ISSN 0954-2388
CMIR **18** (2000)

Continuous Mortality Investigation Reports

Number 18

Institute of Actuaries

Faculty of Actuaries

Published by the Institute of Actuaries
and the Faculty of Actuaries
2000

THE EXECUTIVE COMMITTEE OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU

as on 1 January 2000

INTRODUCTION

The Executive Committee of the Continuous Mortality Investigation Bureau of the Institute of Actuaries and the Faculty of Actuaries has pleasure in presenting this, the eighteenth number of its reports.

The papers presented in this report relate entirely to Permanent Health Insurance (PHI) or, as it is now commonly described, Income Protection Insurance. The first covers the sickness experience for the 1991-94 quadrennium for individual PHI policies. It analyses both inceptions and terminations using the multi-state model approach presented in *C.M.I.R.* **12** in 1991. The methods of analysis are those described in *C.M.I.R.* **15** in 1996.

The second report covers the experience of group PHI policies in the same quadrennium. It uses the same methodology as the first paper to analyse claim terminations for this business and reports on the combined experience of individually costed and unit costed business. The volume of individually costed in force business submitted did not make an analysis of inception experience possible for this business and indeed collection of in force data for group PHI business has now ceased.

The other two papers are research papers written by Athol Korabinski and Prof. Howard Waters of Heriot-Watt University. Using data supplied by the Bureau, the two papers look at claims experience in the period 1987-1994 for individual PHI policies. One paper considers inceptions and the other terminations. The papers use two different methods to analyse and model the data, a generalized linear model and credibility theory. 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. It should be noted 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.

The six months since the publication of the last C.M.I. Report, Number 17, has been a very busy one for the Bureau.

This Report and the publication to member offices of individual PHI results for 1995 and 1996 evidence the progress on the PHI investigation. Data collection for more recent years is progressing well and the Bureau looks forward to producing annual results and quadrennial reports in much improved timescales. The Windows version of the Standard Tables Program has been launched and incorporates the "92" Series of mortality tables based on the 1991-94 mortality experience. At the time of writing the 1995-98 mortality experience is being analysed with the aim of publishing results in the first half of 2000, initially on the profession's web site and then in the next Report in this series.

One of the Bureau's main priorities is to establish a successful Critical Illness investigation. The original investigation was launched in 1995 but has not attracted sufficient data to make publication of results worthwhile. Whilst the Bureau is grateful to those offices that have contributed data to the investigation, it is imperative that additional contributors are recruited. This is being progressed by the recently formed Critical Illness Sub-Committee and we are also liaising with the profession's Health Care Study Group who have themselves conducted an investigation in this area. A revised and more flexible set of data requirements is being developed and the investigation will be "re-launched" during 2000.

I would like to thank all those involved in the preparation of these reports and the other work of the Bureau, but in particular the offices who support us both financially and by providing us with data. I would also like to thank the Secretariat of the Bureau, Alden Press and, very importantly, the members of the Executive Committee and the Sub-Committees.

Finally, I must mention my immediate predecessor as Chairman of the Executive Committee, Colin Kirkwood. Colin retired from his roles with the Bureau on 1 July 1999 after twenty-five years of service on the Executive Committee, the last five of these as Chairman. During this time there have been sixteen CMI Reports and two sets of mortality tables and Colin had a hand in most of them. He was particularly involved in the recent publication of the "92" Series of tables. His vast experience and guiding hand will be greatly missed by all associated with the Bureau.

January 2000

P J Nowell
Chairman, Executive Committee

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SICKNESS EXPERIENCE 1991-94 FOR INDIVIDUAL PHI POLICIES

KEYWORDS

Individual PHI; Inceptions; Terminations; Occupational class

EXECUTIVE SUMMARY

This report presents the results of an analysis of the claims experience for individual PHI policies for the quadrennium 1991-94. The analysis is based on the mathematical model for the analysis of PHI data described in *C.M.I.R.* **12** (1991). The methods of analysis used for claim inceptions and claim terminations are those described in two reports in *C.M.I.R.* **15** (1996). The quadrennium featured the first collection by the C.M.I. Bureau of the PHI data split by occupational class.

The key points arising from the analysis are described below.

- The bulk of the results presented relate to the Standard* data set where data is analysed by occupational class, where known. For the purposes of compatibility with previous quadrennia, the results of the Standard experience are also presented. Paragraph 2.2 describes the two data sets.
- Volumes of data submitted to the investigation showed a small increase on the previous quadrennium, but did decline in the latter two years of the quadrennium.
- Not all contributors could provide information on occupational class. Also, volumes of data for other than Class 1 are low for some sections of the data, particularly DP1, DP52 and females.
- Inception experience for the shorter deferred periods, DP1 and DP4, was somewhat lighter than the previous quadrennium for both males and females.
- Inception experience for males for the longer deferred periods, DP13, DP26 and DP52, was generally heavier than the previous quadrennium but only significantly so for DP52.
- Inception experience for females was significantly heavier than the previous quadrennium for DP26 but a little lighter for DP13 and DP52.
- Female inception rates remain significantly higher than male rates for all deferred periods.

- Overall recovery rates have continued to decline for both males and females, continuing the trend observed over the previous two quadrennia.
- Female recovery rates were lower than male recovery rates, though less marked than the difference in inception rates.
- 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.

1. INTRODUCTION

Several reports have been published to date covering the sickness experience for individual PHI policies.

The first report, published in *C.M.I.R.* **2**, 1 (1976) described the experience of 1972 and 1973 and compared actual weeks of sickness with those expected on the basis of the Manchester Unity A. H. J. table. Inception rates for quinquennial age groups were also tabulated. The report also described the data coding system and computer processes.

The second report, *C.M.I.R.* **4**, 1 (1979) described the experience of 1972-75 and a graduated Manchester Unity-type table and inception rate table based on that experience.

The third report, *C.M.I.R.* **7**, 1 (1984) described the experience of 1975-78 and a graduated Manchester Unity-type table and inception rate table based on that experience. It also introduced the concept of Standard data which is an elite subset of the overall Aggregate data.

The fourth report, *C.M.I.R.* **11**, 113 (1991) described the experience of 1979-82 using the 1975-78 graduated rates as the comparison basis.

The above reports all relied on the traditional Manchester Unity approach to analysing PHI data. Most practical PHI pricing has for many years been based around an inception/disability annuity approach. Although some analysis of inception rates had been carried out in these reports, they contained no analysis of termination rates. *C.M.I.R.* **12** introduced a multiple state model for PHI which reconciled the two approaches. The individual male Standard data for 1975-78 was used to develop graduated transition intensities between healthy and sick, sick and healthy and sick and dead.

Two subsequent reports used the model to compare the experience of subsequent data sets with the graduated rates based on individual Standard data for 1975-78.

One report, *C.M.I.R.* **15**, 1, compared actual and expected inceptions for, *inter alia*, the quadrennia 1975-78, 1979-82, 1983-86 and 1987-90 in respect of individual PHI data. The report described the methodology that has been used to analyse inceptions in this report.

A second report, *C.M.I.R.* **15**, 51, compared actual and expected recoveries and deaths of those sick and claiming under PHI policies for, *inter alia*, individual PHI business in 1975-78, 1979-82, 1983-86 and 1987-90. The report described the methodology that has been used to analyse claim terminations in this report.

With effect from 1991, the investigation started to collect data sub-divided by occupational class. Some offices could not provide information on occupational class from that year but started in a later year. Others could not provide it for any year in the 1991-94 quadrennium and others could provide only claims data sub-divided by occupational class but not in force data. The quadrennium was something of a transition period in this respect but the PHI Sub-Committee still feel that useful results can be produced on experience by occupational class.

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. To address the need for more timely information an article was published in the November 1996 issue of *The Actuary* giving a short report on the 1991-94 experience collected to date. This was published with a health warning that the data was both incomplete and was likely to contain errors which would be subject to subsequent corrections. Nonetheless the PHI Sub-Committee trust that the profession found the interim information useful and are planning to publish similar updates in future.

It is pleasing that data collection for years subsequent to the 1991-94 quadrennium is much more up to date and it is envisaged that future reports will be published within a much reduced timescale, though this may nevertheless require some data being excluded from the investigation if it is not available in time.

2. THE INVESTIGATION OF PHI EXPERIENCE BY OCCUPATIONAL CLASS

2.1 *Classification*

The PHI Sub-Committee wishes to express its gratitude to Alan Jefferies, who has since retired from the Sub-Committee, for his work in developing the C.M.I. Bureau's approach to investigating the effect of occupational class. The approach adopted is for offices to submit data using their own internal class coding field. Each internal class code is then converted to the most appropriate of four C.M.I. standard classes for analysis purposes, based on an inspection of internal rating guides kindly provided by the office. The classes used by the C.M.I. Bureau can broadly be described as follows:

Class 1 Professional, managerial, executive, administrative and clerical classes not engaged in manual labour.

Class 2 Master craftsmen and tradesmen engaged in management and supervision; skilled operatives engaged in light manual work in non-hazardous occupations.

Class 3 Skilled operatives engaged in manual work in non-hazardous occupations.

Class 4 Skilled and semi-skilled operatives engaged in heavy manual work or subject to special hazard.

There will undoubtedly be inconsistencies introduced and the same life insured by two different offices could, in some cases, end up in two different C.M.I. classes. However, the PHI Sub-Committee believes that there will still be useful information to be gained from the analysis. Using a telecommunications analogy, there will be a lot of noise but the underlying signal should still be strong.

2.2 *The Standard* subset*

Since the 1975-78 quadrennium, the main analyses carried out by the Bureau have been based on an elite subset of the overall data known as the Standard data. The Standard data consists of UK policies with no occupational rating, no special benefit types (e.g. lump sums) and no identifiable underwriting exclusions. Since 1991 offices have submitted data containing the old "occupational rating" field and the new occupational class coding field. It is apparent from an examination of the data that some offices have interpreted occupationally rated as "not Class 1" and others have adopted a different definition. This is likely to have been the case in previous quadrennia. It appears, though, that the great majority of the Standard data, probably over 95%, is Class 1.

To make use of the occupational information a new subset of the total, or Aggregate, data has been defined. This uses the same criteria as for the Standard data but ignores completely the contents of the "occupational rating" field. It therefore represents a larger subset than the Standard data and consists of UK policies with no special benefit types and no identifiable underwriting exclusions and has been designated Standard*.

The inception and termination experience for the Standard* data is presented for the four occupational classes described above. Not all offices, however, could provide a complete breakdown of their business by occupational class for all their data. This might arise for a number of reasons:

- None of the data could be coded by occupational class for any year.
- Coding by occupational class was possible for some years (usually the later years) only.
- Only part of the office's portfolio can be coded by occupational class.

This required a fifth subset of the Standard* data, "Class Unknown", to be analysed. This presents no special problems with the analysis of terminations. The analysis of inceptions requires consistent coding by occupational class for three sets of data, in force at both the beginning and end of a year and claims during the year.

Where there are clear inconsistencies (e.g. claims and year end in force data is coded by occupational class and year beginning data is not) all inception experience is analysed under "Class Unknown". This approach has also been adopted where there appears to be some inconsistency e.g. the proportion of business coded as having unknown occupational class differs markedly between the beginning and end of year in force or between in force and claims. Some offices could only code claims data by occupational class but not in force so the proportion of "Class Unknown" business is significantly lower for the termination analysis than for the inception analysis. It is expected that the proportion of "Class Unknown" will reduce in future years.

It is likely that for the future the Standard* experience only will be published. For the purposes of comparability with previous quadrennia this report also contains the Standard experience used in previous reports.

3. THE DATA

3.1 *Description of the data*

The data received by the C.M.I. Bureau is detailed and consists of a record for each in force policy in respect of each year end. Each claim which is in force during an investigation year will also generate one or more records for that year, thus one claim which spans several years will generate at least one separate record in each investigation year. All records contain fields describing the attributes of each policy and claims records contain additional fields relating to the duration and other features of the claim. A full description of the format of the data was given in *C.M.I.R.* **2**, 3-10 although a few amendments have been made subsequently. The most significant amendment is the addition of a field to record the office's own occupational class.

3.2 *Features of the data*

A detailed breakdown by attribute of the data analysed is given in Table A1 of the Appendix. It shows for the Aggregate data, together with the Standard and Standard* subsets, the number of policies in force at the beginning and end of each investigation year summed across all four years in the period. It also shows the number of claims records similarly summed across the four year period.

The following features emerge from this table and an examination of similar tables in respect of earlier quadrennia.

Figure 1 below shows the comparison of the volume of Aggregate in force and claims records submitted for individual PHI business in the previous three quadrennia. The in force volumes are calculated as the average of the in force number of policies at the beginning and end of each year and therefore represent a broad measure of exposure by "policy years in force". The claims volumes are measured by the total number of claims records received. It is pleasing to note that the volume of data available to the investigation has again increased, although at a somewhat slower rate than for earlier quadrennia. The PHI Sub-Committee are keen to ensure that the investigation has access to the largest possible volume of industry data and any new contributors are welcome. Potential contributors should be aware that the C.M.I. Bureau will now accept data in "own format" and perform the conversion to the standard format used in the investigation, if this is more convenient to contributors.

The Standard data represents about 79% of the Aggregate in force data and about 74% of the Aggregate claims data. The Standard* data represents about 95% of the Aggregate in force data and some 90% of the Aggregate claims data.

The breakdown of the Aggregate data and the Standard and Standard* subsets by deferred period is shown in Table 1 below.

The breakdown of the data by sex is very similar for all three data sets. For both Aggregate and Standard* data sets females account for some 14% of the in force records and some 12% of the claims records. For the Standard data set females account for some 15% of the in force and some 13% of the claims records.

It is particularly interesting to look at the composition of the three data sets by occupational class (as allocated by the C.M.I. Bureau from the offices' own coding of occupational class). The percentage of data coded for each occupational class and the percentage of data coded where each class was unknown are shown in Table 2 below.

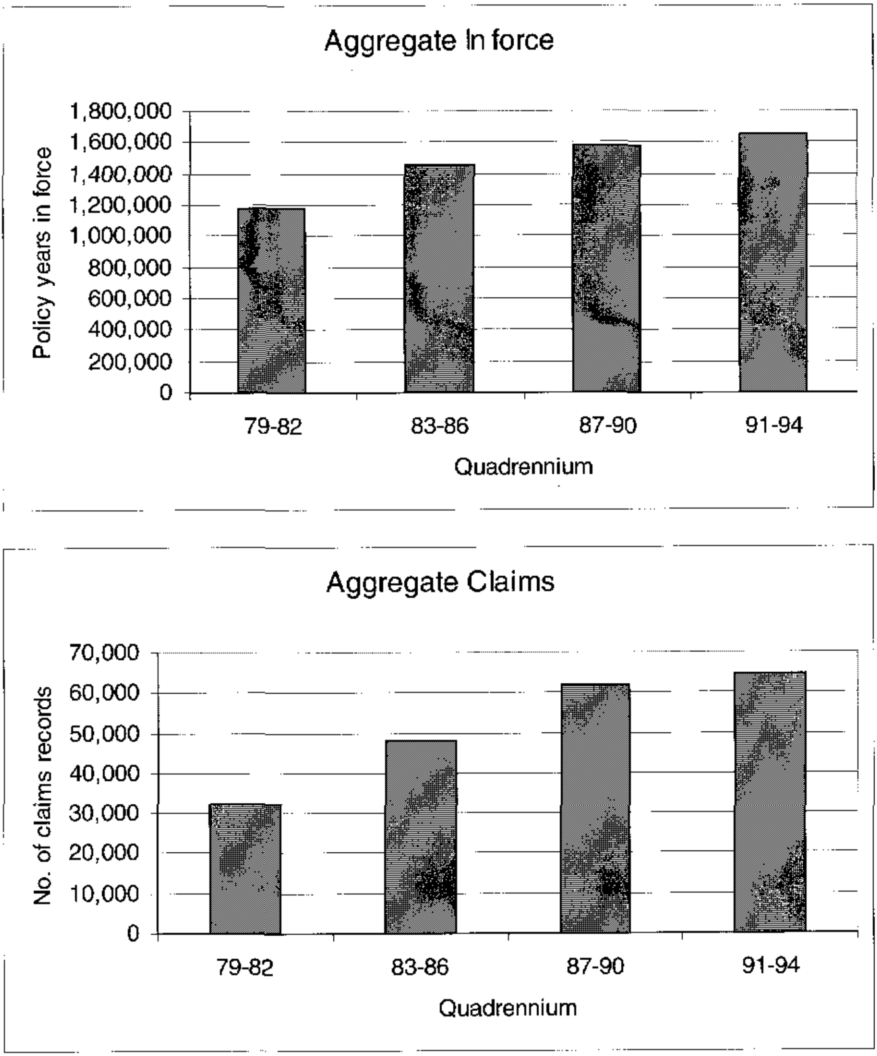

Figure 1. Comparison of volumes of Aggregate data for individual PHI business in 1979-82, 1983-86, 1987-90 and 1991-94.

Table 1. Individual PHI 1991-94. In force and claims. Aggregate, Standard and Standard* data. Percentage of data by deferred period.

Deferred Period	In force records			Claims records		
	Aggregate %	Standard %	Standard* %	Aggregate %	Standard %	Standard* %
1 week	7	8	7	38	45	37
4 weeks	20	14	20	25	16	24
13 weeks	30	29	30	18	16	18
26 weeks	29	33	29	14	17	15
52 weeks	14	16	14	5	6	6
	100	100	100	100	100	100

Table 2. Individual PHI 1991-94. In force and claims. Aggregate, Standard and Standard* data. Percentage of data by occupational class.

CMI allocated occupational class	In force records			Claims records		
	Aggregate %	Standard %	Standard* %	Aggregate %	Standard %	Standard* %
Class 1	47	56	46	67	81	62
Class 2	5	2	5	5	2	4
Class 3	3	1	3	6	3	3
Class 4	2	0	2	5	1	3
Class Unknown	43	41	44	17	13	28
	100	100	100	100	100	100

The following comments apply to Table 2.

- It would appear from the column covering Aggregate in force that, where the occupational class is known, over 80% of the data relates to Class 1 policies.
- The Standard data set contains some policies which are not Class 1 though the proportion, based on cases where the occupational class is known, would appear to be of the order of 5%. This is as a result of some offices coding policies as not occupationally rated when they are in fact not

Class 1. It seems reasonable to suppose that similar coding practices were adopted for earlier submissions and that Standard data sets used to produce results in respect of earlier quadrennia contained a small proportion of non-Class 1 business.

- Some offices could not submit in force data coded by occupational class but could submit claims data so coded. This is reflected in the much lower proportion of claims records for which the occupational class is unknown.
- The Standard* claims data shows a greater proportion of "Class Unknown" business. This reflects the fact that some data is treated as Class Unknown for the purpose of the analysis of inception rates by occupational class where there is reason to believe that there may be inconsistency between the coding of claims and in force by occupational class for a particular office in a particular year.

Only a very small proportion of the data relates to non-UK policies. The amount involved is less than 1% of the total data and relates mainly to the Republic of Ireland.

A second, perhaps more informative, way of looking at volumes of data is by the number of significant 'events' – claim inceptions and claim terminations by recovery and death. A breakdown of the analysed events for the Standard experience for each deferred period is shown in Table 3 below.

It can be seen that the number of terminations by recovery and death is much less than the number of inceptions. The principal reason for this is that the terminations exclude suspected duplicate policies whereas the inceptions do not. In addition, the terminations exclude policy expiries at the policy termination date. Also terminations do not directly correspond to inceptions, some terminations

Table 3. Individual PHI 1991-94. Volume of data by number of analysed events. Standard data by deferred period.

Deferred period	No. of inceptions	%	No. of recoveries	%	No. of deaths	%
1 week	13,297	64	5,508	61	67	12
4 weeks	3,065	15	2,004	22	112	20
13 weeks	2,104	10	1,052	12	179	32
26 weeks	1,590	8	386	4	146	26
52 weeks	602	3	77	1	56	10
Total	*20,658*	*100*	*9,027*	*100*	*560*	*100*

relating to inceptions prior to the investigation period and some inceptions being continuing claims at the end of the period.

The Standard* data can also be analysed by C.M.I. occupational class within deferred period as shown in Table 4 below.

It can be seen that most of the data that could be occupationally coded is Class 1. Although there are significant volumes of data for Classes 2, 3 and 4

Table 4. Individual PHI 1991-94. Volume of data by number of analysed events. Standard* data by occupational class within deferred period.

Occupational class	No. of inceptions	%	No. of recoveries	%	No. of deaths	%
DP1						
Class 1	13,171	99	5,497	99	67	95
Class 2	1	0	21	0	1	1
Class 3	0	0	30	1	2	3
Class 4	2	0	2	0	1	1
Class Unknown	199	1	11	0	0	0
DP4						
Class 1	2,185	34	1,718	38	88	50
Class 2	365	6	562	13	23	13
Class 3	463	7	1,195	26	24	14
Class 4	443	7	772	17	17	10
Class Unknown	2,978	46	260	6	23	13
DP13						
Class 1	848	27	472	29	104	46
Class 2	161	5	198	12	19	8
Class 3	105	4	231	14	24	11
Class 4	120	4	237	15	19	8
Class Unknown	1,877	60	477	30	60	27
DP26						
Class 1	788	44	208	47	88	57
Class 2	73	4	44	10	10	7
Class 3	49	3	28	7	9	6
Class 4	41	2	31	7	2	1
Class Unknown	829	47	129	29	45	29
DP52						
Class 1	302	46	34	38	36	64
Class 2	18	3	6	7	1	2
Class 3	24	4	7	8	3	5
Class 4	4	0	5	5	0	0
Class Unknown	307	47	38	42	16	29

for DP4, DP13 and DP26, there is little data for DP1 and DP52. The problem of paucity of data is exaggerated for the female data.

For all deferred periods but DP1, a substantial proportion of the data is coded as Class Unknown. The proportion is larger for inceptions because some data was analysed as Class Unknown even though the claims data was coded by occupational class. This arose because either the beginning or end of year in force data was not so coded or because it was suspected that coding between claims and in force was inconsistent.

4. CLAIMS EXPERIENCE · STANDARD DATA

4.1 *Inceptions*

The methodology for analysing claim inception experience of PHI business was set out in *C.M.I.R.* **15**, 1. The same methodology and table layout is used in this report. The basic approach is to compare actual inceptions with those expected on the basis of the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

The report in *C.M.I.R.* **15** featured tables giving brief summaries of the analyses of claim inceptions on individual PHI policies for each quadrennium in the period 1975-90. Tables A2.1 and A2.2 in the Appendix are updates of those tables with the addition of the experience for 1991-94. The tables show values of $100A/E$ for each deferred period and a confidence interval of ± 2 standard deviations. The tables in this report also show the number of actual inceptions in each experience and omit $100A/E$ and confidence intervals where the number of inceptions is less than 10.

Figures A1.1 and A1.2 in the Appendix show the same information graphically. No results are shown graphically if the number of actual inceptions is less than 10.

The detailed results are set out in Tables A3.1 and A3.2 in the Appendix to this report covering the male and female experiences respectively. The tables show a statistical analysis of actual claim inceptions, labelled AINC, against expected inceptions, labelled EINC, for quinquennial age groups for each sex and deferred period. The tables also show a statistical analysis of actuals against a modified value of expected, labelled EINC*, where σ_x has been multiplied by a factor required to make the total number of expected claim inceptions equal to the total actual number (this is the factor shown as a percentage at the foot of the 100xA/E column). A more detailed description of the methodology is given in the earlier report.

The statistical tests described in Section 3 of the report in *C.M.I.R.* **15** incorporate a variance ratio to allow for the presence of duplicate policies in the data.

The ratios are different for each deferred period and are those used in *C.M.I.R.* **12**, Part C, paragraph 1.2 for the graduation of the sickness intensity, σ_x. They were derived from an analysis of 1975-78 Aggregate data.

The results in Tables A3.1 and A3.2 suggest that the values of Z and Z* and the corresponding values of χ^2 are overstated. In some cases, the χ^2 tests indicate that the modified values of expected inceptions do not give a good fit whereas a visual inspection suggests that this might not be the case. This in turn suggests that the variance ratio incorporated in the calculation of Z and Z* may be too low or, put another way, the extent of duplicate policies in the data has increased significantly since the 1975-78 quadrennium. This has been confirmed by subsequent investigation. The variance ratios have not been adjusted for the purposes of this report due to time constraints but will be adjusted for future analyses.

The following features are apparent:

The experience, in terms of claim inceptions, is generally lighter than the previous quadrennium for the shorter deferred periods, 1 and 4 weeks. This applies to males and females.

The 13 week deferred period business experience is slightly higher for males and somewhat lower for females than the 1987-90 experience but there is considerable overlap of confidence intervals.

The experience for the longer deferred periods seems generally worse than 1987-90 for D26 females and D52 males, but not significantly different for D26 males and D52 females.

The female experience remains significantly worse than the male experience for all deferred periods.

Readers should exercise caution when attempting to draw conclusions about trends from these results. There is considerable variation of experience between offices and the combined results can be influenced by changes in the mix of offices contributing from year to year. Other factors may also mask any trends in the underlying morbidity, for example changes to underwriting practices and claims control procedures.

4.2 *Terminations*

The methodology for analysing the claim termination experience for PHI business was set out in *C.M.I.R.* **15**, 51. The same methodology and table layout is used in this report. Actual deaths and recoveries are compared with those expected on the basis of the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A4 of the Appendix contains a comparison of the values of $100A/E$, for all ages and durations combined, with those applying to the previous four quadrennia. Values based on fewer than 30 events are shown in *italic*; values where the value of either $p(+/-)$ or $p(B)$ is less than 0.025 are shown in **bold**. No results are shown where the number of actual events is less than 10.

The results in Table A4 are illustrated graphically in Figures A2.1-A2.4 in the Appendix. In addition to the $100A/E$ results shown in the tables, the figures also illustrate a confidence interval, the lower limit being $100(A - 2\sqrt{E})/E$ and the upper limit being $100(A + 2\sqrt{E})/E$. As with Table A4, no results are shown when the number of actual events is less than 10.

The detailed results and statistical analysis of the results are summarised in Tables A5.1-A5.4 of the Appendix for male recoveries, female recoveries, male deaths and female deaths respectively. Readers are referred to the report in *C.M.I.R.* **15** for a full description of the tables and the statistical analysis used.

Note that the statistical analysis is carried out on two bases for expected events. Firstly, they are based on "E", the expected events on the basis of the males, individual policies, Standard experience for 1975-78. Secondly, they are based on "adjusted E", which is equal to the expected number of events multiplied by the overall ratio of actual to expected events for that combination of sex, deferred period and type of event. The purpose of this dual statistical analysis is to indicate whether any lack of fit relates only to the level of the comparison basis rather than the "shape".

The following features are apparent:

For both males and females, overall recovery rates have continued to decline. This continues a trend observed over the previous two quadrennia. This pattern, though, is not observed for 1 week deferred period business where recovery rates have increased somewhat. However, this experience is dominated by recoveries in the first few weeks of sickness.

Overall female recovery rates are lower than the male rates as has been observed in previous quadrennia. The difference though is much less marked than for inceptions. The female data, however, is comparatively sparse and confidence intervals are correspondingly wide.

The pattern of overall actual vs expected recovery rates by duration of sickness for males is similar to that observed in the previous two quadrennia but is different from that for males 1975-78 on which the graduated rates, and hence the expected numbers of recoveries, were based. The pattern involves A/E exceeding 100% in the first 3 weeks of sickness and then declining with duration of sickness until a point in the second half of the first year of sickness. Thereafter, A/E values increase with the duration of sickness. A similar pattern is observed for females.

Overall male death rates have also continued the declining trend observed over the previous two quadrennia, though the data is relatively sparse and confidence intervals are correspondingly wide. There is very little female deaths data.

5. OCCUPATIONAL CLAIMS EXPERIENCE - STANDARD* DATA

5.1 *Inceptions*

The same methodology is used for analysing the Standard* data set as was used to analyse Standard data as described above. This involves a comparison of actual inceptions with those expected on the basis of the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. The results are presented in the same basic format, the difference being that the volume of information increases by a factor of six. This results from the tabulations for each sex and deferred period requiring a further subdivision into tables for Classes 1 to 4, Class Unknown and all business combined.

