0.155560	0.012844	0.002928	0.001950	0.001768
45	0.155280	0.013709	0.003268	0.002186	0.001981
46	0.154764	0.014637	0.003653	0.002454	0.002222
47	0.154059	0.015629	0.004086	0.002756	0.002491
48	0.153215	0.016684	0.004569	0.003094	0.002793
49	0.152288	0.017800	0.005102	0.003470	0.003128
50	0.151334	0.018978	0.005688	0.003885	0.003498
51	0.150414	0.020215	0.006325	0.004340	0.003905
52	0.149589	0.021509	0.007013	0.004834	0.004349
53	0.148923	0.022857	0.007749	0.005368	0.004832
54	0.148483	0.024257	0.008530	0.005941	0.005354
55	0.148336	0.025706	0.009351	0.006549	0.005915
56	0.148557	0.027200	0.010207	0.007191	0.006513
57	0.149221	0.028735	0.011091	0.007863	0.007149
58	0.150413	0.030309	0.011996	0.008560	0.007820
59	0.152227	0.031917	0.012914	0.009279	0.008525
60	0.154768	0.033555	0.013836	0.010015	0.009261
61	0.158159	0.035220	0.014754	0.010760	0.010025
62	0.162542	0.036909	0.015658	0.011511	0.010813
63	0.168090	0.038618	0.016540	0.012260	0.011623
64	0.175011	0.040343	0.017392	0.013002	0.012449
65	0.183561	0.042081	0.018205	0.013730	0.013287
66	0.194059	0.043830	0.018973	0.014438	0.014131
67	0.206904	0.045586	0.019689	0.015121	0.014977
68	0.222604	0.047347	0.020347	0.015773	0.015818
69	0.241807	0.049110	0.020941	0.016389	0.016646
70	0.265354	0.050872	0.021469	0.016962	0.017456

APPENDIX B: SUMMARY OF CHANGES TO DATA AND METHODOLOGY

The Individual IP data collected by the CMI, and the methodology employed for the analysis and graduation of the experience, have both been developed significantly since the publication of CMIR 12 in 1991. The overall effect of the changes is small relative to the inherent uncertainty of IP experience (arising for example from the sample size and from variations in experience over time and between offices). Even so, an awareness of the changes is important for those studying the results and reports issued by the CMI IP Committee. The main changes are summarised below.

1991

CMIR 12: Graduation of Sickness Inceptions and Terminations Experience for 1975-78

This is the baseline from which the changes summarised in this Appendix are measured. The following features of these graduations are of particular note:

- CMIR 12 set out the multiple state model for IP business.
- The exposed-to-risk for the Sickness Inceptions analysis was derived from previously calculated exposures for 'Manchester Unity' Sickness periods, with explicit adjustment to remove time spent Sick (whether Claiming or not).
- In the analysis of Claim Inceptions, both Actual and Expected were increased by adding the estimated numbers of 'Non-reported Claims', that is: Sicknesses which lasted beyond the end of the Deferred Period but for which no Claim was made. Using the terminology of Section 5 of this paper, I/η was compared to $R.\sigma.\pi$.
- The experience of the 'Standard' dataset for Males was graduated. At that time, Occupation Class was not recorded in the CMI data, but the Standard dataset excluded all policies which were marked as having an 'Occupational Rating'.
- In graduating Sickness Inception rates, the method required a recursive process of estimation as it derived estimated numbers of Sicknesses from the exposure and the graduated Sickness rates.
- Records with Deferred Periods that were not 1, 4, 13, 26 or 52 weeks were allocated to the next higher of those 5 DP categories.
- The resulting graduations are referred to as 'SM1975-78'.
- Duplicates records could be identified within the Claims data but not in the In force. Duplicate records were removed from the data used for analysis of Terminations experience, but were retained (in both the Claims and In force data) for analysis of Inceptions experience. [Note: This point applies unchanged to the segments below.]

The changes noted in each segment below apply cumulatively, that is: they apply to the segment they are noted in and to all subsequent segments:

1996 to 2009

Published Results: CMIRs 15, 18, 20 and 22, and reports issued to CMI member offices

- SM1975-78 was adopted as the basis for expected Inceptions and Terminations.
- In calculating the exposed-to-risk for the Sickness Inceptions analysis:
    - For Investigation Years 1987 onwards a more direct and exact method, similar to that set out in CMI Working Paper 47, replaced the use of Manchester Unity-type exposures.
    - However. no allowance was made for time spent Sick but not Claiming, so exposures were slightly overstated.

- In the analysis of Claim Inceptions experience, the 'grossing up' for 'Non-reported Claims' was removed so that I was compared to $R.\sigma.\pi.\eta$.
- With the introduction of Occupation Class to the CMI IP data for 1991 onwards, the 'Standard' data subset was replaced by Standard* ('Standard Star') which includes all Occupation Classes and cases with an 'Occupational Rating' (now fewer in number). Results are reported separately for each Occupation Class. (Note that Table 2, above, shows that the difference between Standard and Standard* is not great.)

2004
CMI Working Paper 5: Graduation of Sickness Terminations experience for 1991-98
- The subset of data used for the graduations is Standard* for Males, Occupation Class 1, which represents around half of the whole dataset.
- False One-Day Claims (where it is believed Sickness ended within the Deferred Period and so no Claim arose) were identified and excluded.
- The resulting graduations are the Sickness Terminations parts of IPM 1991-98.

2010
CMI Working Paper 47: Graduation of Sickness Inceptions experience for 1991-98
- The subset of data used for the graduations is Standard* for Males, Occupation Class 1.
- A number of further changes were made in the treatment of data:
    - The definition of a 'Duplicate' Claim record was revised.
    - Further categories of Claim records with invalid data were identified and processed appropriately, including Premature Revivals and Benefit Changes.
    - Records with Deferred Periods not 1, 4, 13, 26 or 52 weeks were excluded.
    - The deferred Periods for DP1 and DP52 were set to 6 (instead of 7) and 364 (instead of 365) days respectively.
- The calculation of exposed-to-risk was further refined, including changes to the way ages are defined and grouped, and the restoration of the deduction for time spent Sick but not Claiming. For this purpose, the number of Sicknesses was estimated directly from the number of Claim Inceptions, avoiding the recursive approach of CMIR 12 but also not taking the exposure into account.
- The resulting graduations are the Sickness Inception part of IPM 1991-98.

2010 onwards
The next sets of Published Results
The CMI IP Committee intends to publish an analysis of the experience for 1999-2006 measured against IPM 1991-98. In addition to the changes incorporated into analysis methodology during the development of the graduations:
- The calculation of expected Claim Terminations has been refined (using shorter time intervals, taking advantage of increases in computer calculation speed).
- The boundaries of Ages and Sickness durations included in the analysis will be increased (for example, Sickness beyond 11 years duration was previously ignored).
- Separate analyses will be carried out for Deferred Periods 0, 2, and 8 weeks.

The Committee intends that the Working Paper on experience for 1999-2006 will include a step by step quantification of the changes between the new analyses and the previously published results (CMIR 22 for the 1999-2002 experience, and the report issued to CMI members in April 2010 for the 2003-06 experience).