The results are summarised in Tables A6.1 and A6.2 in the Appendix which show, for each occupational class within deferred period, values of $100A/E$ and a confidence interval of ± 2 standard deviations. The tables also show the number of actual inceptions. Figures A3.1 and A3.2 in the Appendix show the same information graphically. No value of $100A/E$ or confidence interval is shown where the number of actual inceptions is less than 10. Tables A6.1-A6.2 and Figures A3.1-A3.2 are similar in appearance to Tables A2.1-A2.2 and Figures A1.1-A1.2, but the latter compare experience across quadrennia and the former compare experience of occupational classes within a quadrennium.

Tables A7.1-A7.10 show a statistical analysis of actual claim inceptions, labelled AINC, against expected, labelled EINC, and against adjusted expected, labelled EINC*, where σ_x has been multiplied by a factor required to make the total number of expected claim inceptions equal to the total actual number (the factor being the percentage at the foot of the 100xA/E column). Tables A7.1-A7.5 relate to males for deferred periods 1, 4, 13, 26 and 52 weeks respectively. Tables A7.6-A7.10 relate to females for the five deferred periods. Each table is then further sub-divided into six elements labelled (a)-(f) where (a)-(d) relate to occupational classes 1-4 respectively, (e) relates to Class Unknown and (f) relates to all classes (including Class Unknown) combined.

Readers are referred to the comments in 4.1 above regarding the allowance for duplicate policies in the statistical tests.

The tables are voluminous and the data available for Classes 2-4 for some deferred periods is very sparse or, in some cases, non-existent. Where the data for any of the subsections (a)-(f) is sparse, the number of actual inceptions being less than 10, that subsection of the tables has been omitted.

The key features emerging from the experience are as follows:

The bulk of the data for Classes 2-4 is concentrated in the male experience for deferred periods 4 and 13 weeks and, to a lesser extent, 26 weeks. For these three experiences there is strong evidence of inception rates increasing from Class 1 to Class 4, i.e. the professional occupations have the lightest experience and the manual occupations have the heaviest. This is the expected result based on intuition and insurers' practice in rating the various classes.

The much smaller experience for male 52 week deferred period business suggests that a similar pattern applies but there is virtually no data for 1 week deferred period business for classes other than Class 1.

For the male 4, 13 and 26 week business, the Class Unknown experience appears to be heavier than Class 1 and lighter than Class 2. For the male 52 week business the Class Unknown business shows slightly lighter experience than Class 1 but not significantly so. For the male 1 week business the Class Unknown experience is significantly lighter than the Class 1 business but there are special features of this business and readers should be cautioned about drawing any conclusions from this.

The female data for Classes 2-4 is very sparse. That which there is relates mainly to Class 2 with some Class 3 for the 4 week deferred period. This limited experience shows a similar pattern to the male experience with inception rates increasing from Class 1 to Class 3.

5.2 *Terminations*

As with inceptions, a similar approach has been made to analysing the Standard* data set as was used with the Standard data. Actual recoveries and deaths are compared with those expected on the basis of the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. The results are presented using the basic format introduced in *C.M.I.R.* **15**, 51. The experience for each sex and deferred period is sub-divided into six elements for Classes 1-4, Class Unknown and all business combined.

Table A8 of the Appendix shows a summary of the experience by sex, deferred period and occupational Class. The figures represent $100A/E$ for all ages. They are shown in *italic* if the number of actual events is less than 30 and omitted completely if the number of actual events is less than 10. Values where the value of $p(+/-)$ or $p(B)$ is less than 0.025 are shown in **bold**.

The results in Table A8 are illustrated graphically in Figures A4.1-A4.4. The figures show a confidence interval in addition to the values of $100A/E$ shown in the tables. The lower limit is $100(A - 2\sqrt{E})/E$ and the upper limit is $100(A + 2\sqrt{E})/E$. As with the table, no results are shown where the number of events is less than 10.

The detailed results by duration of sickness and age group together with the results of the various statistical tests are shown in Tables A9-A12 of the Appendix. These deal with male recoveries, female recoveries, male deaths and female deaths respectively. Each table is further sub-divided into six sections by occupational class. For example, Table A9 is sub-divided as follows:

Table A9.1	Class 1
Table A9.2	Class 2
Table A9.3	Class 3
Table A9.4	Class 4
Table A9.5	Class Unknown
Table A9.6	All business

Readers are referred to the report in *C.M.I.R.* **15** for a full description of the tables and the statistical tests used. Where the volume of data is sparse, less than 10 actual results, the sub-division of the table is omitted for the relevant occupational class.

The following features are apparent:

For male recoveries, there is no strong influence of occupational class on overall recovery rates as observed for inceptions. This is apparent from the results for the 4, 13 and 26 week deferred period experience where there is a reasonable volume of data for all classes.

The overall experience for all deferred periods combined shows that male Class 1 recoveries are significantly higher than for other Classes. This, though, is somewhat misleading as it is dominated by the 1 week deferred period business which has a large number of recoveries at very short duration of sickness and almost no Class 2, 3 or 4 business.

For female recoveries, the data is more sparse. There is no clear pattern for recovery rates to increase or decrease with occupational class.

For male deaths, the data is sparse but there is some evidence that Class 1 business exhibits higher death rates than the Classes 3 and 4.

The data is too sparse to draw any conclusions about the influence of occupational class on female deaths.

6. CONTRIBUTING OFFICES

The Executive Committee and the PHI Sub-Committee wish to thank the following offices which have contributed data to this investigation. The office names given are, generally, those applying at the time of submission.

Britannia Life	Legal & General
Commercial Union	Medical Sickness
Eagle Star	Norwich Union
Friends Provident	Sun Alliance
General Accident	UNUM
Guardian	Zurich Life

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Table A1. Individual PHI policies, 1991-94. Aggregate, Standard and Standard* data. Number of policies in force at the beginning and end of each investigation year and number of claims records summed across the four year period.

		Aggregate data			Standard data			Standard* data		
	Attribute	In force at start of year	In force at end of year	Claim records	In force at start of year	In force at end of year	Claim records	In force at start of year	In force at end of year	Claim records
Sex	Male	1,437,392	1,412,564	56,938	1,117,437	1,096,620	41,435	1,367,461	1,343,376	51,489
	Female	217,353	231,235	7,675	189,324	200,635	6,096	206,934	220,359	6,913
Country	UK	1,641,062	1,631,302	64,026	1,306,761	1,297,255	47,531	1,574,395	1,563,735	58,402
	Republic of Ireland	12,345	11,071	552	0	0	0	0	0	0
	Isle of Man	477	530	9	0	0	0	0	0	0
	Channel Islands	861	896	26	0	0	0	0	0	0
Occupational Rating	Not rated	1,363,256	1,353,633	52,316	1,306,761	1,297,255	47,531	1,306,761	1,297,243	47,528
	Rated	291,489	290,166	12,293	0	0	0	267,634	266,492	10,871
	Unknown	0	0	4	0	0	0	0	0	3
Benefit Type	Level	839,025	805,956	41,343	634,439	604,991	30,622	797,693	765,666	37,589
	Increasing	805,279	828,407	21,736	662,980	683,806	15,509	766,906	789,212	19,412
	Decreasing	10,431	9,425	1,522	9,342	8,458	1,400	9,796	8,857	1,401
	Waiver	2	5	3	0	0	0	0	0	0
	Other	8	6	9	0	0	0	0	0	0

Medical Evidence	Medical	302,728	289,465	14,292	207,958	201,351	8,781	266,242	255,292	11,682
	Non-medical	770,930	788,093	31,370	599,014	608,485	23,445	731,145	745,878	28,274
	Non-selection	524	492	30	492	461	27	515	484	30
	Unknown	580,458	565,488	18,921	499,215	486,768	15,278	576,388	561,821	18,416
	Paramedic	105	261	0	82	190	0	105	260	0
Premium Type	Level annual	1,215,548	1,174,858	51,059	937,239	901,763	37,252	1,157,408	1,118,110	46,511
	Recurrent single	196	883	16	104	470	10	195	878	14
	Increasing annual	438,522	467,622	13,196	369,319	394,940	10,006	416,374	444,370	11,611
	Other	479	436	342	99	82	263	418	377	266
Underwriting Impairment	No extra risk	1,219,251	1,208,503	51,482	1,013,296	1,002,541	42,932	1,206,198	1,196,554	50,912
	Hypertension	1,056	1,073	74	0	0	0	0	0	0
	Neurosis	11,426	11,434	799	0	0	0	0	0	0
	Exclusion possible	368,273	367,243	7,491	293,465	294,714	4,599	368,197	367,181	7,490
	Other	54,739	55,546	4,767	0	0	0	0	0	0
CMI Occupational Class	C.M.I. 1	755,051	778,629	40,499	710,547	735,850	38,555	711,377	734,803	36,256
	C.M.I. 2	70,777	82,770	2,290	25,630	36,815	1,225	66,018	77,912	2,063
	C.M.I. 3	48,795	54,058	2,187	11,941	16,778	1,305	45,290	50,592	2,012
	C.M.I. 4	35,656	39,299	2,238	4,337	6,844	408	32,660	36,402	1,959
	C.M.I. unknown	744,466	689,043	17,399	554,306	500,968	6,038	719,050	664,026	16,112
Investigation Year	1991	439,610	444,472	16,773	331,149	334,804	11,875	410,243	415,205	14,926
	1992	441,851	434,238	16,936	332,585	323,785	11,794	416,909	409,082	15,165
	1993	390,225	383,059	15,650	323,581	319,446	12,171	370,510	363,777	14,231
	1994	383,059	382,030	15,254	319,446	319,220	11,691	368,108	367,030	13,903
	Total records	1,654,745	1,643,799	64,613	1,306,761	1,297,255	47,531	1,574,395	1,563,735	58,402

Table A2.1. Males, individual policies, Standard experience for the quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. Deferred periods 1, 4, 13, 26 and 52 weeks. Ratios of actual claim inceptions to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. Also shown are 100xA/E plus/minus two standard deviations.

Deferred Period	Quadrennium	Inceptions	100x(A/E-2xSD)	100xA/E	100x(A/E+2xSD)
1	1975-78	11,074	94.4	97.2	100.0
	1979-82	10,729	77.3	79.9	82.5
	1983-86	14,370	91.0	93.4	95.8
	1987-90	15,488	106.6	109.1	111.6
	1991-94	12,027	93.8	96.5	99.2
4	1975-78	1,777	95.5	101.7	107.9
	1979-82	1,659	67.3	72.7	78.1
	1983-86	2,030	65.3	70.1	74.9
	1987-90	2,543	76.7	81.3	85.9
	1991-94	2,451	70.1	74.6	79.1
13	1975-78	583	89.9	98.8	107.7
	1979-82	819	76.7	83.6	90.5
	1983-86	1,385	98.6	104.5	110.4
	1987-90	1,500	92.1	97.6	103.1
	1991-94	1,794	95.9	101.0	106.1
26	1975-78	353	83.2	94.8	106.4
	1979-82	439	68.0	77.4	86.8
	1983-86	794	107.7	116.3	124.9
	1987-90	1,087	129.3	137.3	145.3
	1991-94	1,261	131.3	138.7	146.1
52	1975-78	52	68.9	100.0	131.1
	1979-82	115	109.1	133.3	157.5
	1983-86	211	161.7	182.6	203.5
	1987-90	316	202.2	221.0	239.8
	1991-94	494	255.0	271.6	288.2

Note: 100xA/E figures and confidence intervals are omitted from the above table if the number of actual inceptions is less than 10.

Table A2.2. Females, individual policies, Standard experience for the quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. Deferred periods 1, 4, 13, 26 and 52 weeks. Ratios of actual claim inceptions to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. Also shown are 100xA/E plus/minus two standard deviations.

Deferred Period	Quadrennium	Inceptions	100x(A/E–2xSD)	100xA/E	100x(A/E+2xSD)
1	1975-78	686	123.8	137.3	150.8
	1979-82	863	102.1	113.1	124.1
	1983-86	1,279	112.8	122.2	131.6
	1987-90	1,588	132.8	141.8	150.8
	1991-94	1,270	111.6	120.9	130.2
4	1975-78	182	141.0	165.7	190.4
	1979-82	258	139.4	159.8	180.2
	1983-86	378	128.8	144.8	160.8
	1987-90	638	151.4	164.6	177.8
	1991-94	614	125.0	137.3	149.6
13	1975-78	73	174.7	211.5	248.3
	1979-82	111	154.3	182.0	209.7
	1983-86	159	136.7	158.3	179.9
	1987-90	262	173.2	191.7	210.2
	1991-94	310	155.0	171.1	187.2
26	1975-78	56	224.2	273.9	323.6
	1979-82	59	144.4	184.0	223.6
	1983-86	123	235.0	268.1	301.2
	1987-90	211	321.4	350.3	379.2
	1991-94	329	379.3	404.2	429.1
52	1975-78	6	-	-	-
	1979-82	8	-	-	-
	1983-86	27	305.2	390.7	476.2
	1987-90	63	568.5	640.2	711.9
	1991-94	108	566.9	620.7	674.5

Note: 100xA/E figures and confidence intervals are omitted from the above table if the number of actual inceptions is less than 10.

Table A3.1. Males, individual policies, Standard experience for the quadrennium 1991-94. Deferred periods 1, 4, 13, 26 and 52 weeks. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A3.1a: Deferred Period 1 Week

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	19.0	44.3	43	−2.51	42.8	44	−2.40
25-29	234.0	346.9	67	−4.01	334.7	70	−3.64
30-34	858.0	828.7	104	0.67	799.5	107	1.37
35-39	1,549.0	1,406.5	110	2.51	1,357.1	114	3.44
40-44	2,325.0	2,239.4	104	1.20	2,160.6	108	2.34
45-49	2,585.0	2,576.5	100	0.11	2,485.9	104	1.31
50-54	2,038.0	2,017.4	101	0.30	1,946.5	105	1.37
55-59	1,496.0	1,705.9	88	−3.36	1,645.9	91	−2.44
60-64	923.0	1,299.7	71	−6.90	1,254.0	74	−6.18
18-64	12,027.0	12,465.2	96		12,027.0	100	
Total chi-squared				89.6			85.9
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A3.1b: Deferred Period 4 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	46.0	18.8	245	4.85	14.0	328	6.60
25-29	143.0	128.1	112	1.02	95.5	150	3.75
30-34	165.0	166.4	99	−0.08	124.1	133	2.83
35-39	204.0	270.8	75	−3.13	202.0	101	0.11
40-44	323.0	433.6	74	−4.10	323.4	100	−0.02
45-49	450.0	565.1	80	−3.74	421.5	107	1.07
50-54	411.0	516.7	80	−3.59	385.4	107	1.01
55-59	437.0	615.5	71	−5.55	459.1	95	−0.80
60-64	272.0	570.9	48	−9.65	425.9	64	−5.75
18-64	2,451.0	3,285.7	75		2,451.0	100	
Total chi-squared				201.9			101.4
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A3.1c: Deferred Period 13 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	4.0	3.4	↓	↓	3.5	↓	↓
25-29	23.0	22.3	105	0.23	22.5	104	0.19
30-34	55.0	61.7	89	−0.79	62.3	88	−0.85
35-39	123.0	124.4	99	−0.12	125.6	98	−0.21
40-44	207.0	229.0	90	−1.34	231.2	90	−1.47
45-49	347.0	349.4	99	−0.12	352.8	98	−0.28
50-54	389.0	334.4	116	2.76	337.6	115	2.59
55-59	410.0	366.9	112	2.08	370.5	111	1.90
60-64	236.0	285.5	83	−2.71	288.2	82	−2.84
18-64	1,794.0	1,776.9	101		1,794.0	100	
Total chi-squared				21.8			21.4
Degrees of freedom				8			7
Probability value				0.0053			0.0032

Table A3.1d: Deferred Period 26 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	4.0	0.7	↓	↓	0.9	↓	↓
25-29	10.0	4.4	273	3.49	6.2	197	2.30
30-34	23.0	12.4	186	2.68	17.2	134	1.25
35-39	39.0	30.1	130	1.45	41.7	93	−0.38
40-44	100.0	73.8	136	2.72	102.3	98	−0.21
45-49	215.0	146.8	146	5.02	203.6	106	0.71
50-54	290.0	181.9	159	7.14	252.4	115	2.11
55-59	349.0	241.8	144	6.14	335.4	104	0.66
60-64	231.0	217.0	106	0.84	301.1	77	−3.60
18-64	1,261.0	908.9	139		1,261.0	100	
Total chi-squared				143.5			25.4
Degrees of freedom				8			7
Probability value				0.0000			0.0006

Table A3.1e: Deferred Period 52 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	3.0	0.3	↓	↓	0.8	↓	↓
30-34	3.0	2.2	↓	↓	6.0	103	0.06
35-39	12.0	5.3	242	3.54	14.5	83	−0.59
40-44	32.0	11.7	274	5.30	31.7	101	0.05
45-49	96.0	25.3	380	12.54	68.6	140	2.95
50-54	114.0	36.0	317	11.60	97.6	117	1.48
55-59	134.0	51.5	260	10.24	139.8	96	−0.44
60-64	99.0	49.7	199	6.23	134.9	73	−2.76
18-64	494.0	181.9	272		494.0	100	
Total chi-squared				476.1			19.0
Degrees of freedom				6			6
Probability value				0.0000			0.0041

Table A3.2. Females, individual policies, Standard experience for the quadrennium 1991-94. Deferred periods 1, 4, 13, 26 and 52 weeks. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A3.2a: Deferred Period 1 Week

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	21.0	27.0	78	−0.76	32.6	64	−1.34
25-29	122.0	183.8	66	−3.01	222.2	55	−4.44
30-34	131.0	133.4	98	−0.14	161.2	81	−1.57
35-39	180.0	167.6	107	0.63	202.6	89	−1.05
40-44	234.0	178.2	131	2.76	215.3	109	0.84
45-49	240.0	143.9	167	5.30	173.9	138	3.31
50-54	193.0	112.0	172	5.05	135.4	143	3.27
55-59	109.0	78.3	139	2.29	94.7	115	0.97
60-64	40.0	26.6	151	1.72	32.1	125	0.92
18-64	1,270.0	1,050.8	121		1,270.0	100	
Total chi-squared				79.5			49.3
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A3.2b: Deferred Period 4 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	31.0	15.4	201	3.07	21.1	147	1.65
25-29	83.0	86.3	96	−0.27	118.5	70	−2.52
30-34	88.0	49.5	178	4.22	68.0	129	1.87
35-39	81.0	62.9	129	1.76	86.4	94	0.44
40-44	102.0	69.5	147	3.01	95.4	107	0.52
45-49	101.0	68.7	147	3.01	94.3	107	0.53
50-54	73.0	48.9	149	2.66	67.2	109	0.55
55-59	50.0	32.9	152	2.31	45.1	111	0.56
60-64	5.0	13.1	38	−1.72	17.9	28	−2.36
18-64	614.0	447.1	137		614.0	100	
Total chi-squared				63.8			19.5
Degrees of freedom				9			8
Probability value				0.0000			0.0125

Table A3.2c: Deferred Period 13 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	5.0	2.5	↓	↓	4.3	↓	↓
25-29	25.0	9.8	245	4.68	16.7	143	1.82
30-34	43.0	17.2	250	5.75	29.4	146	2.31
35-39	37.0	24.1	153	2.42	41.3	90	−0.62
40-44	55.0	33.2	166	3.50	56.8	97	−0.22
45-49	57.0	38.3	149	2.79	65.5	87	−0.97
50-54	45.0	29.3	154	2.68	50.1	90	−0.67
55-59	39.0	20.8	187	3.69	35.6	110	0.53
60-64	4.0	6.0	66	−0.76	10.3	39	−1.82
18-64	310.0	181.2	171		310.0	100	
Total chi-squared				102.3			14.1
Degrees of freedom				8			7
Probability value				0.0000			0.0502

Table A3.2d: Deferred Period 26 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	2.0	0.7	↓	↓	2.7	↓	↓
25-29	16.0	2.8	↓	↓	11.2	130	0.98
30-34	28.0	4.6	574	11.96	18.5	152	1.97
35-39	40.0	7.1	563	10.99	28.7	139	1.88
40-44	53.0	11.2	472	11.10	45.4	117	1.00
45-49	54.0	15.9	341	8.54	64.0	84	−1.12
50-54	74.0	16.4	451	12.67	66.3	112	0.85
55-59	53.0	16.1	328	8.17	65.3	81	−1.35
60-64	9.0	6.7	135	0.81	26.9	33	−3.08
18-64	329.0	81.4	404		329.0	100	
Total chi-squared				687.7			22.7
Degrees of freedom				7			7
Probability value				0.0000			0.0020

Table A3.2e: Deferred Period 52 Weeks

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	0.0	0.2	↓	↓	1.3	↓	↓
30-34	3.0	0.9	↓	↓	5.7	56	−1.04
35-39	12.0	1.4	↓	↓	9.0	133	0.89
40-44	12.0	2.3	↓	↓	14.2	85	−0.52
45-49	23.0	3.5	611	13.15	21.6	106	0.27
50-54	26.0	3.8	↓	↓	23.9	109	0.39
55-59	28.0	3.7	632	14.23	22.9	122	0.96
60-64	3.0	1.5	↑	↑	9.4	32	−1.85
18-64	108.0	17.4	622		108.0	100	
Total chi-squared				375.6			6.7
Degrees of freedom				2			6
Probability value				0.0000			0.35

Table A4. Table of termination experience for individual PHI claims 1975-94. Standard experience.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
(a) Males, recoveries						
1975-78	100	100	97	96	-	100
1979-82	109	102	**96**	77	*73*	105
1983-86	**101**	74	**67**	59	*35*	**90**
1987-90	**95**	63	**66**	56	64	**82**
1991-94	**100**	61	58	**48**	47	**79**
(b) Females, recoveries						
1975-78	89	80	87	*67*	-	86
1979-82	95	90	99	105	-	94
1983-86	91	76	71	57	-	**83**
1987-90	92	64	61	51	*48*	**77**
1991-94	96	59	**54**	46	*42*	**71**
(c) Males, deaths						
1975-78	92	90	106	125	-	100
1979-82	91	102	105	97	*77*	97
1983-86	63	88	71	83	*97*	77
1987-90	53	71	80	73	76	71
1991-94	47	65	70	62	84	64
(d) Females, deaths						
1975-78	-	-	-	-	-	*89*
1979-82	-	-	-	-	-	*61*
1983-86	-	-	*74*	*60*	-	47
1987-90	-	*39*	*43*	*59*	-	41
1991-94	-	-	*47*	*68*	-	47

Note:
Italic if actual numbers of recoveries or deaths is less than 30.
Not shown if actual numbers of recoveries or deaths is less than 10.
Bold if either $p(+/-)$ or $p(B) < 0.025$ for adjusted E.

Table A5.1. Males, individual policies, 1991-94, Standard experience, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	4,670	1,514	855	287	59	7,385
E	4,682.6	2,463.4	1,466.3	598.8	125.6	9,336.7
100*A*/*E*						
Durations:						
1-2 weeks	127	-	-	-	-	127
2-3 weeks	115	-	-	-	-	115
3-4 weeks	90	-	-	-	-	90
4-8 weeks	78	58	-	-	-	68
8-13 weeks	69	61	-	-	-	63
13-17 weeks	56	66	58	-	-	61
17-26 weeks	41	63	45	-	-	50
26-30 weeks	*57*	80	59	66	-	65
30-39 weeks	*42*	58	60	32	-	49
39 wks-1 yr	*43*	63	68	46	-	57
1-2 years	51	58	73	45	43	56
2-5 years	↓	↓	73	59	↓	62
5-11 years	58	73	*119*	*85*	*53*	99
Ages:						
20-24	*113*	58	↓	↓	↓	73
25-29	87	63	76	*45*	↓	72
30-34	120	66	55	*46*	↓	92
35-39	127	63	64	*41*	↓	95
40-44	113	63	58	60	*54*	88
45-49	97	64	60	51	*49*	79
50-54	93	56	60	50	*43*	74
55-59	75	55	49	33	↓	62
60-64	↓	↓	↓	↓	*41*	↓
65-65	95	70	60	*60*	-	82
All cells	100	61	58	48	47	79
Using *E*						
Σz^2	464.26	384.12	283.77	165.43	32.16	1,282.17
df	75	63	51	29	8	105
$p(\chi^2)$	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0000**
#(+/−)	20/55	2/61	2/49	0/29	0/8	21/84
$p(+/-)$	**0.0001**	**0.0000**	**0.0000**	**0.0000**	**0.0078**	**0.0000**
$p(B)$	**0.000**	0.747	0.154	1.0	1.0	**0.000**
Using adjusted *E*						
Σz^2	465.57	48.47	56.88	29.91	0.45	1,118.71
df	74	54	41	20	2	102
$p(\chi^2)$	**0.0000**	0.69	0.0505	0.0713	0.8	**0.0000**
#(+/−)	20/55	31/24	26/16	10/11	2/1	32/71
$p(+/-)$	**0.0001**	0.42	0.16	1.0	1.0	**0.0002**
$p(B)$	**0.000**	0.741	0.144	**0.024**	1.0	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A5.2. Males, individual policies, 1991-94, Standard experience, deaths.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	64	103	162	118	49	496
E	135.6	157.7	230.3	189.6	58.5	771.7
100A/E						
Durations:						
1-8 weeks	*38*	↓	-	-	-	*28*
8-13 weeks	↓	↓	-	-	-	*54*
13-17 weeks	*38*	*41*	*88*	-	-	*65*
17-26 weeks	↓	↓	↓	-	-	64
26-30 weeks	*54*	*68*	71	↓	-	*77*
30-39 weeks	↓	↓	*56*	*51*	-	52
39 wks-1 yr	*50*	*72*	*100*	*72*	-	79
1-2 years	*44*	*78*	72	87	*113*	79
2-5 years	*52*	↓	*60*	*42*	↓	56
5-11 years	*55*	75	*56*	*64*	*66*	63
Ages:						
20-34	↓	↓	↓	↓	↓	*48*
35-39	↓	*48*	*74*	↓	↓	*58*
40-44	*47*	↓	*66*	*64*	↓	72
45-49	*26*	*66*	84	*65*	*80*	65
50-54	*26*	*74*	83	77	*83*	70
55-59	*60*	70	63	*45*	↓	59
60-64	↓	↓	↓	↓	*86*	↓
65-65	*69*	*58*	*48*	*74*	-	67
All cells	47	65	70	62	84	64
Using E						
Σz^2	36.61	22.74	26.47	35.37	4.01	118.98
df	12	11	17	13	5	41
$p(\chi^2)$	**0.0003**	**0.0192**	0.0664	**0.0007**	0.55	**0.0000**
$\#(+/-)$	0/12	1/10	2/15	2/11	2/3	4/37
$p(+/-)$	**0.0005**	**0.0117**	**0.0023**	**0.0225**	1.0	**0.0000**
$p(B)$	1.0	1.0	1.0	0.711	0.273	0.953
Using adjusted E						
Σz^2	1.05	5.67	5.98	7.34	2.64	39.17
df	3	7	10	7	3	29
$p(\chi^2)$	0.79	0.58	0.82	0.39	0.45	0.0985
$\#(+/-)$	2/2	4/4	5/6	4/4	2/2	13/17
$p(+/-)$	1.0	1.0	1.0	1.0	1.0	0.58
$p(B)$	1.0	0.601	0.823	0.830	0.892	0.636

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A5.3. Females, individual policies, 1991-94, Standard experience, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	838	490	197	99	18	1,642
E	874.0	825.0	363.5	215.4	42.7	2,320.6
100*A*/*E*						
Durations:						
1-2 weeks	102	-	-	-	-	102
2-3 weeks	106	-	-	-	-	106
3-4 weeks	96	-	-	-	-	96
4-8 weeks	80	49	-	-	-	60
8-13 weeks	86	57	-	-	-	62
13-17 weeks	*79*	66	*32*	-	-	56
17-26 weeks	↓	72	45	-	-	58
26-30 weeks	↓	*59*	*57*	*32*	-	56
30-39 weeks	*82*	*54*	*61*	*39*	-	50
39 wks-1 yr	↓	*74*	*59*	*47*	-	60
1-2 years	↓	*87*	77	*38*	*36*	58
2-11 years	*90*	*97*	*92*	*78*	*51*	81
Ages:						
19-24	*66*	*70*	↓	↓	↓	64
25-29	76	53	*34*	*53*	↓	58
30-34	93	52	*41*	*52*	↓	61
35-39	101	56	56	*66*	↓	73
40-44	94	60	82	*68*	*48*	76
45-49	110	63	67	*32*	↓	76
50-54	99	70	*58*	*13*	↓	76
55-59	99	↓	↓	↓	↓	72
60-64	*142*	72	*37*	*33*	*38*	127
All cells	96	59	54	46	*42*	71
Using *E*						
Σz^2	40.33	144.81	84.92	71.52	12.67	323.74
df	42	39	27	18	4	86
$p(\chi^2)$	0.54	**0.0000**	**0.0000**	**0.0000**	**0.0130**	**0.0000**
#(+/−)	18/24	1/38	2/25	0/18	0/4	13/73
p(+/−)	0.44	**0.0000**	**0.0000**	**0.0000**	0.13	**0.0000**
p(*B*)	0.590	0.595	0.437	1.0	1.0	**0.000**
Using adjusted *E*						
Σz^2	40.65	29.49	27.28	21.51	-	184.93
df	41	30	16	7	-	81
$p(\chi^2)$	0.49	0.49	**0.0384**	**0.0031**	-	**0.0000**
#(+/−)	20/22	14/17	9/8	5/3	-	36/46
p(+/−)	0.88	0.72	1	0.73	-	0.32
p(*B*)	0.325	0.437	**0.018**	0.503	-	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A5.4. Females, individual policies, 1991-94, Standard experience, deaths.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	3	9	17	28	7	64
E	11.9	31.9	36.2	41.4	13.8	135.2
100*A*/*E*						
Durations:						
1-17 weeks	↓	↓	↓	-	-	*16*
17-30 weeks	↓	*24*	↓	↓	-	*38*
30 wks-1 yr	↓	↓	*48*	↓	-	*55*
1-2 years	↓	↓	↓	*78*	↓	*76*
2-11 years	*25*	*33*	*46*	*51*	*51*	*40*
Ages:						
19-34	↓	↓	↓	↓	↓	*21*
35-44	↓	*18*	*39*	↓	↓	*55*
45-49	↓	↓	↓	*77*	↓	*64*
50-54	↓	↓	↓	↓	↓	*45*
55-64	*25*	*39*	*53*	*57*	*51*	*42*
All cells	*25*	*28*	*47*	*68*	*51*	47
Using *E*						
Σz^2	5.90	15.15	8.65	5.04	2.88	38.62
df	1	2	3	3	1	11
$p(\chi^2)$	**0.0152**	**0.0005**	**0.0343**	0.17	0.0897	**0.0001**
#(+/−)	0/1	0/2	0/3	0/3	0/1	0/11
p(+/−)	1.0	0.50	0.25	0.25	1.0	**0.0010**
p(*B*)	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	10.47
df	-	-	-	-	-	5
$p(\chi^2)$	-	-	-	-	-	0.0630
#(+/−)	-	-	-	-	-	2/4
p(+/−)	-	-	-	-	-	0.69
p(*B*)	-	-	-	-	-	0.777

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A6.1. Males, individual policies, Standard* experience for the quadrennium 1991-94. Occupational class 1, 2, 3, 4, unknown and all combined. Deferred periods 1, 4, 13, 26 and 52 weeks. Ratios of actual claim inceptions to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. Also shown are 100xA/E plus/minus two standard deviations.

Deferred Period	C.M.I. Occupational Class	Inceptions	100x(A/E−2xSD)	100xA/E	100x(A/E+2xSD)
1	Class 1	11,905	95.2	97.9	100.6
	Class 2	0	-	-	-
	Class 3	0	-	-	-
	Class 4	2	-	-	-
	Class Unknown	191	23.8	37.1	50.4
	All business	12,098	92.7	95.4	98.1
4	Class 1	1,694	67.0	72.4	77.8
	Class 2	290	96.3	112.4	128.5
	Class 3	436	145.2	160.9	176.6
	Class 4	442	214.2	233.0	251.8
	Class Unknown	2,751	105.6	110.8	116.0
	All business	5,613	97.8	101.3	104.8
13	Class 1	676	89.1	97.3	105.5
	Class 2	126	126.0	149.6	173.2
	Class 3	100	178.7	210.1	241.5
	Class 4	120	252.3	285.7	319.1
	Class Unknown	1,699	130.9	137.0	143.1
	All business	2,721	124.4	129.1	133.8
26	Class 1	623	130.3	141.0	151.7
	Class 2	52	114.4	152.9	191.4
	Class 3	46	161.2	209.1	257.0
	Class 4	39	260.2	325.0	389.8
	Class Unknown	655	135.7	146.3	156.9
	All business	1,415	140.4	147.7	155.0
52	Class 1	246	252.6	276.4	300.2
	Class 2	12	252.5	378.0	503.5
	Class 3	20	766.6	918.0	1,069.4
	Class 4	3	-	-	-
	Class Unknown	254	247.6	270.8	294.0
	All business	535	265.7	282.0	298.3

Note: 100xA/E figures and confidence intervals are omitted from the above table if the number of actual inceptions is less than 10.

Table A6.2. Females, individual policies, Standard* experience for the quadrennium 1991-94. Occupational class 1, 2, 3, 4, unknown and all combined. Deferred periods 1, 4, 13, 26 and 52 weeks. Ratios of actual claim inceptions to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78. Also shown are 100xA/E plus/minus two standard deviations.

Deferred Period	C.M.I. Occupational Class	Inceptions	100x(A/E−2xSD)	100xA/E	100x(A/E+2xSD)
1	Class 1	1,266	111.5	120.9	130.3
	Class 2	1	-	-	-
	Class 3	0	-	-	-
	Class 4	0	-	-	-
	Class Unknown	8	-	-	-
	All business	1,275	111.5	120.8	130.1
4	Class 1	491	127.0	140.9	154.8
	Class 2	75	151.6	193.2	234.8
	Class 3	27	244.3	336.0	427.7
	Class 4	1	-	-	-
	Class Unknown	227	119.1	139.4	159.7
	All business	821	135.9	146.9	157.9
13	Class 1	172	177.0	200.4	223.8
	Class 2	35	241.9	306.0	370.1
	Class 3	5	-	-	-
	Class 4	0	-	-	-
	Class Unknown	178	161.2	183.1	205.0
	All business	390	183.0	198.4	213.8
26	Class 1	165	333.9	367.4	400.9
	Class 2	21	550.5	678.0	805.5
	Class 3	3	-	-	-
	Class 4	2	-	-	-
	Class Unknown	174	440.8	478.0	515.2
	All business	365	405.5	429.9	454.3
52	Class 1	56	522.8	596.0	669.2
	Class 2	6	-	-	-
	Class 3	4	-	-	-
	Class 4	1	-	-	-
	Class Unknown	53	591.1	671.0	750.9
	All business	120	615.9	669.0	722.1

Note: 100xA/E figures and confidence intervals are omitted from the above table if the number of actual inceptions is less than 10.

Table A7.1. Males, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 1 week. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.1a: Males, DP1, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	19.0	44.3	43	−2.51	43.4	44	−2.45
25-29	234.0	346.7	67	4.00	339.4	69	−3.78
30-34	858.0	826.0	104	0.74	808.8	106	1.14
35-39	1,545.0	1,398.4	110	2.59	1,369.2	113	3.14
40-44	2,310.0	2,221.2	104	1.24	2,174.8	106	1.92
45-49	2,565.0	2,533.0	101	0.42	2,480.0	103	1.13
50-54	2,013.0	1,949.2	103	0.95	1,908.5	105	1.58
55-59	1,453.0	1,609.0	90	−2.57	1,575.4	92	−2.04
60-64	908.0	1,231.2	74	−6.09	1,205.4	75	−5.66
18-64	11,905.0	12,159.1	98		11,905.0	100	
Total chi-squared				75.8			75.1
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.1e: Males, DP1, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.0	↓	↓
25-29	0.0	0.6	↓	↓	0.2	↓	↓
30-34	0.0	3.7	↓	↓	1.4	↓	↓
35-39	9.0	13.0	52	−1.32	4.8	140	0.68
40-44	23.0	35.7	64	−1.41	13.2	174	1.77
45-49	28.0	73.6	38	−3.51	27.3	102	0.09
50-54	45.0	111.9	40	−4.18	41.5	108	0.36
55-59	59.0	159.6	37	−5.26	59.2	100	−0.02
60-64	27.0	116.7	23	−5.49	43.3	62	−1.64
18-64	191.0	514.8	37		191.0	100	
Total chi-squared				91.3			6.4
Degrees of freedom				6			5
Probability value				0.0000			0.27

Table A7.1f: Males, DP1, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	19.0	44.3	43	−2.51	42.3	45	−2.37
25-29	234.0	347.2	67	−4.02	331.4	71	−3.53
30-34	858.0	829.7	103	0.65	791.9	108	1.55
35-39	1,554.0	1,411.5	110	2.51	1,347.1	115	3.73
40-44	2,333.0	2,256.9	103	1.06	2,154.0	108	2.55
45-49	2,593.0	2,607.4	99	−0.19	2,488.5	104	1.38
50-54	2,058.0	2,061.7	100	−0.05	1,967.7	105	1.35
55-59	1,514.0	1,769.1	86	−4.01	1,688.4	90	−2.80
60-64	935.0	1,348.4	69	−7.44	1,286.9	73	−6.48
18-64	*12,098.0*	*12,676.3*	*95*		*12,098.0*	*100*	
Total chi-squared				101.7			94.5
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Note: Tables A7.1b, A7.1c and A7.1d were omitted due to low data volume (actual inceptions being less than 10).

Table A7.2. Males, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 4 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.2a: Males, DP4, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	17.0	13.1	129	0.82	9.5	179	1.88
25-29	95.0	107.2	89	−0.91	77.5	123	1.53
30-34	104.0	127.3	82	−1.60	92.1	113	0.95
35-39	138.0	199.1	69	−3.34	144.1	96	−0.39
40-44	220.0	308.4	71	−3.88	223.2	99	−0.16
45-49	326.0	390.3	84	−2.51	282.4	115	2.00
50-54	279.0	348.4	80	−2.87	252.1	111	1.31
55-59	317.0	423.5	75	−3.99	306.5	103	0.46
60-64	198.0	423.7	47	−8.46	306.6	65	−4.79
18-64	1,694.0	2,341.1	72		1,694.0	100	
Total chi-squared				132.4			35.8
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.2b: Males, DP4, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	9.0	2.4	↓	↓	2.7	↓	↓
25-29	17.0	13.2	167	2.03	14.8	148	1.56
30-34	26.0	26.8	97	−0.12	30.1	86	−0.58
35-39	56.0	35.3	159	2.70	39.6	141	2.00
40-44	48.0	46.2	104	0.20	52.0	92	−0.43
45-49	53.0	52.4	101	0.06	58.9	90	−0.60
50-54	43.0	34.1	126	1.18	38.3	112	0.58
55-59	28.0	31.4	89	−0.47	35.3	79	−0.95
60-64	10.0	16.1	62	−1.17	18.1	55	−1.47
18-64	290.0	257.9	112		290.0	100	
Total chi-squared				14.4			10.7
Degrees of freedom				8			7
Probability value				0.0710			0.15

Table A7.2c: Males, DP4, C.M.I. Class 3

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	13.0	4.1	↓	↓	6.6	197	1.92
25-29	59.0	19.2	309	7.78	30.9	191	3.90
30-34	57.0	31.6	180	3.48	50.9	112	0.66
35-39	88.0	39.5	223	5.95	63.6	138	2.36
40-44	82.0	48.1	171	3.77	77.4	106	0.41
45-49	70.0	54.3	129	1.65	87.3	80	−1.43
50-54	38.0	38.5	99	−0.06	62.0	61	−2.35
55-59	21.0	24.5	86	−0.55	39.5	53	−2.27
60-64	8.0	11.2	72	−0.73	18.0	45	−1.82
18-64	436.0	271.0	161		436.0	100	
Total chi-squared				125.8			41.1
Degrees of freedom				8			8
Probability value				0.0000			0.0000

Table A7.2d: Males, DP4, C.M.I. Class 4

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	14.0	3.1	↓	↓	7.3	191	1.90
25-29	46.0	13.9	353	8.04	32.3	142	1.86
30-34	70.0	21.1	331	8.20	49.3	142	2.28
35-39	71.0	26.1	272	6.78	60.8	117	1.00
40-44	91.0	35.1	259	7.28	81.8	111	0.79
45-49	55.0	38.4	143	2.07	89.5	61	−2.81
50-54	53.0	26.9	197	3.88	62.8	84	−0.95
55-59	34.0	18.8	181	2.71	43.7	78	−1.13
60-64	8.0	6.2	128	0.55	14.5	55	−1.32
18-64	442.0	189.7	233		442.0	100	
Total chi-squared				257.8			25.7
Degrees of freedom				8			8
Probability value				0.0000			0.0012

Table A7.2e: Males, DP4, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	101.0	25.0	404	11.73	27.7	364	10.74
25-29	225.0	88.1	255	11.25	97.6	230	9.94
30-34	273.0	157.5	173	7.10	174.6	156	5.75
35-39	384.0	233.8	164	7.58	259.2	148	5.98
40-44	407.0	382.0	107	0.99	423.4	96	−0.62
45-49	494.0	491.1	101	0.10	544.3	91	−1.66
50-54	390.0	430.9	91	−1.52	477.6	82	−3.09
55-59	335.0	412.2	81	−2.93	456.9	73	−4.40
60-64	142.0	261.3	54	−5.69	289.6	49	−6.69
18-64	2,751.0	2,481.8	111		2,751.0	100	
Total chi-squared				416.3			359.9
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.2f: Males, DP4, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	154.0	47.8	322	11.85	48.4	318	11.70
25-29	442.0	241.5	183	9.96	244.6	181	9.74
30-34	530.0	364.4	145	6.69	369.1	144	6.46
35-39	737.0	533.8	138	6.79	540.7	136	6.51
40-44	848.0	819.8	103	0.76	830.4	102	0.47
45-49	998.0	1,026.4	97	−0.69	1,039.7	96	−1.00
50-54	803.0	878.8	91	−1.97	890.2	90	−2.25
55-59	735.0	910.4	81	−4.49	922.2	80	−4.76
60-64	366.0	718.5	51	−10.15	727.8	50	−10.35
18-64	5,613.0	5,541.5	101		5,613.0	100	
Total chi-squared				458.3			451.9
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.3. Males, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 13 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.3a: Males, DP13, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.6	↓	↓	0.6	↓	↓
25-29	8.0	7.8	107	0.18	7.6	110	0.26
30-34	17.0	26.2	65	−1.67	25.5	67	−1.56
35-39	49.0	51.4	95	−0.31	50.1	98	−0.14
40-44	60.0	85.6	70	−2.56	83.3	72	−2.36
45-49	111.0	122.9	90	−0.99	119.6	93	−0.73
50-54	137.0	116.6	118	1.75	113.4	121	2.04
55-59	173.0	145.5	119	2.11	141.6	122	2.44
60-64	120.0	137.9	87	−1.41	134.2	89	−1.13
18-64	676.0	694.6	97		676.0	100	
Total chi-squared				19.9			20.0
Degrees of freedom				8			7
Probability value				0.0106			0.0055

Table A7.3b: Males, DP13, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.3	↓	↓	0.5	↓	↓
25-29	6.0	2.2	↓	↓	3.3	↓	↓
30-34	16.0	5.5	274	4.56	8.3	183	2.66
35-39	10.0	9.2	109	0.25	13.7	73	−0.93
40-44	12.0	13.2	91	−0.30	19.7	61	−1.60
45-49	26.0	18.1	143	1.71	27.1	96	−0.20
50-54	35.0	15.9	221	4.44	23.7	147	2.14
55-59	16.0	13.1	122	0.74	19.6	82	−0.75
60-64	5.0	6.7	75	−0.61	10.0	50	−1.47
18-64	126.0	84.2	150		126.0	100	
Total chi-squared				44.5			17.9
Degrees of freedom				7			6
Probability value				0.0000			0.0066

Table A7.3c: Males, DP13, C.M.I. Class 3

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	3.0	0.4	↓	↓	0.9	↓	↓
25-29	7.0	2.1	↓	↓	4.3	193	1.96
30-34	10.0	3.7	322	5.12	7.9	127	0.71
35-39	11.0	5.3	207	2.29	11.1	99	−0.04
40-44	18.0	7.8	229	3.35	16.5	109	0.35
45-49	23.0	10.4	221	3.62	21.8	106	0.24
50-54	11.0	8.4	131	0.83	17.6	62	−1.46
55-59	12.0	6.1	179	2.25	12.9	93	−0.23
60-64	5.0	3.4	↑	↑	7.1	71	−0.71
18-64	100.0	47.6	210		100.0	100	
Total chi-squared				61.5			7.2
Degrees of freedom				6			7
Probability value				0.0000			0.41

Table A7.3d: Males, DP13, C.M.I. Class 4

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.5	↓	↓	1.5	↓	↓
25-29	7.0	2.3	↓	↓	6.6	98	−0.06
30-34	7.0	3.5	235	3.16	10.0	70	−0.89
35-39	20.0	4.5	↓	↓	12.8	156	1.86
40-44	26.0	6.5	417	9.74	18.7	139	1.56
45-49	26.0	8.7	297	5.39	25.0	104	0.18
50-54	18.0	7.4	243	3.59	21.2	85	−0.64
55-59	12.0	6.3	178	2.09	18.1	66	−1.33
60-64	3.0	2.1	↑	↑	5.9	50	−1.12
18-64	120.0	42.0	286		120.0	100	
Total chi-squared				151.2			10.2
Degrees of freedom				5			7
Probability value				0.0000			0.18

Table A7.3e: Males, DP13, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	17.0	4.4	↓	↓	6.0	282	4.13
25-29	67.0	20.5	338	10.96	28.1	239	6.80
30-34	107.0	46.8	228	8.13	64.2	167	4.94
35-39	162.0	91.0	178	6.88	124.7	130	3.09
40-44	251.0	172.5	145	5.52	236.4	106	0.88
45-49	348.0	261.5	133	4.95	358.3	97	−0.50
50-54	332.0	245.4	135	5.11	336.2	99	−0.21
55-59	283.0	241.1	117	2.49	330.5	86	−2.41
60-64	132.0	156.6	84	−1.82	214.6	62	−5.21
18-64	1,699.0	1,239.8	137		1,699.0	100	
Total chi-squared				324.2			131.3
Degrees of freedom				8			8
Probability value				0.0000			0.0000

Table A7.3f: Males, DP13, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	22.0	6.3	350	5.80	8.1	271	4.51
25-29	95.0	34.8	273	9.42	45.0	211	6.90
30-34	157.0	85.9	183	7.10	110.8	142	4.05
35-39	252.0	161.4	156	6.59	208.3	121	2.80
40-44	367.0	285.7	128	4.45	368.8	100	−0.08
45-49	534.0	421.6	127	5.06	544.2	98	−0.40
50-54	533.0	393.6	135	6.50	508.0	105	1.02
55-59	496.0	412.2	120	3.81	532.1	93	−1.45
60-64	265.0	306.6	86	−2.20	395.7	67	−6.08
18-64	*2,721.0*	*2,108.1*	*129*		*2,721.0*	*100*	
Total chi-squared				323.2			132.4
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.4. Males, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 26 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.4a: Males, DP26, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	3.0	0.4	↓	↓	0.5	↓	↓
25-29	5.0	2.2	↓	↓	3.2	↓	↓
30-34	11.0	6.6	207	2.88	9.3	147	1.49
35-39	18.0	15.0	120	0.69	21.1	85	−0.61
40-44	50.0	33.7	148	2.50	47.5	105	0.32
45-49	104.0	65.5	159	4.24	92.4	113	1.08
50-54	122.0	80.9	151	4.07	114.1	107	0.66
55-59	181.0	117.4	154	5.23	165.6	109	1.07
60-64	129.0	120.1	107	0.73	169.3	76	−2.76
18-64	623.0	441.8	141		623.0	100	
Total chi-squared				77.4			13.1
Degrees of freedom				7			6
Probability value				0.0000			0.0421

Table A7.4b: Males, DP26, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.1	↓	↓
25-29	1.0	0.3	↓	↓	0.4	↓	↓
30-34	3.0	0.7	↓	↓	1.0	↓	↓
35-39	2.0	1.4	↓	↓	2.1	↓	↓
40-44	8.0	3.5	240	3.01	5.3	157	1.51
45-49	9.0	7.5	120	0.50	11.4	79	−0.64
50-54	8.0	7.6	105	0.13	11.6	69	-0.95
55-59	15.0	8.2	160	1.95	12.5	120	0.64
60-64	6.0	4.9	↑	↑	7.5	79	−0.50
18-64	52.0	34.0	153		52.0	100	
Total chi-squared				13.1			4.3
Degrees of freedom				4			4
Probability value				0.0106			0.37

Table A7.4c: Males, DP26, C.M.I. Class 3

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	1.0	0.2	↓	↓	0.4	↓	↓
30-34	2.0	0.4	↓	↓	0.9	↓	↓
35-39	1.0	0.9	↓	↓	1.9	↓	↓
40-44	7.0	2.5	↓	↓	5.1	143	1.12
45-49	13.0	5.3	269	4.59	11.1	117	0.52
50-54	3.0	4.8	↓	↓	10.1	30	−1.99
55-59	11.0	4.5	165	2.07	9.3	118	0.50
60-64	7.0	3.4	↑	↑	7.2	98	−0.05
18-64	46.0	22.0	209		46.0	100	
Total chi-squared				25.3			5.7
Degrees of freedom				2			4
Probability value				0.0000			0.22

Table A7.4d: Males, DP26, C.M.I. Class 4

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.1	↓	↓
25-29	2.0	0.2	↓	↓	0.5	↓	↓
30-34	2.0	0.3	↓	↓	1.0	↓	↓
35-39	2.0	0.7	↓	↓	2.1	↓	↓
40-44	11.0	1.4	↓	↓	4.4	207	2.73
45-49	6.0	2.7	443	6.97	8.7	69	-0.80
50-54	6.0	2.6	↓	↓	8.6	70	−0.78
55-59	7.0	2.5	235	3.14	8.3	85	−0.40
60-64	3.0	1.6	↑	↑	5.3	57	−0.88
18-64	39.0	12.0	325		39.0	100	
Total chi-squared				58.4			9.6
Degrees of freedom				2			4
Probability value				0.0000			0.0474

Table A7.4e: Males, DP26, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.3	↓	↓	0.5	↓	↓
25-29	6.0	2.2	↓	↓	3.3	↓	↓
30-34	11.0	6.0	209	2.85	8.8	143	1.36
35-39	33.0	15.5	213	3.97	22.6	146	1.95
40-44	53.0	39.4	135	1.93	57.6	92	−0.54
45-49	109.0	76.0	143	3.37	111.2	98	−0.19
50-54	174.0	96.1	181	7.08	140.6	124	2.51
55-59	168.0	119.2	141	3.98	174.3	96	−0.43
60-64	100.0	93.0	108	0.65	136.0	74	−2.75
18-64	655.0	447.7	146		655.0	100	
Total chi-squared				105.4			20.0
Degrees of freedom				7			6
Probability value				0.0000			0.0028

Table A7.4f: Males, DP26, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	5.0	0.8	↓	↓	1.2	↓	↓
25-29	15.0	5.1	340	5.19	7.5	230	3.42
30-34	29.0	14.0	207	3.56	20.7	140	1.62
35-39	56.0	33.4	168	3.48	49.4	113	0.84
40-44	129.0	80.4	161	4.83	118.8	109	0.84
45-49	241.0	157.0	154	5.98	232.0	104	0.53
50-54	313.0	192.1	163	7.77	283.9	110	1.54
55-59	382.0	251.8	152	7.31	372.0	103	0.46
60-64	245.0	223.0	110	1.31	329.6	74	−4.15
18-64	1,415.0	957.5	148		1,415.0	100	
Total chi-squared				226.4			35.8
Degrees of freedom				8			7
Probability value				0.0000			0.0000

Table A7.5. Males, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 52 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.5a: Males, DP52, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.0	↓	↓
25-29	2.0	0.1	↓	↓	0.4	↓	↓
30-34	0.0	1.5	↓	↓	4.1	↓	↓
35-39	8.0	3.1	↓	↓	8.6	84	−0.50
40-44	17.0	6.2	257	4.62	17.0	100	−0.01
45-49	58.0	12.3	470	11.58	34.1	170	3.64
50-54	48.0	16.4	293	6.97	45.2	106	0.37
55-59	62.0	24.0	259	6.92	66.2	94	−0.46
60-64	50.0	25.5	196	4.33	70.4	71	−2.16
18-64	246.0	89.0	276		246.0	100	
Total chi-squared				270.6			18.6
Degrees of freedom				5			5
Probability value				0.0000			0.0023

Table A7.5b: Males, DP52, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.0	↓	↓
25-29	0.0	0.0	↓	↓	0.1	↓	↓
30-34	0.0	0.1	↓	↓	0.3	↓	↓
35-39	0.0	0.1	↓	↓	0.5	↓	↓
40-44	1.0	0.3	↓	↓	1.1	↓	↓
45-49	2.0	0.6	↓	↓	2.1	↓	↓
50-54	4.0	0.8	↓	↓	2.9	100	-0.01
55-59	1.0	0.7	↓	↓	2.8	↓	↓
60-64	4.0	0.6	378	4.42	2.2	101	0.01
18-64	12.0	3.2	378		12.0	100	
Total chi-squared				19.5			0.0
Degrees of freedom				1			1
Probability value				0.0000			0.99

Table A7.5c: Males, DP52, C.M.I. Class 3

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.0	↓	↓
25-29	0.0	0.0	↓	↓	0.2	↓	↓
30-34	1.0	0.1	↓	↓	0.5	↓	↓
35-39	7.0	0.1	↓	↓	0.9	↓	↓
40-44	1.0	0.2	↓	↓	2.1	↓	↓
45-49	4.0	0.4	↓	↓	3.9	170	1.72
50-54	7.0	0.5	↓	↓	4.9	↓	↓
55-59	0.0	0.5	↓	↓	4.2	57	−1.36
60-64	0.0	0.4	918	10.76	3.3	↑	↑
18-64	20.0	2.2	918		20.0	100	
Total chi-squared				115.8			4.8
Degrees of freedom				1			1
Probability value				0.0000			0.0283

Table A7.5e: Males, DP52, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.0	↓	↓
25-29	2.0	0.2	↓	↓	0.4	↓	↓
30-34	3.0	0.8	↓	↓	2.1	↓	↓
35-39	4.0	2.3	↓	↓	6.3	100	0.01
40-44	15.0	5.7	265	4.43	15.5	97	−0.12
45-49	38.0	13.1	289	6.11	35.6	107	0.36
50-54	63.0	19.6	321	8.73	53.1	119	1.21
55-59	75.0	27.9	269	7.96	75.4	99	−0.04
60-64	54.0	24.2	223	5.41	65.4	83	−1.26
18-64	254.0	93.8	271		254.0	100	
Total chi-squared				225.7			3.2
Degrees of freedom				5			5
Probability value				0.0000			0.67

Table A7.5f: Males, DP52, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	4.0	0.4	↓	↓	1.0	↓	↓
30-34	4.0	2.4	↓	↓	6.8	114	0.35
35-39	19.0	5.8	326	5.91	16.3	117	0.60
40-44	34.0	12.5	271	5.40	35.4	96	−0.21
45-49	103.0	26.7	385	13.14	75.4	137	2.83
50-54	123.0	37.6	327	12.42	105.9	116	1.48
55-59	139.0	53.3	261	10.46	150.3	92	−0.82
60-64	108.0	51.0	212	7.12	143.7	75	−2.66
18-64	535.0	189.7	282		535.0	100	
Total chi-squared				550.7			18.4
Degrees of freedom				6			6
Probability value				0.0000			0.0052

Note: Table A7.5d was omitted due to low data volumes (actual inceptions being less than 10).

Table A7.6. Females, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 1 week. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.6a: Females, DP1, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	21.0	27.0	78	−0.76	32.6	64	−1.34
25-29	122.0	184.0	66	−3.02	222.5	55	−4.45
30-34	132.0	133.4	99	−0.08	161.3	82	−1.52
35-39	178.0	167.1	107	0.56	202.0	88	−1.11
40-44	234.0	177.0	132	2.83	214.0	109	0.90
45-49	239.0	143.5	167	5.27	173.5	138	3.29
50-54	191.0	110.4	173	5.06	133.5	143	3.29
55-59	109.0	78.3	139	2.30	94.6	115	0.98
60-64	40.0	26.6	151	1.72	32.1	125	0.92
18-64	1,266.0	1,047.3	121		1,266.0	100	
Total chi-squared				79.7			49.4
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Table A7.6f: Females, DP1, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	21.0	27.2	77	−0.79	32.8	64	−1.37
25-29	123.0	184.7	67	−3.00	223.1	55	−4.43
30-34	132.0	134.1	98	−0.12	161.9	82	−1.55
35-39	180.0	167.6	107	0.63	202.3	89	−1.04
40-44	234.0	178.8	131	2.73	215.8	108	0.82
45-49	242.0	144.8	167	5.34	174.8	138	3.36
50-54	193.0	113.0	171	4.97	136.5	141	3.20
55-59	110.0	78.8	140	2.32	95.1	116	1.01
60-64	40.0	26.9	149	1.67	32.5	123	0.87
18-64	1,275.0	1,055.9	121		1,275.0	100	
Total chi-squared				78.9			48.9
Degrees of freedom				9			8
Probability value				0.0000			0.0000

Note: Tables A7.6b, A7.6c, A7.6d and A7.6e were omitted due to low data volumes (actual inceptions being less than 10).

Table A7.7. Females, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 4 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.7a: Females, DP4, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	22.0	11.5	192	2.40	16.2	136	1.12
25-29	72.0	77.8	93	−0.51	109.6	66	−2.77
30-34	77.0	39.5	195	4.59	55.7	138	2.20
35-39	60.0	47.4	127	1.42	66.7	90	−0.64
40-44	81.0	50.4	161	3.32	71.1	114	0.91
45-49	80.0	49.7	161	3.31	70.0	114	0.92
50-54	53.0	36.3	146	2.13	51.2	104	0.19
55-59	42.0	23.9	176	2.86	33.6	125	1.11
60-64	4.0	12.0	33	−1.78	16.9	24	−2.42
18-64	491.0	348.5	141		491.0	100	
Total chi-squared				67.0			23.0
Degrees of freedom				9			8
Probability value				0.0000			0.0034

Table A7.7b: Females, DP4, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	5.0	2.1	↓	↓	4.0	↓	↓
25-29	14.0	6.2	230	2.88	12.0	119	0.59
30-34	10.0	7.0	143	0.87	13.6	74	−0.74
35-39	9.0	6.0	150	0.95	11.6	78	−0.58
40-44	14.0	6.3	222	2.37	12.2	115	0.41
45-49	15.0	5.5	272	3.12	10.7	141	1.03
50-54	5.0	3.8	↓	↓	7.3	72	−0.72
55-59	3.0	1.9	139	0.72	3.6	↑	↑
60-64	0.0	0.1	↑	↑	0.2	↑	↑
18-64	75.0	38.8	193		75.0	100	
Total chi-squared				25.8			3.0
Degrees of freedom				6			5
Probability value				0.0002			0.70

Table A7.7c: Females, DP4, C.M.I. Class 3

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.5	↓	↓	1.5	↓	↓
25-29	1.0	0.9	↓	↓	2.9	↓	↓
30-34	4.0	1.0	↓	↓	3.2	66	−0.73
35-39	8.0	1.2	↓	↓	3.9	↓	↓
40-44	3.0	1.3	↓	↓	4.4	132	0.71
45-49	6.0	1.5	336	5.16	5.0	119	0.33
50-54	5.0	1.1	↑	↑	3.6	↓	↓
55-59	0.0	0.7	↑	↑	2.4	83	−0.32
60-64	0.0	0.0	↑	↑	0.0	↑	↑
18-64	27.0	8.0	336		27.0	100	
Total chi-squared				26.6			1.3
Degrees of freedom				1			3
Probability value				0.0000			0.74

Table A7.7e: Females, DP4, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	14.0	7.2	195	1.97	10.0	140	0.98
25-29	24.0	16.3	147	1.46	22.8	105	0.19
30-34	30.0	18.7	161	2.02	26.1	115	0.60
35-39	38.0	25.3	150	1.95	35.3	108	0.36
40-44	45.0	33.0	136	1.61	46.0	98	−0.12
45-49	34.0	30.3	112	0.52	42.2	81	−0.98
50-54	31.0	19.2	162	2.09	26.7	116	0.64
55-59	10.0	11.3	86	−0.40	15.8	61	−1.26
60-64	1.0	1.5	↑	↑	2.1	↑	↑
18-64	227.0	162.8	139		227.0	100	
Total chi-squared				21.3			4.4
Degrees of freedom				8			7
Probability value				0.0065			0.73

Table A7.7f: Females, DP4, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	41.0	21.2	193	3.31	31.2	132	1.36
25-29	111.0	101.3	110	0.74	148.8	75	−2.39
30-34	121.0	66.4	182	5.17	97.5	124	1.84
35-39	115.0	79.8	144	3.04	117.2	98	−0.16
40-44	143.0	91.2	157	4.18	134.0	107	0.60
45-49	136.0	87.2	156	4.03	128.2	106	0.53
50-54	94.0	60.3	156	3.34	88.6	106	0.44
55-59	55.0	37.8	145	2.15	55.6	99	−0.06
60-64	5.0	13.6	37	−1.80	19.9	25	−2.58
18-64	821.0	558.9	147		821.0	100	
Total chi-squared				100.3			18.5
Degrees of freedom				9			8
Probability value				0.0000			0.0180

Note: Table A7.7d was omitted due to low data volumes (actual inceptions being less than 10).

Table A7.8. Females, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 13 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.8a: Females, DP13, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	2.0	0.8	↓	↓	1.5	↓	↓
25-29	19.0	4.5	396	6.31	9.1	198	2.95
30-34	32.0	9.6	334	6.70	19.2	167	2.70
35-39	19.0	12.9	147	1.56	25.9	73	−1.25
40-44	34.0	16.5	206	3.97	33.1	103	0.14
45-49	26.0	16.3	159	2.21	32.8	79	−1.09
50-54	21.0	12.8	164	2.11	25.7	82	−0.86
55-59	17.0	9.3	154	1.75	18.7	91	−0.37
60-64	2.0	3.0	↑	↑	6.0	33	−1.51
18-64	172.0	85.8	200		172.0	100	
Total chi-squared				115.3			21.9
Degrees of freedom				7			7
Probability value				0.0000			0.0026

Table A7.8b: Females, DP13, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.3	↓	↓	0.8	↓	↓
25-29	4.0	1.0	↓	↓	3.0	↓	↓
30-34	6.0	1.2	↓	↓	3.7	145	1.15
35-39	4.0	1.6	↓	↓	5.0	81	-0.40
40-44	8.0	1.8	388	6.48	5.6	142	0.91
45-49	4.0	2.2	↓	↓	6.9	58	−1.02
50-54	6.0	1.9	↓	↓	5.9	81	−0.57
55-59	2.0	1.1	219	2.57	3.2	↑	↑
60-64	0.0	0.3	↑	↑	0.8	↑	↑
18-64	35.0	11.4	306		35.0	100	
Total chi-squared				48.6			3.7
Degrees of freedom				2			4
Probability value				0.0000			0.45

Table A7.8e: Females, DP13, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	5.0	1.8	↓	↓	3.3	↓	↓
25-29	10.0	5.3	211	2.73	9.7	115	0.51
30-34	19.0	7.8	243	3.69	14.3	133	1.14
35-39	30.0	11.5	262	5.06	21.0	143	1.82
40-44	26.0	17.2	151	1.96	31.5	83	−0.91
45-49	41.0	22.5	183	3.62	41.1	100	−0.02
50-54	25.0	16.9	148	1.82	30.9	81	−0.98
55-59	20.0	11.3	154	1.89	20.7	96	−0.15
60-64	2.0	3.0	↑	↑	5.4	37	-1.35
18-64	178.0	97.2	183		178.0	100	
Total chi-squared				70.5			8.5
Degrees of freedom				7			7
Probability value				0.0000			0.29

Table A7.8f: Females, DP13, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	9.0	2.9	↓	↓	5.8	154	1.21
25-29	33.0	11.0	300	6.93	21.9	151	2.20
30-34	58.0	18.9	307	8.31	37.5	155	3.10
35-39	53.0	26.3	201	4.81	52.1	102	0.11
40-44	69.0	35.9	192	5.10	71.2	97	−0.24
45-49	72.0	41.4	174	4.39	82.1	88	−1.03
50-54	53.0	32.0	166	3.43	63.5	84	−1.21
55-59	39.0	21.9	178	3.37	43.5	90	−0.62
60-64	4.0	6.3	64	−0.83	12.4	32	−2.20
18-64	390.0	196.8	198		390.0	100	
Total chi-squared				209.2			23.8
Degrees of freedom				8			8
Probability value				0.0000			0.0025

Note: Tables A7.8c and A7.8d were omitted due to low data volumes (actual inceptions being less than 10).

Table A7.9. Females, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 26 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.9a: Females, DP26, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.4	↓	↓	1.6	↓	↓
25-29	9.0	1.7	↓	↓	6.4	125	0.63
30-34	14.0	2.8	482	7.59	10.3	136	1.03
35-39	18.0	4.3	↓	↓	15.9	114	0.48
40-44	27.0	6.3	425	9.43	23.0	118	0.75
45-49	21.0	8.0	264	4.12	29.2	72	−1.36
50-54	42.0	8.2	515	10.56	29.9	140	1.97
55-59	26.0	8.8	249	4.82	32.2	81	−0.98
60-64	7.0	4.5	↑	↑	16.5	42	−2.08
18-64	165.0	44.9	367		165.0	100	
Total chi-squared				298.2			13.2
Degrees of freedom				5			7
Probability value				0.0000			0.0664

Table A7.9b: Females, DP26, C.M.I. Class 2

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.3	↓	↓
25-29	2.0	0.2	↓	↓	1.3	↓	↓
30-34	1.0	0.2	↓	↓	1.7	↓	↓
35-39	2.0	0.3	↓	↓	1.9	98	-0.04
40-44	4.0	0.3	↓	↓	2.3	↓	↓
45-49	7.0	0.7	↓	↓	4.8	155	1.31
50-54	3.0	0.6	↓	↓	4.2	↓	↓
55-59	2.0	0.5	↓	↓	3.5	57	-1.15
60-64	0.0	0.2	678	9.07	1.1	↑	↑
18-64	21.0	3.1	678		21.0	100	
Total chi-squared				82.2			3.0
Degrees of freedom				1			2
Probability value				0.0000			0.22

Table A7.9e: Females, DP26, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	2.0	0.2	↓	↓	1.0	↓	↓
25-29	8.0	1.0	↓	↓	4.6	177	1.63
30-34	15.0	1.7	↓	↓	8.3	182	2.09
35-39	23.0	2.7	849	15.87	13.1	175	2.43
40-44	22.0	5.1	434	6.70	24.2	91	-0.40
45-49	39.0	7.9	495	9.87	37.7	104	0.19
50-54	37.0	8.4	441	8.79	40.1	92	-0.44
55-59	26.0	7.3	298	5.40	35.1	74	-1.37
60-64	2.0	2.1	↑	↑	9.9	20	-2.23
18-64	174.0	36.4	478		174.0	100	
Total chi-squared				500.7			20.2
Degrees of freedom				5			7
Probability value				0.0000			0.0052

Table A7.9f: Females, DP26, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	4.0	0.7	↓	↓	3.1	↓	↓
25-29	20.0	2.9	↓	↓	12.5	154	1.89
30-34	30.0	4.8	639	13.96	20.7	145	1.82
35-39	44.0	7.4	595	12.00	31.8	139	1.93
40-44	54.0	11.7	460	10.99	50.4	107	0.45
45-49	67.0	16.7	402	10.98	71.6	94	−0.49
50-54	83.0	17.3	481	14.09	74.2	112	0.91
55-59	54.0	16.7	323	8.13	71.7	75	−1.86
60-64	9.0	6.7	134	0.78	28.9	31	−3.30
18-64	365.0	84.9	430		365.0	100	
Total chi-squared				845.4			26.3
Degrees of freedom				7			7
Probability value				0.0000			0.0004

Note: Tables A7.9c and A7.9d were omitted due to low data volumes (actual inceptions being less than 10).

Table A7.10. Females, individual policies, Standard* experience for the quadrennium 1991-94. Deferred period 52 weeks. Occupational class 1, 2, 3, 4, unknown and all combined. Comparison of actual claim inceptions by quinquennial age group to those expected using the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table A7.10a: Females, DP52, C.M.I. Class 1

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	0.0	0.1	↓	↓	0.7	↓	↓
30-34	3.0	0.7	↓	↓	4.0	↓	↓
35-39	3.0	0.9	↓	↓	5.6	67	−0.94
40-44	6.0	1.4	↓	↓	8.4	72	−0.73
45-49	10.0	1.9	596	13.54	11.4	88	−0.37
50-54	14.0	2.0	↑	↑	12.0	117	0.52
55-59	16.0	1.7	↑	↑	10.0	137	1.23
60-64	3.0	0.6	↑	↑	3.8	↑	↑
18-64	56.0	9.4	596		56.0	100	
Total chi-squared				183.3			3.3
Degrees of freedom				1			4
Probability value				0.0000			0.51

Table A7.10e: Females, DP52, C.M.I. Class Unknown

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	0.0	0.0	↓	↓	0.0	↓	↓
25-29	0.0	0.1	↓	↓	0.5	↓	↓
30-34	1.0	0.2	↓	↓	1.6	↓	↓
35-39	7.0	0.5	↓	↓	3.3	148	0.99
40-44	5.0	0.9	↓	↓	5.9	85	−0.33
45-49	14.0	1.6	↓	↓	10.5	133	0.95
50-54	13.0	1.8	671	14.30	12.0	108	0.25
55-59	13.0	2.0	↑	↑	13.4	97	−0.11
60-64	0.0	0.8	↑	↑	5.7	0	−2.12
18-64	53.0	7.9	671		53.0	100	
Total chi-squared				204.5			6.6
Degrees of freedom				1			5
Probability value				0.0000			0.25

Table A7.10f: Females, DP52, All business

AGE GROUP	AINC	EINC	100xA/E	Z	EINC*	100xA/E*	Z*
18-24	1.0	0.0	↓	↓	0.1	↓	↓
25-29	0.0	0.2	↓	↓	1.5	↓	↓
30-34	4.0	0.9	↓	↓	6.3	63	−0.93
35-39	12.0	1.5	↓	↓	10.0	120	0.57
40-44	15.0	2.4	634	10.69	15.8	95	−0.18
45-49	28.0	3.6	↓	↓	24.2	116	0.69
50-54	28.0	4.0	736	15.63	26.7	105	0.23
55-59	29.0	3.8	↓	↓	25.3	115	0.65
60-64	3.0	1.5	604	10.34	10.1	30	−1.99
18-64	120.0	17.9	669		120.0	100	
Total chi-squared				465.5			6.1
Degrees of freedom				3			6
Probability value				0.0000			0.41

Note : Tables A7.10b, A7.10c and A7.10d were omitted due to low data volumes (actual inceptions being less than 10).

Table A8. Summary of termination experience for individual PHI claims 1991-94. Standard* experience. Occupational class 1, 2, 3, 4, unknown and all combined.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
(a) Males, recoveries						
Class 1	**100**	61	49	43	*31*	**82**
Class 2	*48*	53	55	48	-	53
Class 3	36	**54**	55	*36*	-	53
Class 4	-	**55**	52	57	-	**54**
Class Unknown	-	58	**68**	59	103	**64**
All business	**98**	**56**	56	**48**	49	**69**
(b) Females, recoveries						
Class 1	96	59	50	40	-	**72**
Class 2	-	48	43	*45*	-	46
Class 3	-	56	-	-	-	52
Class 4	-	-	-	-	-	-
Class Unknown	-	*59*	68	*65*	-	67
All business	95	57	**52**	44	*42*	**67**
(c) Males, deaths						
Class 1	48	58	80	61	86	63
Class 2	-	*57*	*52*	-	-	50
Class 3	-	*25*	*50*	-	-	36
Class 4	-	*31*	*41*	-	-	34
Class Unknown	-	*73*	64	75	*89*	70
All business	48	47	63	59	76	56
(d) Females, deaths						
Class 1	-	-	*50*	*65*	-	44
Class 2	-	-	-	-	-	-
Class 3	-	-	-	-	-	-
Class 4	-	-	-	-	-	-
Class Unknown	-	-	-	-	-	*68*
All business	-	*27*	*45*	*65*	*47*	44

Note:
Italic if actual numbers of recoveries or deaths is less than 30.
Not shown if actual numbers of recoveries or deaths is less than 10.
Bold if either $p(+/-)$ or $p(B) < 0.025$ for adjusted E.

Table A9.1. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 1.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	4,660	1,251	345	147	25	6,428
E	4,660.5	2,052.6	699.2	343.0	81.4	7,836.8
100*A*/*E*						
Durations:						
1-2 weeks	127	-	-	-	-	127
2-3 weeks	116	-	-	-	-	116
3-4 weeks	90	-	-	-	-	90
4-8 weeks	79	59	-	-	-	70
8-13 weeks	70	57	-	-	-	62
13-17 weeks	56	67	65	-	-	64
17-26 weeks	41	66	43	-	-	51
26-30 weeks	*55*	80	*47*	*75*	-	64
30-39 weeks	*45*	57	49	37	-	47
39 wks-1 yr	*41*	63	*40*	*46*	-	48
1-2 years	49	52	54	37	*32*	46
2-5 years	↓	↓	↓	↓	↓	45
5-11 years	58	72	*51*	*39*	*29*	87
Ages:						
20-24	*113*	*47*	↓	↓	↓	66
25-29	87	61	*83*	↓	↓	73
30-34	120	61	*33*	*49*	↓	94
35-39	127	61	47	*45*	↓	100
40-44	113	64	50	*55*	*33*	92
45-49	97	63	48	38	*25*	80
50-54	93	56	52	42	*29*	77
55-59	75	55	43	*29*	↓	63
60-64	↓	77	↓	↓	*37*	↓
65-65	97	-	67	*74*	-	89
All cells	100	61	49	43	*31*	82
Using *E*						
Σz^2	458.87	332.54	176.55	113.31	35.18	1,081.90
df	75	61	39	22	6	101
$p(\chi^2)$	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
#(+/−)	19/56	3/58	1/38	0/22	0/6	18/83
$p(+/-)$	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0313**	**0.0000**
$p(B)$	**0.000**	0.054	1.0	1.0	1.0	**0.000**
Using adjusted *E*						
Σz^2	458.93	45.91	12.39	6.05	-	1,021.70
df	74	51	23	11	-	98
$p(\chi^2)$	**0.0000**	0.68	0.96	0.87	-	**0.0000**
#(+/−)	19/56	24/28	13/11	5/7	-	28/71
$p(+/-)$	**0.0000**	0.68	0.84	0.77	-	**0.0000**
$p(B)$	**0.000**	0.625	0.688	0.748	-	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A9.2. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 2.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	18	433	153	30	4	638
E	37.5	824.0	280.0	63.0	8.0	1,212.4
100*A*/*E*						
Durations:						
1-4 weeks	*62*	-	-	-	-	*62*
4-8 weeks	↓	39	-	-	-	39
8-13 weeks	↓	56	-	-	-	55
13-17 weeks	↓	51	*52*	-	-	51
17-26 weeks	↓	65	49	-	-	56
26-30 weeks	↓	*16*	*71*	↓	-	*44*
30-39 weeks	↓	*40*	*47*	↓	-	37
39 wks-1 yr	↓	*72*	*74*	*24*	-	63
1-2 years	↓	117	*68*	↓	↓	83
2-11 years	*31*	*80*	*38*	*73*	*50*	63
Ages:						
19-24	-	*75*	↓	-	-	*69*
25-29	-	52	*46*	↓	↓	50
30-34	-	47	*84*	↓	↓	54
35-39	↓	46	*55*	*52*	↓	49
40-44	*65*	49	*53*	↓	↓	50
45-49	↓	59	51	*63*	↓	57
50-54	↓	66	58	↓	↓	60
55-59	↓	48	↓	↓	↓	46
60-64	*32*	*60*	*40*	↓	*50*	↓
65-65	-	-	-	*30*	-	*42*
All cells	*48*	53	55	48	*50*	53
Using *E*						
Σz^2	9.95	218.92	65.54	19.20	1.50	293.20
df	2	40	21	6	1	56
$p(\chi^2)$	**0.0069**	**0.0000**	**0.0000**	**0.0038**	0.22	**0.0000**
#(+/−)	0/2	4/36	3/18	0/6	0/1	2/54
$p(+/-)$	0.50	**0.0000**	**0.0015**	**0.0313**	1.0	**0.0000**
$p(B)$	1.0	0.108	0.277	1.0	1.0	0.769
Using adjusted *E*						
Σz^2	-	44.59	7.31	-	-	60.63
df	-	27	12	-	-	41
$p(\chi^2)$	-	**0.0180**	0.84	-	-	**0.0247**
#(+/−)	-	10/18	5/8	-	-	17/25
$p(+/-)$	-	0.18	0.58	-	-	0.28
$p(B)$	-	0.113	0.631	-	-	0.225

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A9.3. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 3.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	30	1,156	223	24	6	1,439
E	84.2	2,144.3	406.3	66.3	18.1	2,719.3
100*A*/*E*						
Durations:						
1-4 weeks	*35*	-	-	-	-	*35*
4-8 weeks	↓	44	-	-	-	43
8-13 weeks	*30*	55	-	-	-	54
13-17 weeks	↓	57	75	-	-	60
17-26 weeks	↓	56	38	-	-	49
26-30 weeks	↓	47	*42*	↓	-	47
30-39 weeks	↓	68	*54*	↓	-	59
39 wks-1 yr	↓	73	*50*	*23*	-	60
1-2 years	↓	65	72	↓	↓	64
2-11 years	*45*	101	*92*	*50*	*33*	82
Ages:						
18-24	-	50	↓	↓	-	54
25-29	-	50	*49*	↓	↓	49
30-34	-	47	*42*	↓	↓	46
35-39	-	59	63	↓	↓	59
40-44	↓	51	51	*33*	↓	51
45-49	↓	53	65	*49*	↓	54
50-54	*38*	60	63	↓	↓	58
55-59	↓	63	↓	↓	↓	55
60-64	*33*	59	*47*	*31*	*33*	51
All cells	36	54	55	*36*	*33*	53
Using *E*						
Σz^2	32.10	494.97	97.62	25.52	7.45	639.37
df	6	61	29	5	1.0	71
$p(\chi^2)$	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0063**	**0.0000**
#(+/−)	0/6	4/57	2/27	0/5	0/1	1/70
$p(+/-)$	**0.0313**	**0.0000**	**0.0000**	0.0625	1.0	**0.0000**
$p(B)$	1.0	0.063	0.667	1.0	1.0	0.108
Using adjusted *E*						
Σz^2	-	86.86	25.79	-	-	104.24
df	-	46	17	-	-	59
$p(\chi^2)$	-	**0.0003**	0.0784	-	-	**0.0003**
#(+/−)	-	26/21	8/10	-	-	29/31
$p(+/-)$	-	0.56	0.81	-	-	0.90
$p(B)$	-	**0.008**	0.396	-	-	0.292

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A9.4. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 4.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	2	770	233	30	5	1,040
E	5.0	1,411.7	447.2	53.0	4.6	1,921.6
100*A*/*E*						
Durations:						
1-8 weeks	↓	48	-	-	-	48
8-13 weeks	↓	50	-	-	-	50
13-17 weeks	↓	52	57	-	-	53
17-26 weeks	↓	66	38	-	-	53
26-30 weeks	↓	*68*	88	↓	-	76
30-39 weeks	↓	*45*	*48*	↓	-	46
39 wks-1 yr	↓	72	*54*	*46*	-	61
1-2 years	↓	84	64	↓	↓	69
2-11 years	*40*	*79*	*56*	*67*	*108*	77
Ages:						
19-24	-	*35*	↓	-	-	39
25-29	-	49	53	↓	↓	51
30-34	-	58	60	↓	↓	58
35-39	-	51	52	*56*	↓	51
40-44	-	59	49	↓	↓	57
45-49	-	63	57	↓	↓	61
50-54	-	57	*39*	↓	↓	52
55-59	*40*	↓	↓	↓	↓	50
60-64	-	50	*54*	*57*	*108*	*40*
All cells	*40*	55	52	57	*108*	54
Using *E*						
Σz^2	1.26	301.24	109.69	8.94	0.00	413.02
df	1	50	30	4	1	64
$p(\chi^2)$	0.26	**0.0000**	**0.0000**	0.0627	**0.0000**	**0.0000**
#(+/−)	0/1	1/49	1/29	0/4	1/0	2/62
p(+/−)	1.0	**0.0000**	**0.0000**	0.13	1.0	**0.0000**
p(*B*)	1.0	1.0	1.0	1.0	1.0	0.723
Using adjusted *E*						
Σz^2	-	47.56	21.72	-	-	49.04
df	-	37	18	-	-	53
$p(\chi^2)$	-	0.11	0.24	-	-	0.63
#(+/−)	-	15/23	9/10	-	-	26/28
p(+/−)	-	0.26	1.0	-	-	0.89
p(*B*)	-	**0.003**	0.406	-	-	**0.002**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A9.5. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = Unknown.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	9	244	415	104	30	802
E	19.9	422.7	614.2	176.4	29.3	1,262.5
100*A*/*E*						
Durations:						
1-8 weeks	↓	50	-	-	-	49
8-13 weeks	↓	70	-	-	-	69
13-17 weeks	↓	69	41	-	-	50
17-26 weeks	↓	↓	50	-	-	50
26-30 weeks	↓	50	81	*31*	-	69
30-39 weeks	↓	↓	64	*29*	-	53
39 wks-1 yr	↓	*59*	91	*56*	-	75
1-2 years	↓	↓	93	*56*	↓	75
2-5 years	↓	↓	↓	↓	↓	104
5-11 years	*45*	*35*	120	112	103	*127*
Ages:						
18-24	-	↓	↓	↓	↓	*88*
25-29	-	80	60	↓	↓	57
30-34	-	*100*	*63*	*32*	↓	73
35-39	↓	*78*	65	↓	↓	67
40-44	↓	*54*	70	*66*	↓	69
45-49	↓	57	73	72	↓	69
50-54	↓	47	74	*63*	↓	62
55-59	↓	57	66	↓	↓	60
60-64	↓	↓	*44*	*45*	103	↓
65-65	*45*	*31*	-	-	-	*34*
All cells	*45*	58	68	59	103	64
Using *E*						
Σz^2	5.40	90.70	105.08	41.20	0.00	229.13
df	1	26	40	14	1	64
$p(\chi^2)$	**0.0201**	**0.0000**	**0.0000**	**0.0002**	0.96	**0.0000**
#(+/−)	0/1	2/24	8/32	2/12	1/0	8/56
p(+/−)	1.0	**0.0000**	**0.0002**	**0.0129**	1.0	**0.0000**
p(*B*)	1.0	0.144	0.259	0.133	1.0	**0.002**
Using adjusted *E*						
Σz^2	-	29.39	58.26	27.45	-	100.94
df	-	16	29	8	-	51
$p(\chi^2)$	-	**0.0215**	**0.0010**	**0.0006**	-	**0.0000**
#(+/−)	-	7/10	15/15	4/5	-	22/30
p(+/−)	-	0.63	1.0	1.0	-	0.33
p(*B*)	-	0.288	**0.000**	0.351	-	**0.001**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A9.6. Males, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = All classes.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	4,719	3,854	1,369	335	70	10,347
E	4,807.0	6,855.4	2,446.9	701.8	141.4	14,952.5
100*A*/*E*						
Durations:						
1-2 weeks	126	-	-	-	-	126
2-3 weeks	114	-	-	-	-	114
3-4 weeks	90	-	-	-	-	90
4-8 weeks	77	49	-	-	-	57
8-13 weeks	68	56	-	-	-	57
13-17 weeks	53	59	58	-	-	58
17-26 weeks	40	61	44	-	-	52
26-30 weeks	*56*	58	65	60	-	61
30-39 weeks	*45*	56	53	31	-	49
39 wks-1 yr	*43*	68	61	44	-	58
1-2 years	49	70	70	48	42	61
2-5 years	↓	75	71	62	↓	66
5-11 years	59	*90*	*105*	*88*	61	95
Ages:						
18-24	*113*	49	*71*	↓	↓	56
25-29	87	53	53	*55*	↓	59
30-34	120	54	53	*39*	↓	70
35-39	127	56	56	*47*	*55*	74
40-44	112	56	56	61	*64*	73
45-49	95	59	58	51	*56*	71
50-54	91	57	59	48	*40*	69
55-59	73	56	50	32	↓	60
60-64	↓	↓	↓	↓	*41*	↓
65-65	92	64	56	*56*	-	76
All cells	98	56	56	48	49	69
Using *E*						
Σz^2	470.09	1,360.63	511.63	201.16	35.21	2,464.74
df	75	76	58	34	10	110
$p(\chi^2)$	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0000**
#(+/−)	18/57	2/74	3/55	0/34	0/10	17/93
$p(+/-)$	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0020**	**0.0000**
$p(B)$	**0.000**	0.309	0.362	1.0	1.0	**0.000**
Using adjusted *E*						
Σz^2	477.90	115.73	86.14	35.24	2.58	1,535.92
df	74	70	50	22	5	107
$p(\chi^2)$	**0.0000**	**0.0005**	**0.0012**	**0.0365**	0.77	**0.0000**
#(+/−)	21/54	37/34	29/22	11/12	2/4	35/73
$p(+/-)$	**0.0002**	0.81	0.40	1.0	0.69	**0.0003**
$p(B)$	**0.000**	**0.000**	0.363	**0.030**	0.357	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A10.1. Females, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 1.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	837	467	127	61	9	1,501
E	873.7	785.0	251.6	152.3	27.8	2,090.4
100*A*/*E*						
Durations:						
1-2 weeks	102	-	-	-	-	102
2-3 weeks	105	-	-	-	-	105
3-4 weeks	97	-	-	-	-	97
4-8 weeks	79	49	-	-	-	60
8-13 weeks	87	58	-	-	-	63
13-17 weeks	*74*	65	*35*	-	-	58
17-26 weeks	↓	72	50	-	-	63
26-30 weeks	↓	*57*	*64*	*40*	-	62
30-39 weeks	*82*	*49*	*44*	*38*	-	44
39 wks-1 yr	↓	*79*	*53*	*35*	-	57
1-2 years	↓	↓	*67*	*32*	↓	55
2-11 years	*90*	89	*49*	*62*	*32*	64
Ages:						
19-24	*66*	*73*	↓	↓	↓	68
25-29	76	54	*31*	*31*	↓	58
30-34	93	51	*36*	*33*	↓	59
35-39	101	54	*72*	*62*	↓	75
40-44	94	60	*73*	*82*	↓	77
45-49	110	64	*61*	*28*	↓	78
50-54	99	70	*39*	*12*	↓	76
55-59	99	↓	↓	↓	↓	79
60-64	*142*	80	*38*	*33*	*32*	130
All cells	96	59	50	40	*32*	72
Using *E*						
Σz^2	42.09	140.87	61.95	57.02	12.03	287.86
df	42	37	19	12	1	83
$p(\chi^2)$	0.47	**0.0000**	**0.0000**	**0.0000**	**0.0005**	**0.0000**
#(+/−)	18/24	3/34	0/19	0/12	0/1	13/70
$p(+/-)$	0.44	**0.0000**	**0.0000**	**0.0005**	1.0	**0.0000**
$p(B)$	0.608	0.064	1.0	1.0	1.0	**0.000**
Using adjusted *E*						
Σz^2	42.52	26.25	11.00	9.22	-	179.14
df	41	28	10	4	-	76
$p(\chi^2)$	0.41	0.56	0.36	0.0558	-	**0.0000**
#(+/−)	20/22	16/13	6/5	2/3	-	34/43
$p(+/-)$	0.88	0.71	1.0	1.0	-	0.36
$p(B)$	0.313	0.317	0.189	0.872	-	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A10.2. Females, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 2.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	3	129	45	14	2	193
E	7.9	269.5	105.6	31.3	6.2	420.5
$100A/E$						
Durations:						
1-8 weeks	↓	*34*	-	-	-	*33*
8-13 weeks	↓	39	-	-	-	39
13-17 weeks	↓	*49*	*33*	-	-	*44*
17-26 weeks	↓	*50*	↓	-	-	*35*
26-30 weeks	↓	↓	*24*	↓	-	*56*
30-39 weeks	↓	*69*	↓	↓	-	*54*
39 wks-1 yr	↓	↓	*40*	↓	-	*60*
1-2 years	↓	↓	↓	↓	↓	*76*
2-11 years	*38*	*105*	*100*	*45*	*32*	*82*
Ages:						
20-24	-	*33*	↓	↓	↓	*36*
25-29	↓	*37*	*45*	↓	↓	40
30-34	↓	*48*	↓	↓	↓	*46*
35-39	↓	*56*	*26*	↓	↓	*40*
40-44	↓	*59*	*24*	↓	↓	47
45-49	↓	*41*	↓	↓	↓	50
50-59	*38*	↓	*80*	*45*	*32*	↓
60-60	-	*74*	-	-	-	*69*
All cells	*38*	48	43	*45*	*32*	46
Using E						
Σz^2	2.44	82.22	42.19	8.99	2.22	126.91
df	1	19	8	1	1	31
$p(\chi^2)$	0.12	**0.0000**	**0.0000**	**0.0027**	0.14	**0.0000**
$\#(+/-)$	0/1	1/18	1/7	0/1	0/1	0/31
$p(+/-)$	1.0	**0.0001**	0.0703	1.0	1.0	**0.0000**
$p(B)$	1.0	0.325	0.592	1.0	1.0	1.0
Using adjusted E						
Σz^2	-	23.82	9.43	-	-	26.29
df	-	10	2	-	-	15
$p(\chi^2)$	-	**0.0081**	**0.0090**	-	-	**0.0350**
$\#(-/-)$	-	5/6	1/2	-	-	9/7
$p(+/-)$	-	1.0	1.0	-	-	0.80
$p(B)$	-	0.359	0.756	-	-	0.602

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A10.3. Females, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = C.M.I. Class 3.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	-	39	8	4	1	52
E	-	70.2	17.1	8.9	3.7	100.0
100*A*/*E*						
Durations:						
1-8 weeks	-	*20*	-	-	-	*20*
8-13 weeks	-	↓	-	-	-	*69*
13-17 weeks	-	*74*	↓	-	-	↓
17-26 weeks	-	↓	↓	-	-	*63*
26 wks-1 yr	-	↓	↓	↓	-	*72*
1-11 years	-	*62*	*47*	*45*	*27*	*31*
Ages:						
18-34	-	*71*	↓	↓	↓	*54*
35-39	-	↓	↓	↓	↓	*42*
40-44	-	*44*	↓	↓	↓	*50*
45-59	-	*64*	↓	*45*	*27*	↓
60-60	-	-	*47*	-	-	*59*
All cells	-	56	*47*	*45*	*27*	52
Using *E*						
Σz^2	-	16.44	4.34	2.18	1.30	25.75
df	-	4	1	1	1	7
$p(\chi^2)$	-	**0.0025**	**0.0372**	0.14	0.25	**0.0006**
#(+/−)	-	0/4	0/1	0/1	0/1	0/7
p(+/−)	-	0.13	1.0	1.0	1.0	**0.0156**
p(*B*)	-	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	0.00	-	-	-	0.16
df	-	1	-	-	-	2
$p(\chi^2)$	-	**0.0000**	-	-	-	0.92
#(+/−)	-	1/1	-	-	-	1/2
p(+/−)	-	1.0	-	-	-	1.0
p(*B*)	-	1.0	-	-	-	1.0

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A10.5. Females, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = Unknown.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	2	16	62	25	8	113
E	1.8	27.3	91.5	38.4	8.8	167.8
100*A*/*E*						
Durations:						
1-13 weeks	↓	↓	-	-	-	*39*
13-17 weeks	↓	↓	↓	-	-	*57*
17-30 weeks	↓	↓	*37*	↓	-	*38*
30-39 weeks	↓	↓	↓	↓	-	*39*
39 wks-1 yr	↓	↓	*76*	*36*	-	*86*
1-2 years	↓	↓	↓	↓	↓	*103*
2-11 years	*112*	*59*	*152*	*106*	*91*	*153*
Ages:						
20-29	-	↓	*37*	↓	↓	*50*
30-34	-	↓	↓	↓	↓	*84*
35-39	-	↓	*69*	*92*	↓	*78*
40-44	-	↓	↓	↓	↓	*102*
45-49	*112*	↓	↓	↓	↓	*67*
50-54	-	↓	↓	↓	↓	*56*
55-59	-	*59*	↓	*43*	*91*	↓
60-62	-	-	82	-	-	*18*
All cells	*112*	*59*	68	*65*	*91*	67
Using *E*						
Σz^2	0.00	4.28	27.48	8.22	0.01	38.80
df	1	1	6	3	1	14
$p(\chi^2)$	**0.0000**	**0.0386**	**0.0001**	**0.0417**	0.92	**0.0004**
#(+/−)	1/0	0/1	2/4	1/2	0/1	2/12
$p(+/-)$	1.0	1.0	0.69	1.0	1.0	**0.0129**
$p(B)$	1.0	1.0	0.205	0.673	1.0	0.348
Using adjusted *E*						
Σz^2	-	-	22.49	-	-	28.50
df	-	-	3	-	-	7
$p(\chi^2)$	-	-	**0.0001**	-	-	**0.0002**
#(+/−)	-	-	1/3	-	-	4/4
$p(+/-)$	-	-	0.63	-	-	1.0
$p(B)$	-	-	0.488	-	-	0.641

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A10.6. Females, individual policies, 1991-94, Standard* experience, recoveries. Occupational class = All classes.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	842	653	246	105	20	1,866
E	883.4	1,154.9	470.7	237.6	47.5	2,794.10
100*A*/*E*						
Durations:						
1-2 weeks	101	-	-	-	-	101
2-3 weeks	104	-	-	-	-	104
3-4 weeks	97	-	-	-	-	97
4-8 weeks	79	44	-	-	-	54
8-13 weeks	85	54	-	-	-	58
13-17 weeks	*78*	64	*39*	-	-	57
17-26 weeks	↓	65	40	-	-	54
26-30 weeks	↓	*63*	*53*	*29*	-	55
30-39 weeks	*84*	*54*	*48*	*36*	-	45
39 wks-1 yr	↓	*89*	*60*	*49*	-	65
1-2 years	↓	82	84	*39*	*36*	62
2-5 years	↓	↓	↓	↓	↓	68
5-11 years	*88*	*103*	*91*	*70*	*51*	*146*
Ages:						
18-24	*66*	59	↓	↓	↓	59
25-29	76	49	34	*44*	↓	53
30-34	93	*51*	44	*51*	↓	*59*
35-39	101	54	49	*66*	↓	68
40-44	94	59	72	*64*	*45*	72
45-49	107	57	70	*32*	↓	71
50-54	99	71	*53*	*15*	↓	75
55-59	99	↓	↓	↓	↓	72
60-64	*142*	71	*39*	*36*	*39*	127
All cells	95	57	52	44	*42*	67
Using *E*						
Σz^2	40.95	244.15	120.44	80.44	14.10	459.15
df	42	43	33	20	4	88
$p(\chi^2)$	0.52	**0.0000**	**0.0000**	**0.0000**	**0.0070**	**0.0000**
#(+/−)	18/24	4/39	2/31	1/19	0/4	13/75
p(+/−)	0.44	**0.0000**	**0.0000**	**0.0000**	0.13	**0.0000**
p(*B*)	0.545	0.183	0.297	0.797	1.0	**0.000**
Using adjusted *E*						
Σz^2	39.52	49.41	34.76	17.94	-	228.51
df	39	34	19	7	-	82
$p(\chi^2)$	0.45	**0.0426**	**0.0149**	**0.0123**	-	**0.0000**
#(+/−)	20/20	20/15	10/10	4/4	-	40/43
p(+/−)	1.0	0.50	1.0	1.0	-	0.83
p(*B*)	0.363	0.163	**0.005**	0.762	-	**0.000**

Note: 100A/E is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A10.4 was omitted due to low data volumes (actual recoveries being less than 10).

Table A11.1. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = C.M.I. Class 1.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	64	80	92	69	32	337
E	134.4	137.5	115.4	113.5	37.3	538.0
$100A/E$						
Durations:						
1-8 weeks	*38*	↓	-	-	-	*28*
8-13 weeks	↓	↓	-	-	-	*44*
13-17 weeks	*39*	*32*	↓	-	-	*63*
17-26 weeks	↓	↓	↓	-	-	*66*
26-30 weeks	*55*	*62*	*90*	↓	-	*71*
30-39 weeks	↓	↓	↓	↓	-	*57*
39 wks-1 yr	*50*	*69*	*88*	*47*	-	68
1-2 years	*44*	*65*	*87*	*101*	↓	86
2-5 years	*52*	↓	↓	*39*	↓	55
5-11 years	*55*	*70*	*61*	*64*	86	58
Ages:						
20-34	↓	↓	↓	↓	↓	*56*
35-39	↓	*46*	↓	↓	↓	*48*
40-44	*47*	↓	*66*	↓	↓	*60*
45-49	*26*	*49*	*86*	*82*	↓	66
50-54	*27*	*68*	*108*	*58*	*77*	62
55-59	*61*	*62*	*73*	*46*	↓	60
60-64	↓	*62*	↓	↓	*97*	↓
65-65	*71*	-	*68*	*64*	-	74
All cells	48	58	80	61	86	63
Using E						
Σz^2	34.85	27.42	8.22	24.60	0.88	92.92
df	11	11	9	7	2	33
$p(\chi^2)$	**0.0003**	**0.0040**	0.51	**0.0009**	0.65	**0.0000**
$\#(+/-)$	0/11	0/11	2/7	1/6	0/2	3/30
$p(+/-)$	**0.0010**	**0.0010**	0.18	0.13	0.50	**0.0000**
$p(B)$	1.0	1.0	0.975	1.0	1.0	0.387
Using adjusted E						
Σz^2	1.08	10.21	4.25	13.71	-	34.70
df	3	5	7	5	-	23
$p(\chi^2)$	0.78	0.0696	0.75	**0.0175**	-	0.0557
$\#(+/-)$	2/2	3/3	4/4	3/3	-	11/13
$p(+/-)$	1.0	1.0	1.0	1.0	-	0.84
$p(B)$	1.0	0.972	0.357	0.669	-	0.495

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A11.2. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = C.M.I. Class 2.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	1	21	17	6	1	46
E	2.0	36.6	32.8	17.0	3.6	91.9
100*A*/*E*						
Durations:						
1-17 weeks	↓	↓	↓	-	-	*73*
17-30 weeks	↓	*58*	↓	↓	-	*63*
30 wks-1 yr	↓	↓	↓	↓	-	*54*
1-2 years	↓	↓	↓	↓	↓	*73*
2-11 years	*50*	*56*	*52*	*35*	*28*	*8*
Ages:						
19-39	↓	↓	↓	↓	↓	*23*
40-44	↓	*30*	↓	↓	↓	↓
45-49	↓	↓	*67*	↓	↓	*70*
50-54	↓	↓	↓	↓	↓	*43*
55-64	*50*	*79*	*36*	↓	*28*	↓
65-65	-	-	-	*35*	-	*50*
All cells	*50*	*57*	*52*	*35*	*28*	50
Using *E*						
Σz^2	0.12	6.35	7.45	6.49	1.23	26.05
df	1	3	2	1	1	7
$p(\chi^2)$	0.73	0.0958	**0.0241**	**0.0109**	0.27	**0.0005**
#(+/−)	0/1	0/3	0/2	0/1	0/1	0/7
$p(+/-)$	1.0	0.25	0.50	1.0	1.0	**0.0156**
$p(B)$	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	3.59
df	-	-	-	-	-	3
$p(\chi^2)$	-	-	-	-	-	0.31
#(+/−)	-	-	-	-	-	2/2
$p(+/-)$	-	-	-	-	-	1.0
$p(B)$	-	-	-	-	-	0.870

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A11.3. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = C.M.I. Class 3.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	2	23	23	9	3	60
E	4.4	90.4	45.7	18.2	7.0	165.8
100*A*/*E*						
Durations:						
1-17 weeks	↓	*20*	↓	-	-	*28*
17-30 weeks	↓	*28*	↓	↓	-	*26*
30-39 weeks	↓	↓	↓	↓	-	*32*
39 wks-1 yr	↓	*44*	*35*	↓	-	*56*
1-2 years	↓	↓	↓	↓	↓	*49*
2-11 years	*45*	*19*	*71*	*49*	*43*	*35*
Ages:						
18-34	-	↓	↓	↓	↓	*10*
35-39	-	*19*	↓	↓	↓	*30*
40-44	↓	*13*	*40*	↓	↓	*32*
45-49	↓	*12*	↓	↓	↓	*22*
50-54	↓	↓	↓	↓	↓	*56*
55-64	*45*	*44*	*55*	*49*	*43*	*50*
All cells	*45*	*25*	*50*	*49*	*43*	36
Using *E*						
Σz^2	0.84	46.59	11.36	4.15	1.79	63.58
df	1	8	3	1	1	13
$p(\chi^2)$	0.36	**0.0000**	**0.0099**	**0.0415**	0.18	**0.0000**
#(+/−)	0/1	0/8	0/3	0/1	0/1	0/13
$p(+/-)$	1.0	**0.0078**	0.25	1.0	1.0	**0.0002**
$p(B)$	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	5.06
df	-	-	-	-	-	3
$p(\chi^2)$	-	-	-	-	-	0.17
#(+/−)	-	-	-	-	-	2/2
$p(+/-)$	-	-	-	-	-	1
$p(B)$	-	-	-	-	-	0.886

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A11.4. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = C.M.I. Class 4.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	1	17	19	2	0	39
E	0.4	54.7	46.1	12.0	1.8	114.8
100*A*/*E*						
Durations:						
1-17 weeks	↓	*11*	↓	-	-	*22*
17-30 weeks	↓	↓	↓	↓	-	*32*
30 wks-1 yr	↓	*35*	*39*	↓	-	*30*
1-2 years	↓	↓	↓	↓	↓	*59*
2-11 years	*272*	*49*	*43*	*17*	-	*28*
Ages:						
19-34	-	↓	↓	↓	↓	*22*
35-39	-	*26*	↓	↓	↓	↓
40-44	-	↓	*27*	↓	↓	*29*
45-49	-	*35*	↓	↓	↓	*24*
50-54	-	↓	↓	↓	↓	*28*
55-59	*272*	↓	↓	↓	↓	↓
60-64	-	*32*	*51*	*17*	-	*69*
All cells	*272*	*31*	*41*	*17*	-	34
Using *E*						
Σz^2	0.05	25.26	15.32	7.51	0.90	47.30
df	1	3	4	1	1	10
$p(\chi^2)$	0.83	**0.0000**	**0.0041**	**0.0061**	0.34	**0.0000**
#(+/−)	1/0	0/3	0/4	0/1	0/1	0/10
p(+/−)	1.0	0.25	0.13	1.0	1.0	**0.0020**
p(*B*)	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	2.92
df	-	-	-	-	-	2
$p(\chi^2)$	-	-	-	-	-	0.23
#(+/−)	-	-	-	-	-	2/1
p(−/−)	-	-	-	-	-	1.0
p(*B*)	-	-	-	-	-	0.747

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A11.5. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = Unknown.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	0	22	55	39	13	129
E	1.1	30.2	86.5	51.8	14.5	184.1
100*A*/*E*						
Durations:						
1-30 weeks	↓	↓	*61*	↓	-	*56*
30-39 weeks	↓	*46*	↓	↓	-	*49*
39 wks-1 yr	↓	↓	*68*	↓	-	*99*
1-2 years	↓	↓	*48*	*75*	↓	*58*
2-5 years	↓	↓	↓	↓	↓	81
5-11 years	-	*100*	*72*	*76*	*89*	*84*
Ages:						
18-39	↓	↓	↓	↓	↓	*48*
40-44	↓	↓	*63*	↓	↓	*100*
45-49	↓	↓	*78*	*62*	↓	*62*
50-54	↓	↓	*69*	↓	↓	91
55-59	↓	↓	↓	↓	↓	*51*
60-64	↓	↓	*52*	*83*	*89*	↓
65-65	-	*73*	-	-	-	*72*
All cells	-	*73*	64	75	*89*	70
Using *E*						
Σz^2	0.33	3.88	11.94	2.98	0.07	20.20
df	1	2	7	4	1	13
$p(\chi^2)$	0.57	0.14	0.10	0.56	0.79	0.0904
#(+/−)	0/1	0/2	1/6	0/4	0/1	1/12
p(+/−)	1.0	0.50	0.13	0.13	1.0	**0.0034**
p(*B*)	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	0.31	0.00	-	2.69
df	-	-	2	2	-	9
$p(\chi^2)$	-	-	0.86	**0.0000**	-	0.98
#(+/−)	-	-	1/2	2/1	-	5/5
p(+/−)	-	-	1.0	1.0	-	1.0
p(*B*)	-	-	0.749	1.0	-	0.284

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A11.6. Males, individual policies, 1991-94, Standard* experience, deaths. Occupational class = All classes.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	68	163	206	125	49	611
E	142.3	349.3	326.4	212.5	64.2	1,094.7
100*A*/*E*						
Durations:						
1-8 weeks	*41*	*20*	-	-	-	*28*
8-13 weeks	↓	*35*	-	-	-	*36*
13-17 weeks	*42*	*30*	*81*	-	-	54
17-26 weeks	↓	*44*	59	-	-	51
26-30 weeks	*51*	*64*	*49*	↓	-	59
30-39 weeks	↓	*53*	*47*	*47*	-	48
39 wks-1 yr	*47*	*58*	*80*	*67*	-	65
1-2 years	*41*	*54*	*78*	81	*102*	72
2-5 years	*57*	60	53	*43*	↓	53
5-11 years	*54*	*54*	*49*	*57*	*60*	55
Ages:						
18-29	↓	*24*	↓	↓	↓	*28*
30-34	↓	*22*	*42*	↓	↓	*27*
35-39	↓	*35*	*45*	↓	↓	*40*
40-44	*47*	*42*	*55*	*55*	↓	54
45-49	*25*	*42*	73	*60*	*70*	56
50-54	*25*	56	73	74	*78*	62
55-59	65	62	70	*42*	↓	60
60-64	↓	↓	↓	↓	*79*	↓
65-65	*64*	*52*	*48*	*77*	-	64
All cells	48	47	63	59	76	56
Using *E*						
Σz^2	38.09	100.64	49.45	41.21	5.84	230.67
df	12	27	25	15	5	54
$p(\chi^2)$	**0.0001**	**0.0000**	**0.0025**	**0.0003**	0.32	**0.0000**
#(−/−)	0/12	1/26	0/25	1/14	1/4	2/52
$p(+/-)$	**0.0005**	**0.0000**	**0.0000**	**0.0010**	0.38	**0.0000**
$p(B)$	1.0	1.0	1.0	0.149	0.793	0.742
Using adjusted *E*						
Σz^2	5.54	26.31	15.13	8.29	2.55	58.18
df	4	14	17	8	3	38
$p(\chi^2)$	0.24	**0.0236**	0.59	0.41	0.47	**0.0191**
#(+/−)	2/3	7/8	8/10	4/5	2/2	17/22
$p(+/-)$	1.0	1.0	0.81	1.0	1.0	0.52
$p(B)$	0.933	0.421	0.404	0.764	0.880	0.119

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A12.1. Females, individual policies, 1991-94, Standard* experience, deaths. Occupational class = C.M.I. Class 1.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	3	8	12	19	4	46
E	11.8	29.9	24.1	29.4	8.7	104.0
$100A/E$						
Durations:						
1-30 weeks	↓	↓	↓	↓	-	*22*
30 wks-1 yr	↓	↓	↓	↓	-	*57*
1-2 years	↓	↓	↓	↓	↓	*70*
2-11 years	*25*	*27*	*50*	*65*	*46*	*41*
Ages:						
19-34	↓	↓	↓	↓	↓	*25*
35-44	↓	↓	↓	↓	↓	*53*
45-49	↓	↓	↓	↓	↓	*58*
50-54	↓	↓	↓	↓	↓	*46*
55-64	*25*	*27*	*50*	*65*	*46*	*34*
All cells	*25*	*27*	*50*	*65*	*46*	44
Using E						
Σz^2	5.88	15.31	5.59	3.35	2.05	34.79
df	1	1	1	1	1	8
$p(\chi^2)$	**0.0153**	**0.0001**	**0.0181**	0.0674	0.15	**0.0000**
$\#(+/-)$	0/1	0/1	0/1	0/1	0/1	0/8
$p(-/-)$	1.0	1.0	1.0	1.0	1.0	**0.0078**
$p(B)$	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted E						
Σz^2	-	-	-	-	-	2.57
df	-	-	-	-	-	3
$p(\chi^2)$	-	-	-	-	-	0.46
$\#(+/-)$	-	-	-	-	-	1/3
$p(+/-)$	-	-	-	-	-	0.63
$p(B)$	-	-	-	-	-	0.892

Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A12.5. Females, individual policies, 1991-94, Standard* experience, deaths. Occupational class = Unknown.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	0	1	5	6	3	15
E	0.0	1.6	9.3	7.8	3.5	22.2
100*A*/*E*						
Durations:						
1 wk-11 yrs	-	*61*	*54*	*77*	*86*	*68*
Ages:						
20-59	-	*61*	↓	*77*	*86*	↓
60-62	-	-	*54*	-	-	*68*
All cells	-	*61*	*54*	*77*	*86*	*68*
Using *E*						
Σz^2	0.00	0.01	1.53	0.21	0.00	2.01
df	1	1	1	1	1	1
$p(\chi^2)$	**0.0000**	0.91	0.22	0.65	**0.0000**	0.16
#(+/−)	0/1	0/1	0/1	0/1	0/1	0/1
$p(+/-)$	1.0	1.0	1.0	1.0	1.0	1.0
$p(B)$	1.0	1.0	1.0	1.0	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	-
df	-	-	-	-	-	-
$p(\chi^2)$	-	-	-	-	-	-
#(+/−)	-	-	-	-	-	-
$p(+/-)$	-	-	-	-	-	-
$p(B)$	-	-	-	-	-	-

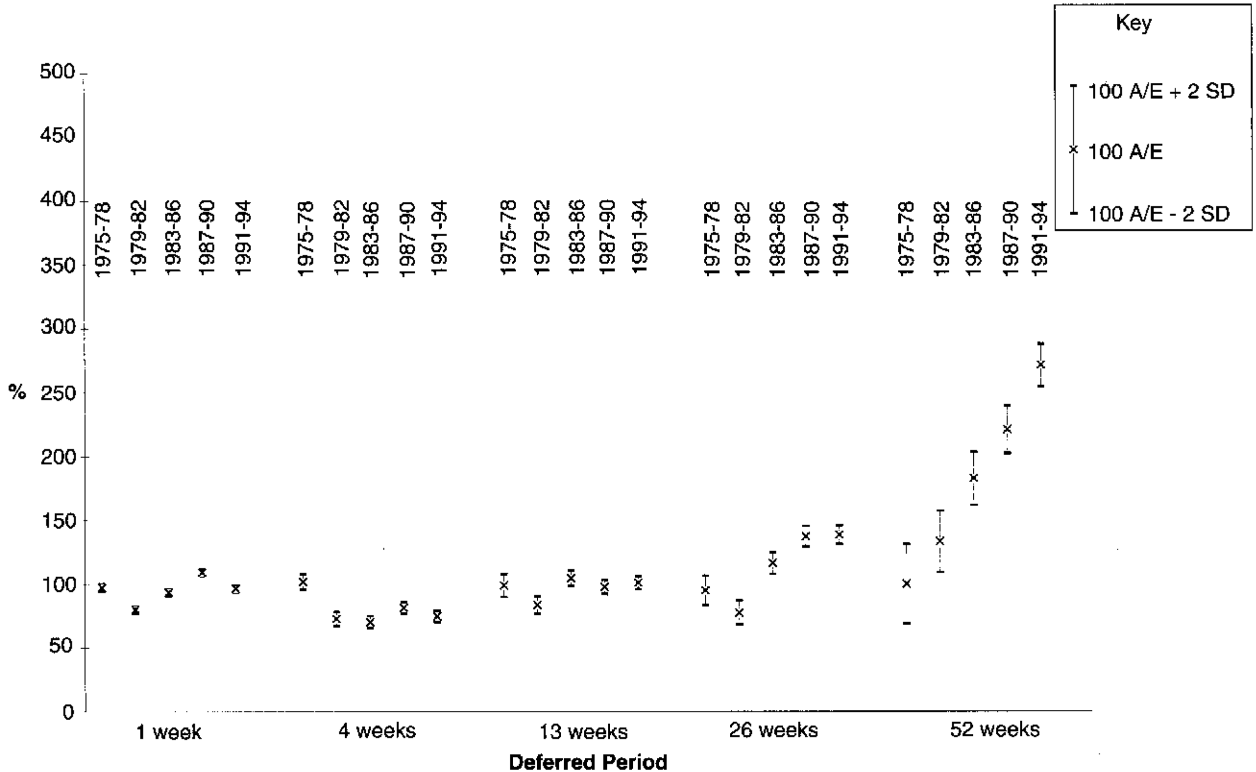
Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold if** less than 0.050.

Table A12.6. Females, individual policies, 1991-94, Standard* experience, deaths. Occupational class = All classes.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	3	12	20	29	7	71
E	12.1	44.1	44.0	44.8	14.7	159.8
100*A*/*E*						
Durations:						
1-13 weeks	↓	↓	-	-	-	*19*
13-26 weeks	↓	↓	↓	-	-	*22*
26-39 weeks	↓	*19*	↓	↓	-	*39*
39 wks-1 yr	↓	↓	*46*	↓	-	*70*
1-2 years	↓	↓	↓	*75*	↓	*75*
2-5 years	↓	↓	↓	↓	↓	*37*
5-11 years	*25*	*40*	*44*	*47*	*47*	*33*
Ages:						
18-34	↓	↓	↓	↓	↓	*20*
35-39	↓	*6*	↓	↓	↓	*56*
40-44	↓	↓	*39*	*79*	↓	*45*
45-49	↓	↓	↓	↓	↓	*61*
50-54	↓	↓	↓	↓	↓	*44*
55-64	*25*	*39*	*51*	*57*	*47*	*39*
All cells	*25*	*27*	*45*	*65*	*47*	44
Using *E*						
Σz^2	6.07	21.79	11.15	6.69	3.56	52.90
df	1	3	4	3	1	12
$p(\chi^2)$	**0.0137**	**0.0001**	**0.0250**	0.0824	0.0592	**0.0000**
#(+/−)	0/1	0/3	0/4	1/2	0/1	1/11
p(+/−)	1.0	0.25	0.13	1.0	1.0	**0.0063**
p(*B*)	1.0	1.0	1.0	0.665	1.0	1.0
Using adjusted *E*						
Σz^2	-	-	-	-	-	11.68
df	-	-	-	-	-	4
$p(\chi^2)$	-	-	-	-	-	**0.0199**
#(+/−)	-	-	-	-	-	2/3
p(+/−)	-	-	-	-	-	1.0
p(*B*)	-	-	-	-	-	0.665

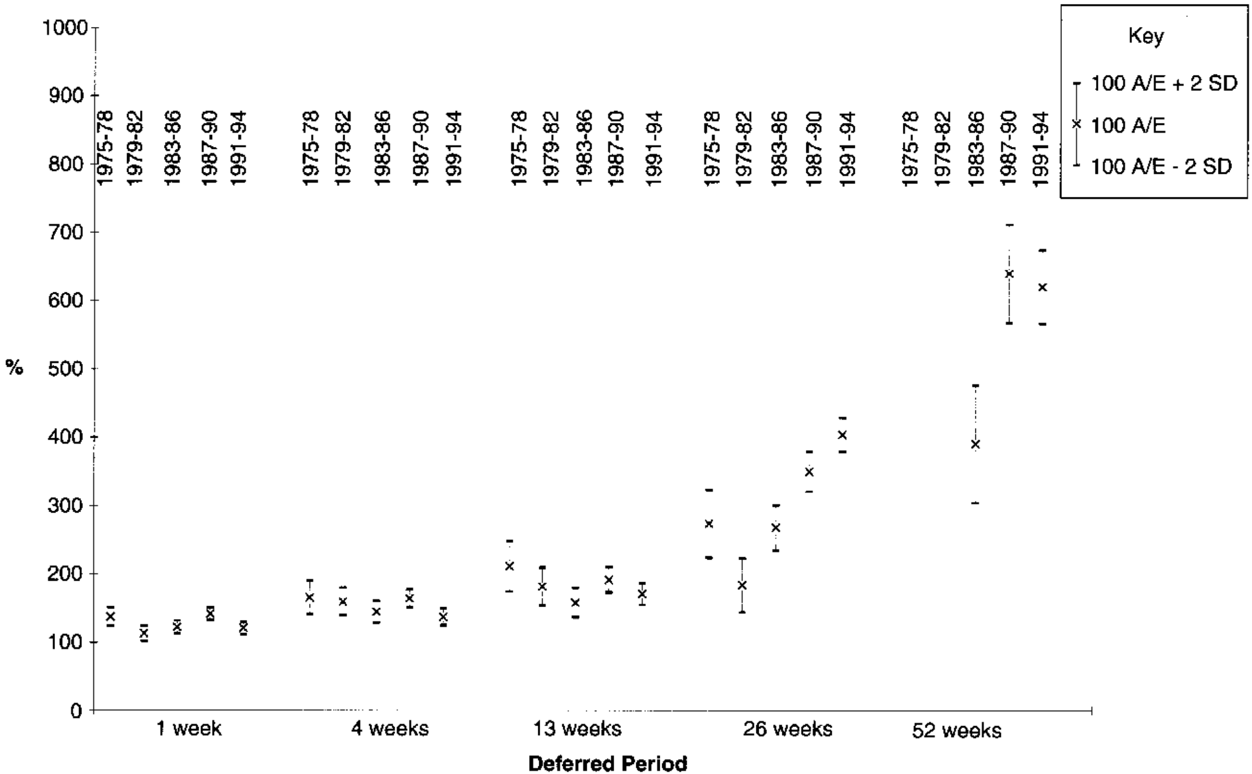
Note: 100A/E is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and *p*(+/−) are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Tables A12.2, A12.3 and A12.4 were omitted due to low data volumes (actual recoveries being less than 10).



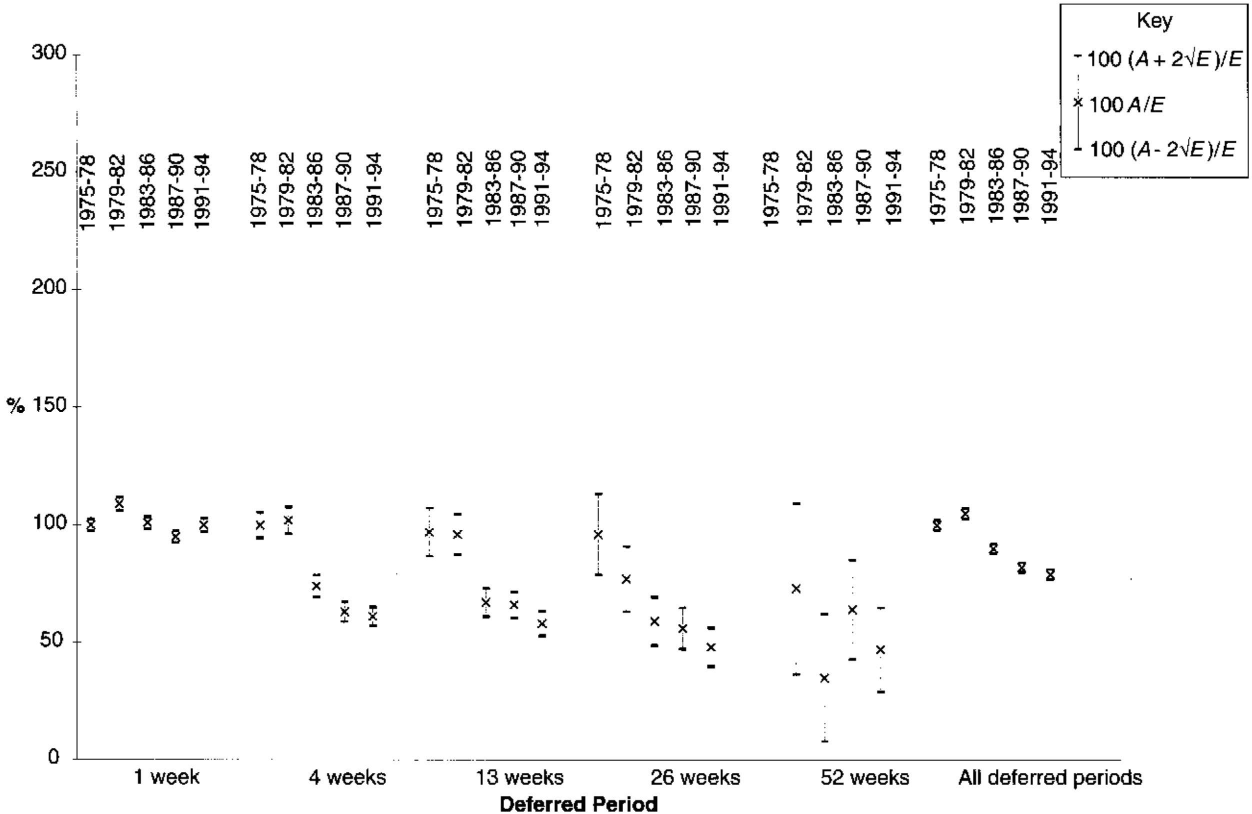
Note: Results are omitted from the above figure if based on less than 10 actual inceptions.

Figure A1.1. Males, individual policies, Standard inception experience for the quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. Graphical presentation of Table A3.1.



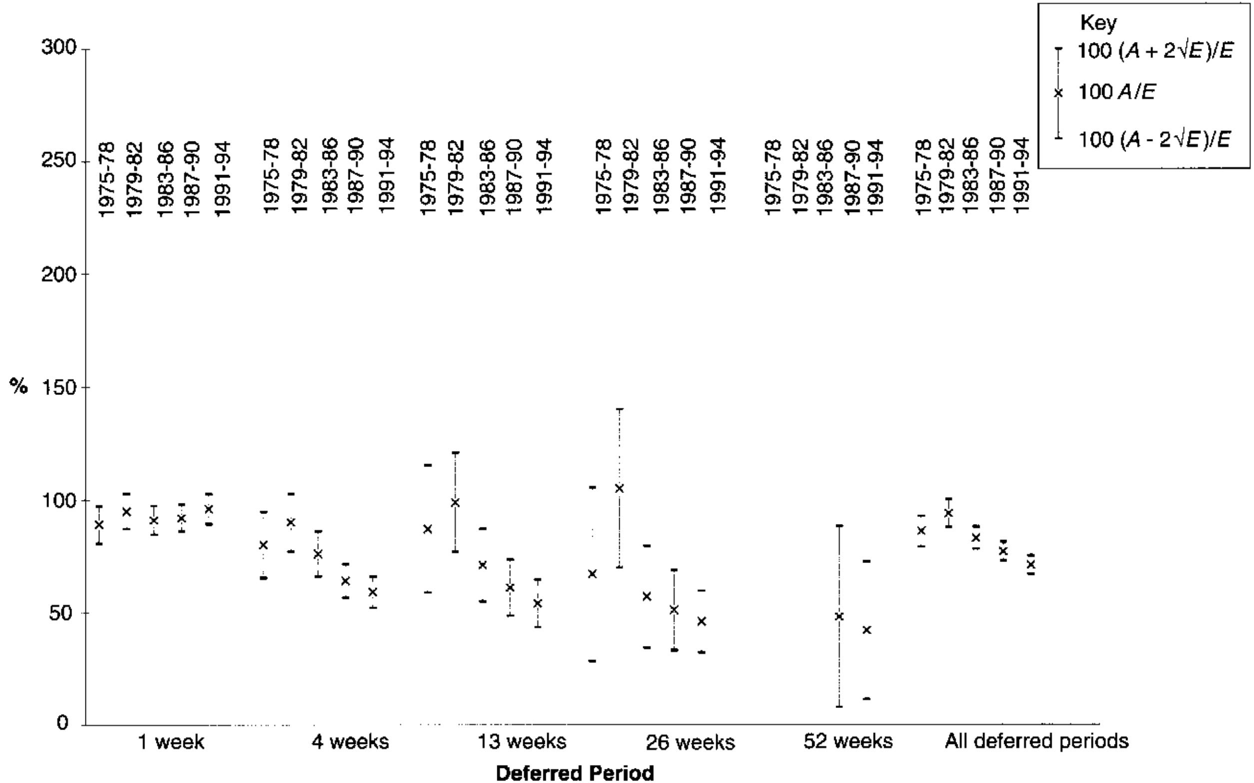
Note: Results are omitted from the above figure if based on less than 10 actual inceptions.

Figure A1.2. Females, individual policies, Standard inception experience for the quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. Graphical presentation of Table A3.2.



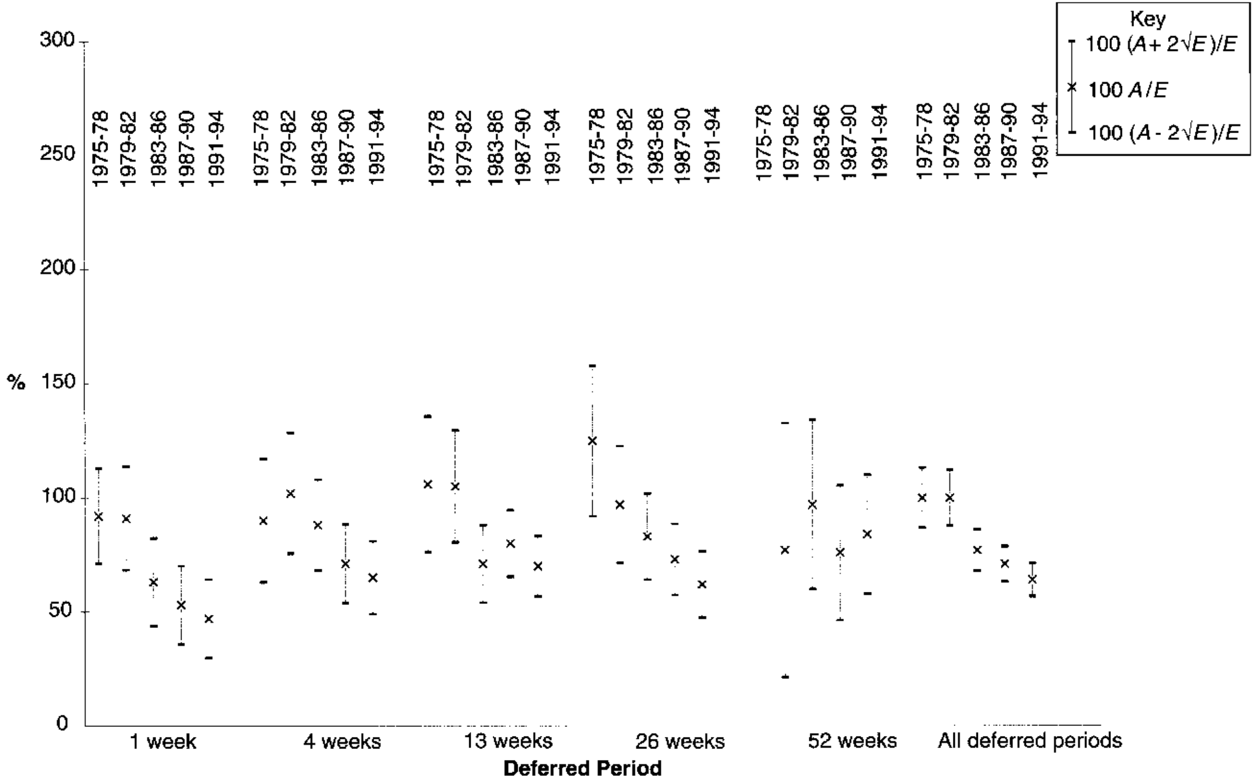
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A2.1. Individual males, recoveries, quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A4.



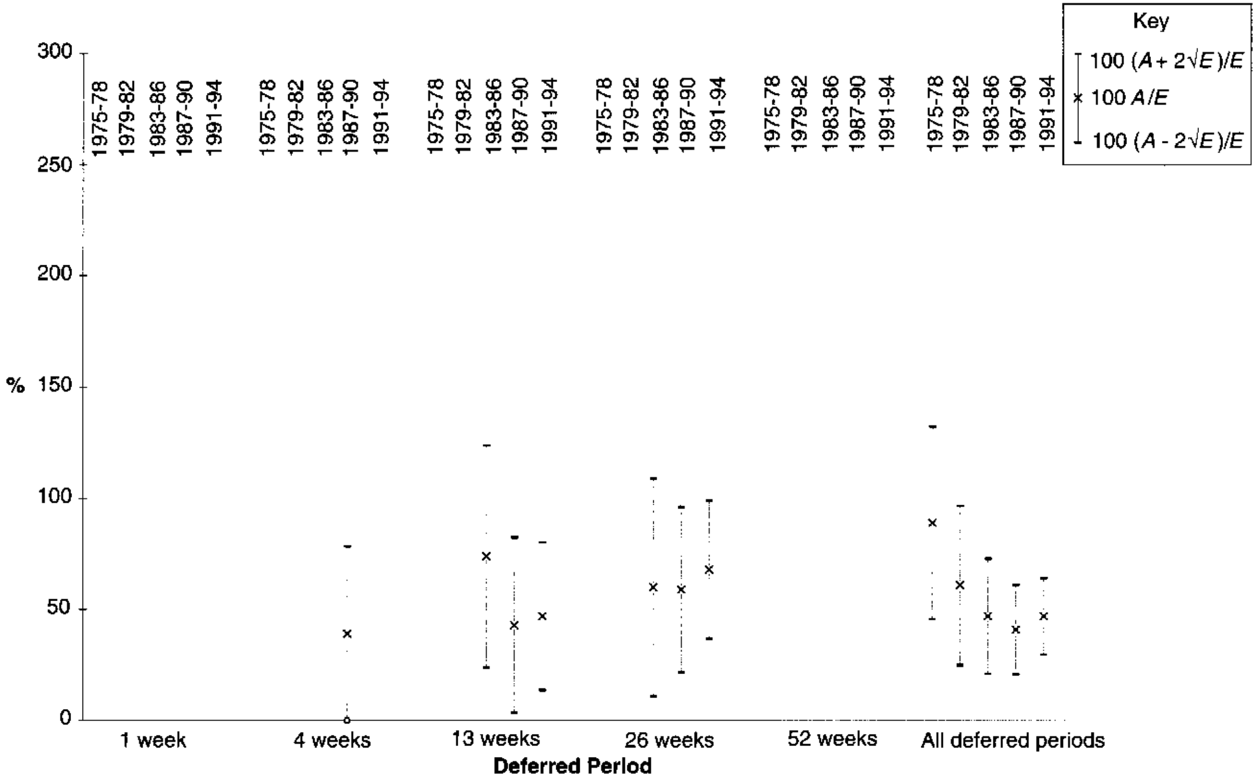
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A2.2. Individual females, recoveries, quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A4.



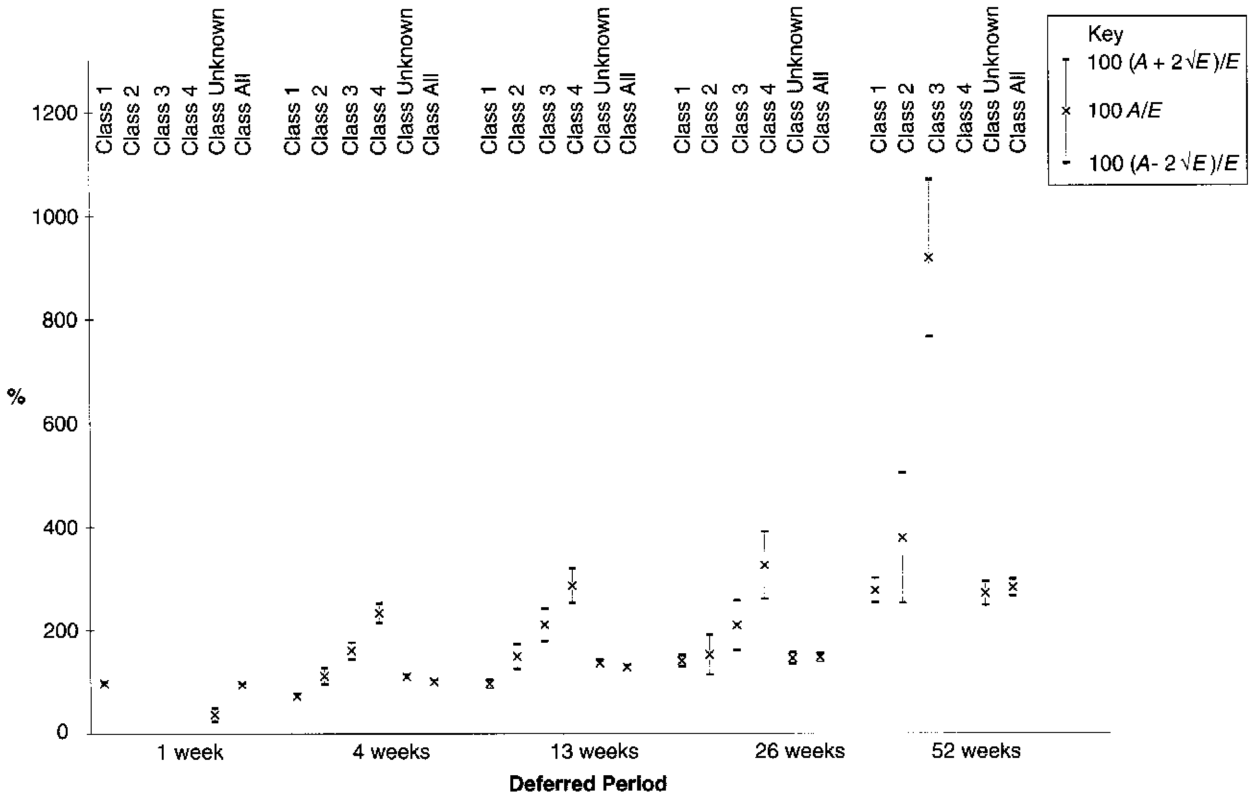
Note: Results are omitted from the above figure if based on less than 10 actual deaths.

Figure A2.3. Individual males, deaths, quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A4.



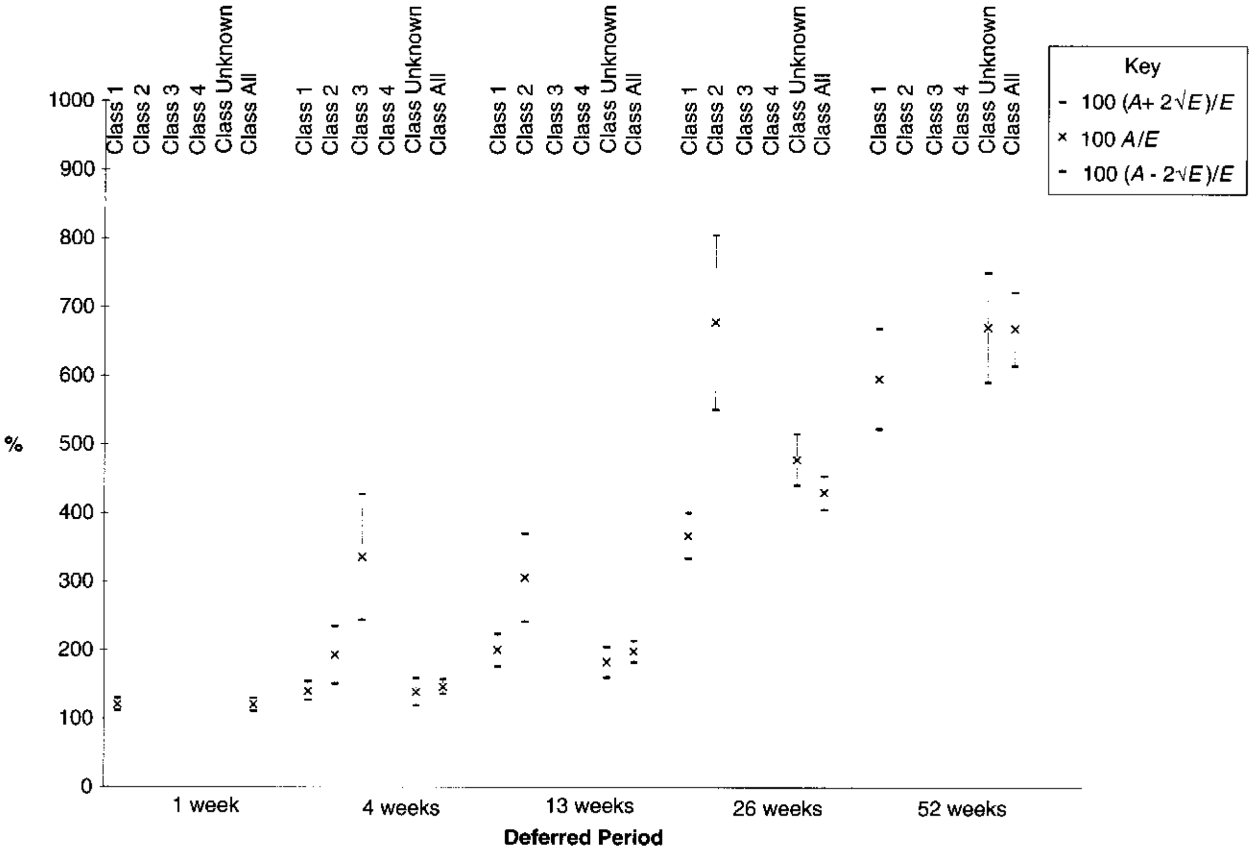
Note: Results are omitted from the above figure if based on less than 10 actual deaths.

Figure A2.4. Individual females, deaths, quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A4.



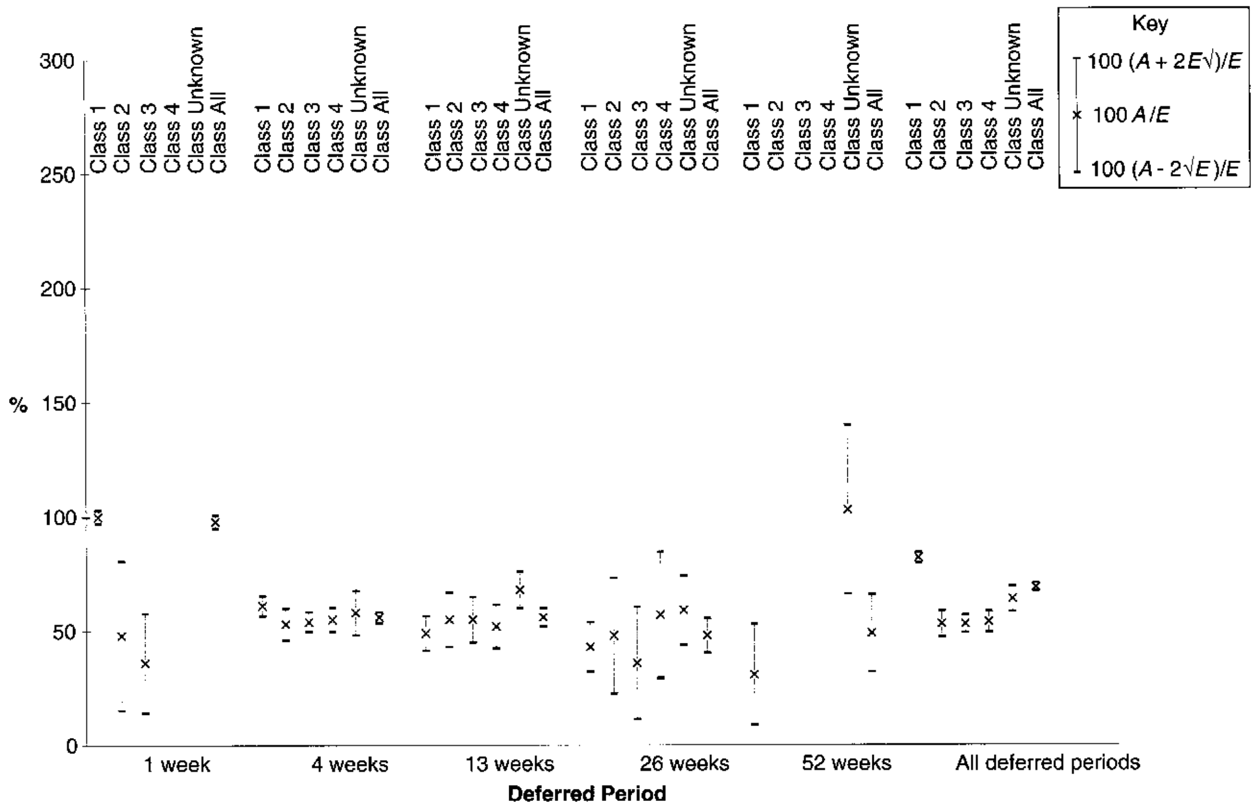
Note: Results are omitted from the above figure if based on less than 10 actual inceptions.

Figure A3.1. Males, individual policies, Standard* inception experience for the quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. Graphical presentation of Table A6.1.



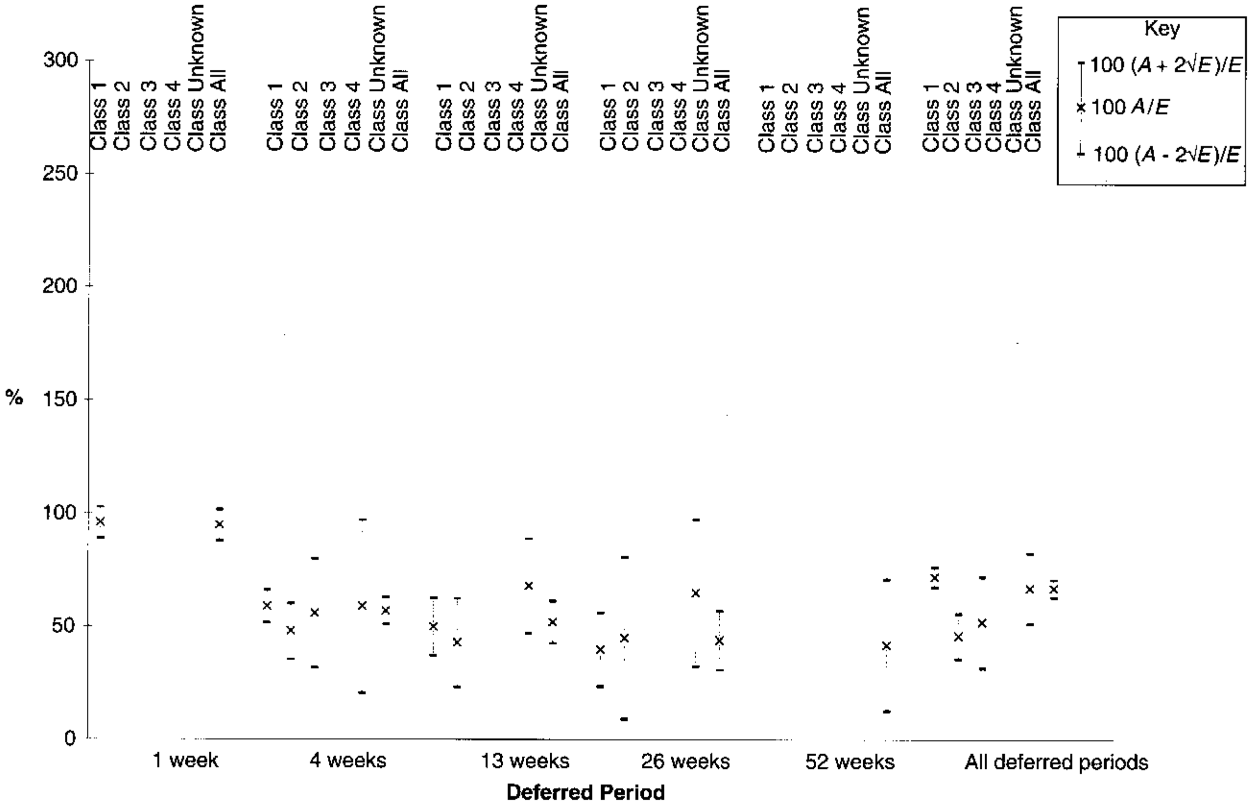
Note: Results are omitted from the above figure if based on less than 10 actual inceptions.

Figure A3.2. Females, individual policies, Standard* inception experience for the quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. Graphical presentation of Table A6.2.



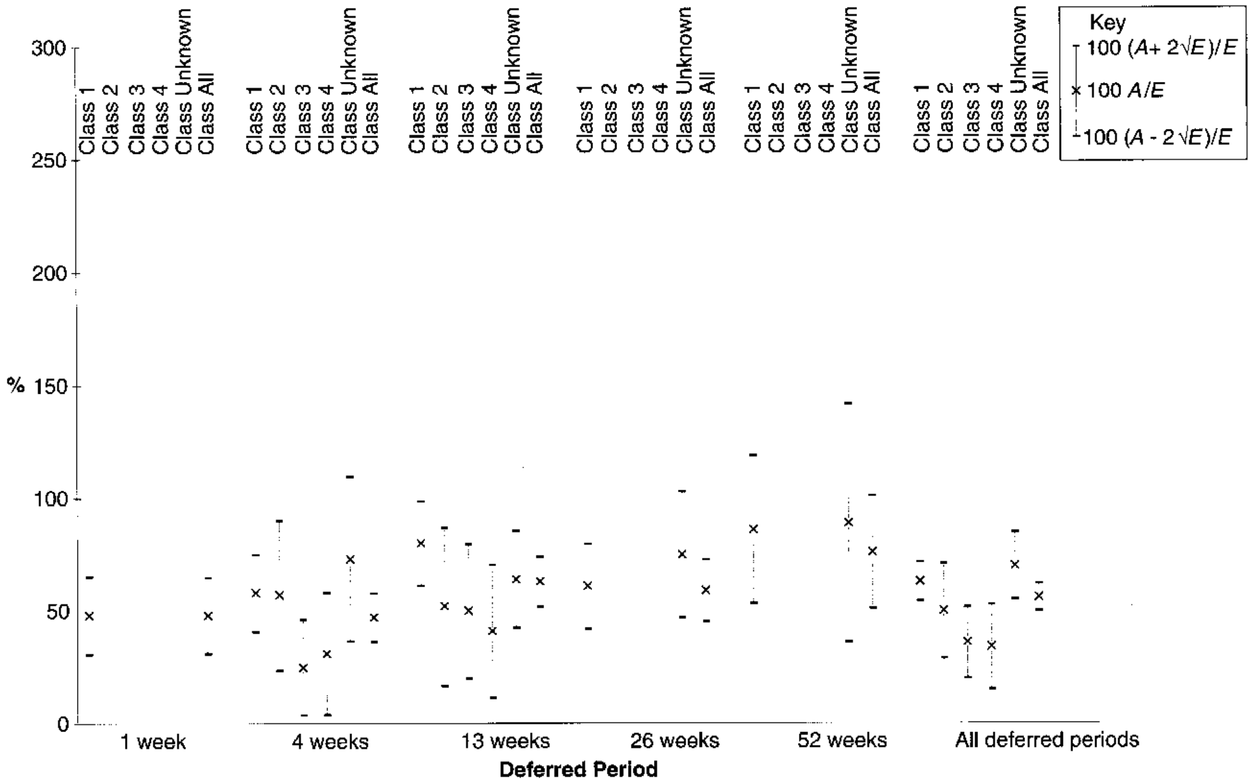
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A4.1. Individual males, recoveries, quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. 100 A/E and confidence intervals. Compare with Table A8(a).



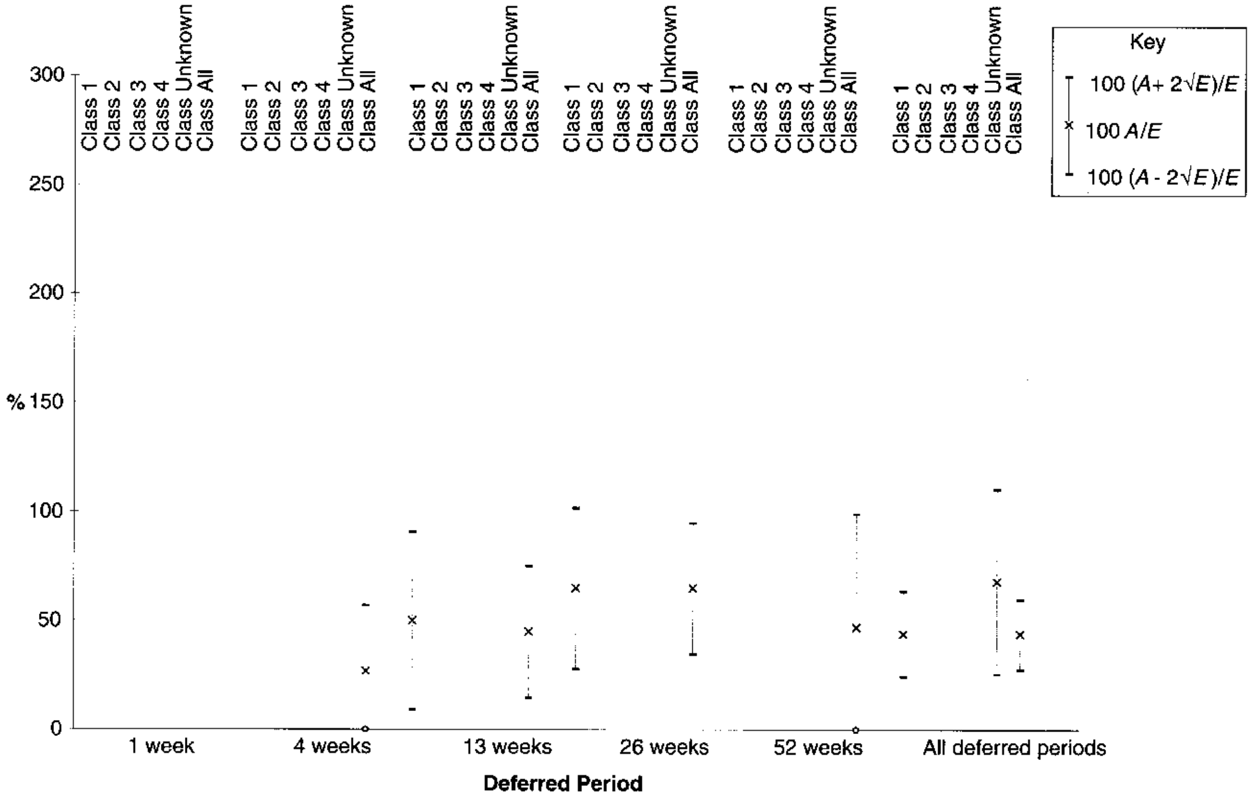
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A4.2. Individual females, recoveries, quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. 100 A/E and confidence intervals. Compare with Table A8(b).



Note: Results are omitted from the above figure if based on less than 10 actual deaths.

Figure A4.3. Individual males, deaths, quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. 100 A/E and confidence intervals. Compare with Table A8(c).



Note: Results are omitted from the above figure if based on less than 10 actual deaths.

Figure A4.4. Individual females, deaths, quadrennium 1991-94. C.M.I. occupational class 1, 2, 3, 4, unknown and all combined. 100 A/E and confidence intervals. Compare with Table A8(d).

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SICKNESS TERMINATION EXPERIENCE 1991-94 FOR GROUP PHI POLICIES

KEYWORDS

Group PHI; Terminations; Recoveries; Deaths

EXECUTIVE SUMMARY

This report presents the results of an analysis of the claims experience for group PHI policies for the quadrennium 1991-94. The analysis is based on the mathematical model for the analysis of PHI data described in *C.M.I.R.* **12** (1991). The method of analysis for claim terminations is that described in a report in *C.M.I.R.* **15** (1996).

The key points arising from the analysis are described below.

- The overall volume of claims data submitted to the group PHI investigation increased by some 10% from the volume in the previous quadrennium, 1987-90. However, a greater proportion could not be included in the Standard subset and the number of analysed events, recoveries and deaths, was some 5% lower than the previous quadrennium.
- 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.
- The individually costed and unit costed claims were combined to produce the analysis of termination experience contained in this paper.
- The bulk of the data relates to the 26 week deferred period (DP26). There is a reasonable volume of data for DP13 and DP52 but a negligible amount for the shorter deferred periods, DP1 and DP4.
- Overall male recovery rates for the quadrennium are at virtually the same level as the previous quadrennium, some 69% of those expected on the basis of SM1975-78.
- Overall female recovery rates have increased from 67% of those expected on the basis of SM1975-78 for the previous quadrennium to 80% for 1991-94.
- Both males and females show similar patterns for *A*/*E* recoveries to vary with sickness duration. Values of *A*/*E* decrease as sickness duration increases,

reaching a minimum in the second six months of sickness before increasing with sickness duration. A similar pattern has been observed for individual PHI business in recent quadrennia.

- Male and female death rates have increased since the previous quadrennium.

1. INTRODUCTION

Six reports have been published to date covering the sickness experience for group PHI policies.

The first report, published in *C.M.I.R.* **5**, 51 (1981) described the experience of 1973-76 and compared actual weeks of sickness with those expected on the basis of the Manchester Unity A.H.J. table. Inception rates for quinquennial age groups were also tabulated.

The second report, *C.M.I.R.* **8**, 89 (1986) described the experience of 1975-78. The main basis of comparison was again the Manchester Unity A.H.J. table of sickness rates. Some comparisons were carried out against both sickness rates and inception rates derived from the 1975-78 individual Standard experience as set out in *C.M.I.R.* 7, 99 (1984).

A third report, *C.M.I.R.* **15**, 209 covered the experience of 1979-82 and 1983-86 and compared Manchester Unity-type sickness rates and inception rates with those expected on the basis of the 1975-78 individual Standard experience. The report also contained some commentary on the variation of experience between the eight offices whose experience was analysed.

The above reports all relied on the traditional Manchester Unity approach to analysing PHI data. Most practical PHI pricing has for many years been based around an inception/disability annuity approach. Although some analysis of inception rates had been carried out in these reports, they contained no analysis of termination rates. *C.M.I.R.* **12** introduced a multiple state model for PHI which reconciled the two approaches. The individual male Standard data for 1975-78 was used to develop graduated transition intensities between healthy and sick, sick and healthy and sick and dead. *C.M.I.R.* **12** described how inception rates, disability annuities and other functions could be derived from these basic building blocks.

Three subsequent reports used the model to compare the experience of subsequent data sets with the graduated rates based on individual Standard data for 1975-78.

One report, *C.M.I.R.* **15**, 1, compared actual and expected inceptions for, *inter alia*, the quadrennia 1975-78, 1979-82 and 1983-86 in respect of group

PHI business. The report described the methodology used to analyse inceptions.

A second report, *C.M.I.R.* **15**, 51, compared actual and expected recoveries and deaths of those sick and claiming under PHI policies for, *inter alia*, group PHI business in 1975-78, 1979-82 and 1983-86. The report described the methodology that has been used to analyse claim terminations in this report.

The third report *C.M.I.R.* **16**, 143 (1998) covered the experience of 1987-90 and used the methodology of the two reports in *C.M.I.R.* **15** to analyse inception and termination rates of group PHI business.

Group PHI business can be sub-divided into two basic types, individually costed and unit costed. Individually costed business involves a premium being calculated separately for each person in the scheme. Full records of the in force by age and sex are available and can be passed to the C.M.I. Bureau each year for analysis. This permits a detailed analysis of claim inceptions and claim terminations as well as Manchester Unity-type sickness rates. Unit costed business has premiums calculated on the basis of a single rate for all and records of in force by age and sex are not generally available on an annual basis. Claim records have, however, been collected by the C.M.I. Bureau which permits an analysis of claim terminations but not of claim inceptions or Manchester Unity-type sickness rates.

With effect from the 1991 investigation year, the C.M.I. Bureau has been asking offices to submit data containing the office's own coding for occupational class, if known. This code is then converted by the Bureau to one of four C.M.I. occupational classes to which it most closely corresponds based on an inspection of the office's internal coding manuals. The volume of data which could be subdivided by occupational class for the quadrennium was disappointingly small.

There were a number of difficulties experienced in collecting and analysing the data for the 1991-94 quadrennium which led to a delay in publishing the results and limited the scope of the results that could be published. In particular, paucity of data in the relevant areas has meant that no publication of inception rates for individually costed business, nor any form of analysis by occupational class, has proved possible for the quadrennium.

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 prior to writing this report. It now seems unlikely that any inception experience can be published in respect of the 1995-98 quadrennium. Therefore the results published in *C.M.I.R.* **16** in respect of 1987-90 would appear to be the final set of results published by the C.M.I. in respect of group PHI claim inceptions.

On a more positive note, the collection of data in respect of years 1995 and thereafter is progressing well and it is anticipated that future experience can be published within a much reduced timescale, though this will relate to claim terminations only. The volume of data which contributing offices can sub-divide by occupational class has also increased significantly for those later years and the PHI Sub-Committee hope to be in a position to produce some results by occupational class for the 1995-98 quadrennium.

2. THE DATA

2.1 *Description of the data*

The data received by the C.M.I. Bureau is detailed and consists of a record for each in force policy in respect of each year end. Each claim which is in force during an investigation year will also generate one or more records for that year, thus one claim which spans several years will generate at least one separate record in each investigation year. All records contain fields describing the attributes of each policy and claims records contain additional fields relating to the duration and other features of the claim. A full description of the format of the data was given in *C.M.I.R.* **5**, 82-90 although a few amendments have been made subsequently, principally, since the 1991 investigation year, the addition of a field to code the office's own occupational class.

The total data is described in this and other reports as the Aggregate data. It has been the practice in recent reports to concentrate the analysis of claims experience on a more homogeneous subset of the Aggregate data known as the Standard data. The Standard data has the following criteria:

policies issued in the UK (the most significant exclusion being policies issued in the Republic of Ireland).

policies without an occupational rating.

policies without a known health impairment.

policies with regular benefit payments (lump sums and waiver of premium benefits being excluded).

In addition to the delays experienced by some contributors in producing the data, there were a number of problems which arose when the data came to be analysed.

Firstly, as discussed above, volumes of individually costed data were low and the PHI Sub-Committee did not consider it worthwhile separately publishing the results of this experience.

Secondly, some contributors were unable to distinguish in their submissions whether claims related to individually costed or unit costed business. For this reason, and to make use of the claims data supplied in respect of individually costed business, the Sub-Committee have decided that the results for the termination experience of the total combined group PHI business should be published in respect of 1991-94. This was, in fact, the approach adopted for the termination analysis published in *C.M.I.R.* **15** in respect of the three quadrennia in the period 1975-86. Only in respect of the 1987-90 quadrennium in *C.M.I.R.* **16** was a separate analysis of termination experience for individually costed and unit costed business produced. A detailed breakdown by attribute of the data analysed is given in Table A1 of the Appendix. This shows the number of claims records for both the Aggregate and Standard data sets.

The following features emerge from this table and an examination of the data for the previous three quadrennia.

Figure 1 shows the comparison of the total volume of Aggregate claims records for individually costed and unit costed business combined for 1991-94 and the previous two quadrennia. It also shows how the data for each quadrennium breaks down between the two types of business.

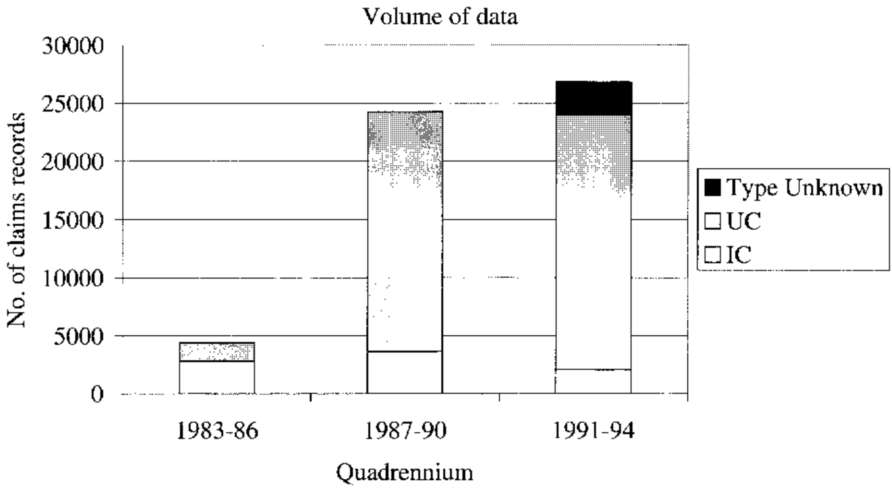


Figure 1. Comparison of volumes of Aggregate claims data for group PHI business. Individually costed, unit costed and type unknown. Quadrennia 1983-86, 1987-90 and 1991-94.

The figure shows clearly that the rapid expansion of the combined data in 1987-90 was explained by the large increase in the volume of unit costed claims data compared to the previous quadrennium. The volume of data submitted for 1991-94 increased by some 10% from the levels of the previous quadrennium. Whilst this is pleasing, the PHI Sub-Committee would like to further increase the volume of data to the investigation. New contributors are welcome and should note that the C.M.I. Bureau will now accept data in a format convenient to the office and make the conversion to the format used for analysis internally if this is more convenient to the office.

The Standard data represents some 81% of the Aggregate data. The principal reason for the elimination of the non-Standard data is data which is coded as "occupationally rated" or when the office could not tell whether the case was so rated or not. Some 7% of the Aggregate data related to the Republic of Ireland and this data was also excluded from the Standard data. The proportion of the Aggregate data included in the Standard data subset reduced significantly from the levels of the previous quadrennium. The overall effect was to reduce the number of analysed events, recoveries and deaths, by some 5% compared with 1987-90.

Some 21% of the Aggregate data were female lives and the proportion of Standard data was marginally higher, some 22%. These figures compare with the 18% observed for both data sets in the 1987-90 quadrennium. This continues the trend of an increasing proportion of female lives observed since the start of the investigation.

Table 1 below shows the breakdown of the Aggregate and Standard data by deferred period. The proportions are virtually identical for each data set. There is virtually no data for the two shorter deferred periods and the experience is dominated by the 26 week deferred period business.

A further informative way of looking at the breakdown of the data is by the number of analysed events. Table 2 below shows the number of recoveries and deaths by sex and deferred period for the Standard data.

3. TERMINATION EXPERIENCE

3.1 *Analysis of the data*

The methodology for analysing the claim termination experience of PHI business was set out in *C.M.I.R.* **15**, 51. The same methodology and table layout is used in this report. Actual deaths and recoveries are compared with those expected on the basis of the *C.M.I.R.* **12** model parameterised using the males, individual policies, Standard experience for 1975-78.

Table 1. Group PHI 1991-94. Individually costed and unit costed combined. Volume of data by deferred period. Aggregate and Standard.

Deferred Period	Aggregate		Standard	
	No. of claims records	%	No. of claims records	%
1 week	40	0	27	0
4 weeks	91	0	25	0
13 weeks	3,227	12	2,530	12
26 weeks	18,676	70	15,271	70
52 weeks	4,785	18	3,972	18
	26,819	100	21,825	100

Table 2. Group PHI 1991-94. Individually costed and unit costed combined. Volume of data by number of analysed events. Standard data by sex and deferred period.

Deferred Period	Recoveries				Deaths			
	Males	Females	Total	% by DP	Males	Females	Total	% by DP
1 week	3	0	3	0	1	0	1	0
4 weeks	6	0	6	0	0	0	0	0
13 weeks	280	189	469	25	81	18	99	15
26 weeks	794	381	1,175	63	367	83	450	69
52 weeks	141	70	211	12	78	22	100	16
	1,224	640	1,864	100	527	123	650	100
% by sex	66	34			81	19		

Table A2 of the Appendix contains a comparison of the values of $100A/E$, for all ages and durations combined, with those applying to the previous four quadrennia. Values based on fewer than 30 events are shown in *italic*; values where the value of either $p(+/-)$ or $p(B)$ is less than 0.025 are shown in **bold**. Note that the individually costed and unit costed data, analysed separately in respect of 1987-90 in *C.M.I.R.* **16**, has been recombined for the purpose of this table in order to make it comparable with other quadrennia, including 1991-94.

The results in Table A2 are illustrated graphically in Figures A1.1-A1.4 of the Appendix. In addition to the $100A/E$ results shown in the tables, the figures also illustrate a confidence interval, the lower limit being $100(A - 2\sqrt{E})/E$ and the upper limit being $100(A + 2\sqrt{E})/E$.

The detailed results, by sickness duration and age group, and statistical analysis of the results are summarised in Tables A3.1-A3.4 of the Appendix for male recoveries, female recoveries, male deaths and female deaths respectively. Readers are referred to the report in *C.M.I.R.* **15** for a full description of the tables and the statistical analysis used.

Readers must exercise caution when attempting to draw conclusions about trends from these results. There is considerable variation of experience between offices and the combined results can be influenced significantly by changes in the mix of offices contributing from year to year. In particular there were considerable changes in the mix and volume of business submitted between the 1983-86 and 1987-90 quadrennia. Other factors may also mask any trends in the underlying morbidity, for example changes to underwriting practices or claims control procedures.

3.2 *Recoveries – males*

Overall recovery rates are at virtually the same level as the previous quadrennium, 1987-90, being some 69% of those expected on the basis of SM1975-78. Recovery rates for both DP13 and DP26 business are very slightly higher than the previous quadrennium and for DP52 somewhat lower.

Overall recovery patterns by duration of sickness show $100A/E$ values diminishing with increasing duration towards a minimum value in the second six months of sickness and then steadily increasing with sickness duration. A similar pattern has also been observed in the same quadrennium for individual PHI business.

3.3 *Recoveries – females*

Female overall recovery rates for the quadrennium have increased to 80% of those expected from the 67% observed in the previous quadrennium. This is also somewhat higher than the overall male recovery rate as described above.

Male and female recovery rates had been very similar in previous quadrennia. The increase in recovery rates comes from the DP26 and DP52 experiences, DP13 recoveries being slightly reduced.

There is evidence of a similar pattern of variation of A/E with duration of sickness as described for the male recovery experience.

3.4 *Deaths – males*

Overall male death rates have increased from 83% of those expected in 1987-90 to 92% of those expected in 1991-94. There is an increase in rates for DP13 and DP26 policies, but a small fall for DP52. However, confidence intervals are wide for other than D26 business reflecting the low volumes of data.

The number of deaths in the first year of sickness is too small to draw any conclusions about any sort of pattern in the variation of A/E with sickness duration.

3.5 *Deaths – females*

Female overall death rates for the quadrennium have increased from 69% in 1987-90 to 87% in 1991-94.

Overall female death rates are less than the male rates for the quadrennium (87% vs 92%) and have been less for all the five quadrennia analysed, although confidence intervals for the female experience are quite large.

There is too little data to draw conclusions on other aspects.

4. CONTRIBUTING OFFICES

The Executive Committee and the PHI Sub-Committee wish to thank the following offices which have contributed data to this investigation. The office names given are, generally, those applying at the time of submission.

Eagle Star
Friends Provident
Guardian
Norwich Union
Scottish Amicable
Sun Alliance
UNUM

Table A1. Group PHI policies, 1991-94. Aggregate and Standard data. Individually costed and unit costed combined. Number of claims records for each investigation year summed across the four year period.

		Aggregate	**Standard**
	Attribute	Claims records	Claims records
Sex	Male	21,076	17,122
	Female	5,743	4,703
Country	UK	25,120	21,825
	Republic of Ireland	1,671	0
	Isle of Man	2	0
	Channel Islands	26	0
Occupational Rating	Not rated	23,469	21,825
	Rated	1,156	0
	Unknown	2,194	0
Benefit Type	Level	6,701	5,486
	Increasing	20,108	16,339
	Decreasing	0	0
	Other	10	0
Medical Evidence	Medical	506	243
	Non-medical	153	5
	Non-selection	9,528	6,179
	Unknown	16,632	15,398
Premium Type	Level annual	777	325
	Recurrent single	25,994	21,466
	Increasing annual	2	1
	Other	46	33
Underwriting Impairment	No extra risk	26,777	21,824
	Hypertension	9	0
	Neurosis	15	0
	Exclusion possible	3	1
	Unknown impairment	0	0
	Other	15	0
CMI Occupational Class	Class 1	1,188	930
	Class 2	631	283
	Class 3	744	335
	Class 4	718	261
	Class Unknown	23,538	20,016
Investigation Year	1991	6,966	6,072
	1992	6,837	5,872
	1993	6,466	4,927
	1994	6,550	4,954
	Total records	26,819	21,825

Table A2. Summary of termination experience for group PHI claims 1975-94. Individually costed and unit costed combined. Standard experience.

(a) Males, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
1975-78	*59*	102	111	59	-	74
1979-82	74	83	77	40	*41*	52
1983-86	*63*	*77*	60	**31**	*29*	39
1987-90	*64*	-	61	**69**	88	**69**
1991-94	-	-	62	**71**	76	**69**

(b) Females, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
1975-78	-	*54*	*112*	66	-	72
1979-82	-	*78*	75	35	-	46
1983-86	-	-	66	33	-	43
1987-90	-	-	83	**63**	*55*	**67**
1991-94	-	-	77	79	*92*	**80**

(c) Males, deaths.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
1975-78	-	-	203	204	*167*	199
1979-82	-	-	93	96	*97*	94
1983-86	-	-	121	**116**	96	114
1987-90	-	-	78	83	88	83
1991-94	-	-	110	90	85	92

(d) Females, deaths.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
1975-78	-	-	-	*120*	-	*92*
1979-82	-	-	-	91	-	91
1983-86	-	-	*88*	62	-	64
1987-90	-	-	*79*	**71**	-	69
1991-94	-	-	*81*	83	*113*	**87**

Note:

Italic if actual number of recoveries or deaths is less than 30.

Not shown if actual number of recoveries or deaths is less than 10.

Bold if either $p(+/-)$ or $p(B) < 0.025$ for adjusted E.

Table A3.1. Males, group PHI (individually costed and unit costed combined) policies, 1991-94, Standard experience, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	3	6	280	794	141	1,224
E	4.2	10.7	452.9	1,112.9	186.1	1,766.8
100*A*/*E*						
Durations:						
1-17 weeks	↓	↓	51	-	-	54
17-26 weeks	↓	↓	44	-	-	44
26-30 weeks	↓	↓	*72*	*32*	-	44
30-39 weeks	↓	↓	69	31	-	38
39 wks-1 yr	↓	↓	*69*	64	-	65
1-2 years	↓	↓	88	72	66	73
2-5 years	↓	↓	↓	104	↓	97
5-11 years	*72*	*56*	95	150	89	147
Ages:						
18-24	-	-	*109*	*55*	↓	72
25-29	-	↓	78	63	↓	67
30-34	-	↓	*57*	69	*63*	65
35-39	-	↓	68	56	*63*	60
40-44	-	↓	63	74	*82*	72
45-49	↓	↓	65	79	87	76
50-54	↓	↓	55	87	84	79
55-59	↓	↓	59	70	↓	67
60-64	↓	*56*	*30*	↓	68	↓
65-65	*72*	-	-	61	-	54
All cells	*72*	*56*	62	71	76	69
Using *E*						
Σz^2	0.11	1.65	87.82	250.29	13.72	329.54
df	1	1	34	44	11	64
$p(\chi^2)$	0.74	0.20	**0.0000**	**0.0000**	0.25	**0.0000**
#(+/−)	0/1	0/1	6/28	8/36	1/10	10/54
p(−/−)	1.0	1.0	**0.0002**	**0.0000**	**0.0117**	**0.0000**
p(*B*)	1.0	1.0	**0.005**	**0.000**	1.0	**0.000**
Using adjusted *E*						
Σz^2	-	-	37.79	227.07	5.58	248.90
df	-	-	23	40	8	58
$p(\chi^2)$	-	-	**0.0268**	**0.0000**	0.69	**0.0000**
#(+/−)	-	-	11/13	18/23	3/6	22/37
p(+/−)	-	-	0.84	0.53	0.51	0.0674
p(*B*)	-	-	0.103	**0.001**	0.237	**0.000**

Note: 100*A*/*E* is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. *p*(*B*) is shown as **bold** if less than 0.050.

Table A3.2. Females, group PHI (individually costed and unit costed combined) policies, 1991-94, Standard experience, recoveries.

	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	-	-	189	381	70	640
E	-	-	247.0	479.8	75.8	802.6
$100A/E$						
Durations:						
1-17 weeks	-	-	*60*	-	-	*60*
17-26 weeks	-	-	52	-	-	52
26-30 weeks	-	-	*119*	*17*	-	53
30-39 weeks	-	-	*100*	37	-	49
39 wks-1 yr	-	-	*92*	76	-	79
1-2 years	-	-	*82*	90	93	90
2-5 years	-	-	↓	121	↓	115
5-11 years	-	-	*137*	174	*92*	169
Ages:						
18-24	-	-	↓	*75*	↓	97
25-29	-	-	61	83	↓	66
30-34	-	-	*59*	62	*76*	62
35-39	-	-	*55*	94	↓	77
40-44	-	-	*88*	52	*81*	69
45-49	-	-	114	100	↓	104
50-54	-	-	*107*	89	↓	100
55-63	-	-	*64*	75	110	71
All cells	-	-	77	79	92	80
Using E						
Σz^2	-	-	40.25	117.65	1.99	142.58
df	-	-	19	33	5	47
$p(\chi^2)$	-	-	**0.0030**	**0.0000**	0.85	**0.0000**
$\#(+/-)$	-	-	5/14	11/22	2/3	11/36
$p(+/-)$	-	-	0.0636	0.0801	1.0	**0.0003**
$p(B)$	-	-	*0.428*	***0.001***	*0.310*	***0.000***
Using adjusted E						
Σz^2	-	-	32.18	126.55	1.76	141.00
df	-	-	16	30	4	43
$p(\chi^2)$	-	-	**0.0095**	**0.0000**	0.78	**0.0000**
$\#(+/-)$	-	-	9/8	14/17	2/3	19/25
$p(+/-)$	-	-	1.0	0.72	1.0	0.45
$p(B)$	-	-	0.392	0.068	0.501	**0.001**

Note: $100A/E$ is shown as *italic* if the actual number of recoveries is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A3.3. Males, group PHI (individually costed and unit costed combined) policies, 1991-94, Standard experience, deaths.

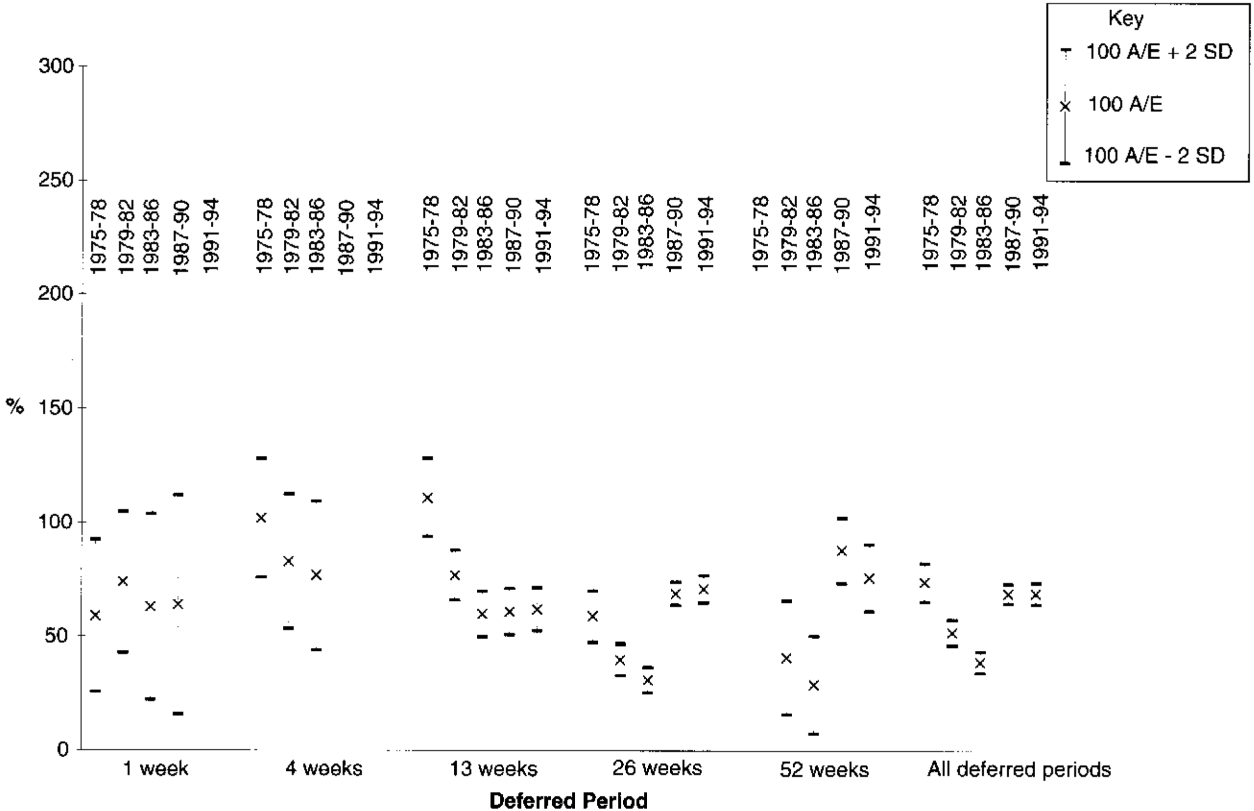
	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	1	0	81	367	78	527
E	0.9	1.0	73.3	408.1	91.3	574.6
$100A/E$						
Durations:						
1-26 weeks	↓	↓	↓	-	-	*79*
26-30 weeks	↓	↓	↓	*91*	-	*79*
30-39 weeks	↓	↓	*92*	*80*	-	92
39 wks-1 yr	↓	↓	↓	119	-	128
1-2 years	↓	↓	*124*	96	116	101
2-5 years	↓	↓	↓	84	*70*	84
5-11 years	*116*	-	117	85	*73*	85
Ages:						
18-34	-	↓	↓	*79*	↓	*75*
35-39	-	↓	↓	*95*	↓	102
40-44	-	↓	↓	99	↓	100
45-49	↓	↓	*76*	77	*93*	74
50-54	↓	↓	↓	90	*88*	92
55-59	↓	↓	↓	97	↓	101
60-64	↓	-	129	↓	80	↓
65-65	*116*	-	-	85	-	86
All cells	*116*	*0*	110	90	85	92
Using E						
Σz^2	0.00	0.25	3.67	21.40	8.67	35.36
df	1	1	5	23	6	27
$p(\chi^2)$	**0.0000**	0.62	0.6	0.56	0.19	0.13
$\#(+/-)$	1/0	0/1	2/3	6/17	1/5	11/16
$p(-/-)$	1.0	1.0	1.0	**0.0347**	0.22	0.44
$p(B)$	1.0	1.0	0.504	0.651	0.827	**0.017**
Using adjusted E						
Σz^2	-	-	7.73	23.87	4.84	31.92
df	-	-	5	20	5	24
$p(\chi^2)$	-	-	0.17	0.25	0.44	0.13
$\#(+/-)$	-	-	2/4	11/10	3/3	12/13
$p(+/-)$	-	-	0.69	1.0	1.0	1.0
$p(B)$	-	-	0.966	0.793	0.907	0.199

Note: $100A/E$ is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.

Table A3.4. Females, group PHI (individually costed and unit costed combined) policies, 1991-94, Standard experience, deaths.

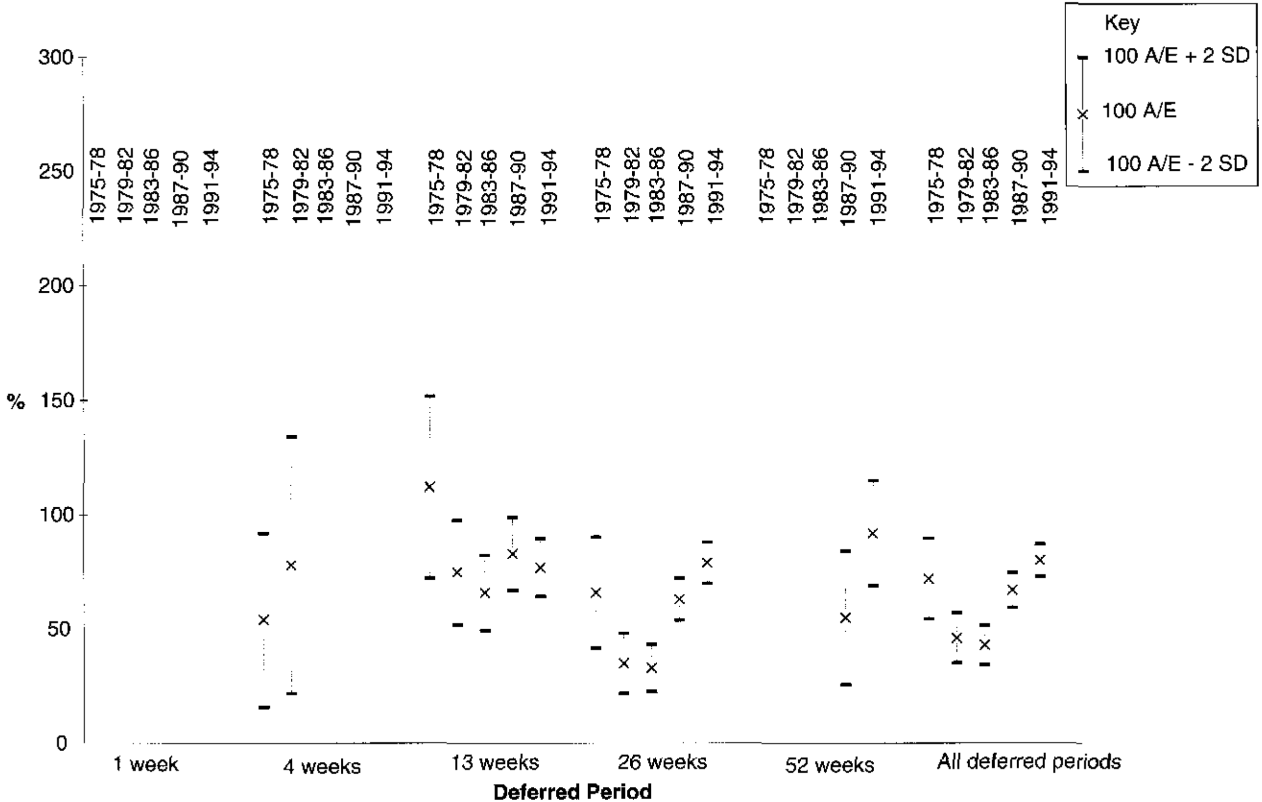
	DP 1	DP 4	DP 13	DP 26	DP 52	All DP
A	-	0	18	83	22	123
E	-	0.0	22.2	100.0	19.1	141.4
$100A/E$						
Durations:						
1 wk-1 yr	-	↓	↓	*77*	-	*66*
1-2 years	-	↓	↓	147	↓	137
2-5 years	-	↓	↓	*75*	↓	91
5-11 years	-	↓	*81*	*44*	*115*	*54*
Ages:						
18-34	-	-	↓	*79*	↓	*74*
35-44	-	-	↓	*112*	↓	110
45-49	-	-	↓	*75*	↓	*76*
50-54	-	-	↓	*69*	↓	*83*
55-63	-	-	*81*	*78*	*115*	*86*
All cells	-	*0*	*81*	83	*115*	87
Using E						
Σz^2	-	-	0.63	17.67	0.29	20.68
df	-	-	1	8	1	9
$p(\chi^2)$	-	-	0.43	**0.0239**	0.59	**0.0142**
$\#(+/-)$	-	-	0/1	3/5	1/0	3/6
$p(+/-)$	-	-	1.0	0.73	1.0	0.51
$p(B)$	-	-	1.0	0.581	1.0	0.639
Using adjusted E						
Σz^2	-	-	-	14.47	-	21.28
df	-	-	-	6	-	8
$p(\chi^2)$	-	-	-	0.0248	-	**0.0064**
$\#(+/-)$	-	-	-	4/3	-	4/5
$p(+/-)$	-	-	-	1.0	-	1.0
$p(B)$	-	-	-	0.869	-	0.638

Note: $100A/E$ is shown as *italic* if the actual number of deaths is less than 30. $p(\chi^2)$ and $p(+/-)$ are shown to 4 decimal places if less than 0.10 and as **bold** if less than 0.05. $p(B)$ is shown as **bold** if less than 0.050.



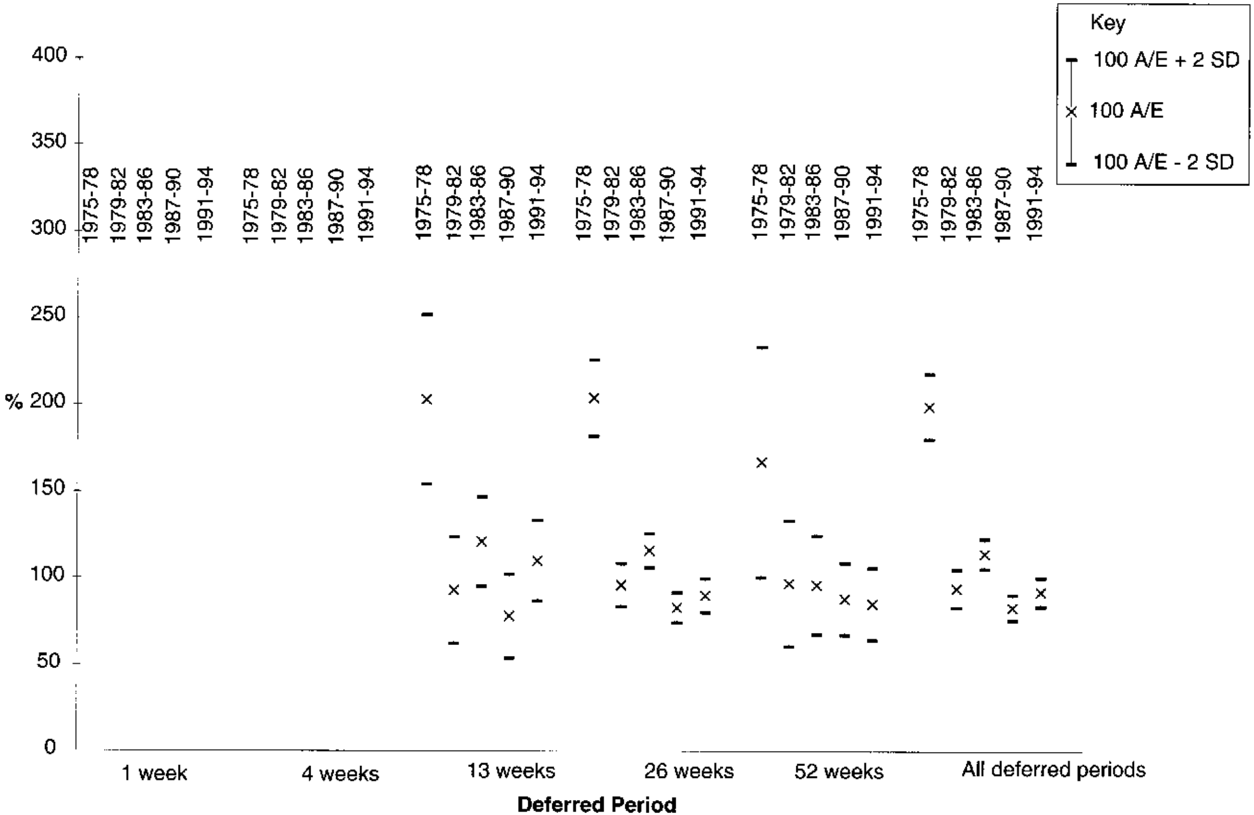
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A1.1. Males, recoveries. Individually costed and unit costed group PHI policies combined. Standard experience for quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A2(a).



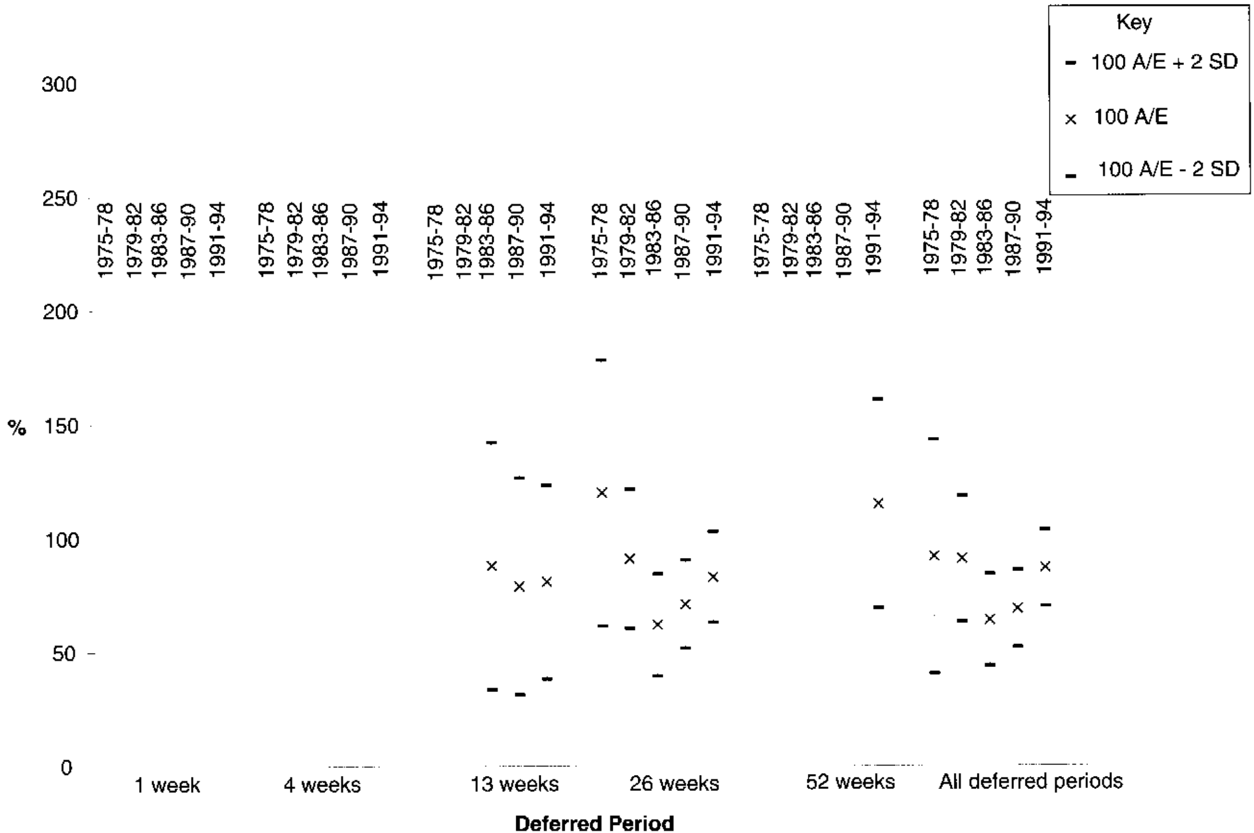
Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A1.2. Females, recoveries. Individually costed and unit costed group PHI policies combined. Standard experience for quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A2(b).



Note: Results are omitted from the above figure if based on less than 10 actual recoveries.

Figure A1.3. Males, deaths. Individually costed and unit costed group PHI policies combined. Standard experience for quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A2(c).



Note: Results are omitted from the above figure if based on less than 10 actual deaths.

Figure A1.4. Females, deaths. Individually costed and unit costed group PHI policies combined. Standard experience for quadrennia 1975-78, 1979-82, 1983-86, 1987-90 and 1991-94. 100 A/E and confidence intervals. Compare with Table A2(d).

CMIR 18 (2000) 109–150

AN ANALYSIS OF THE PHI EXPERIENCE OF INDIVIDUAL COMPANIES IN THE UNITED KINGDOM I: CLAIM INCEPTION RATES

BY A A KORABINSKI AND H R WATERS

KEYWORDS

PHI; Inceptions; Company; Generalized Linear model; Credibility model

ABSTRACT

In this paper we analyse the Permanent Health Insurance claim inception rates for 18 UK insurers for the years 1987 to 1994, inclusive. The data relate to policies on individual lives, males and females, with deferred periods ranging from 1 week to 52 weeks. For each Company/Deferred Period/Sex/Year we have a value for the sum over all ages of the actual number of claim inceptions (A) and the expected number (E) on a standard basis. The data are described in Section 2. In Section 3 we fit a generalized linear model to the values of A/E for the whole data set. The main effects – Company, Deferred Period, Sex and Year – are all significant, as are the following interactions: Company by Deferred Period, Company by Sex, Company by Year, Deferred Period by Sex and Deferred Period by Year. In Section 4 we consider separately the data for a given Deferred Period and Sex. We use the Bühlmann-Straub credibility model to estimate the correct A/E value for a given company. In Section 5 we discuss our numerical results. Finally, in Section 6 we present some conclusions and discuss the relative merits of our two approaches in terms of predicting the future claim inception experience of any particular company.

1. INTRODUCTION

Insurers who supply individual Permanent Health Insurance (PHI) data to the Continuous Mortality Investigation Bureau (CMIB) receive in return in respect of each year's experience from 1995:

(a) a summary analysis of their own experience, and,

(b) a summary analysis of the experience of all contributing companies.

These analyses cover claim inceptions, recoveries and deaths. In this paper, Part

I of a series of two papers, we are concerned only with claim inceptions: recoveries and deaths are analysed in Part II. The references and acknowledgements for both papers are given in Part II.

Examples of the style of the CMIB's summary analyses for claim inceptions can be found in *C.M.I.R.* **15** (1996, Claim Inception Rates under PHI Policies, Individual 1975–90 and Group 1975–86, Tables 2.1a–2.14e). A key feature of these summaries is the figure given for A/E, as a percentage, for each combination of deferred period and sex, where A is the actual number of claim inceptions and E is the expected number and where both numerator and denominator are summed over all single ages. The expected number of claim inceptions is calculated from the appropriate exposure using a standard basis; the standard basis was constructed from the experience of male lives in the years 1975–78.

The claim inceptions A/E value for a company is of importance since, in principle, it indicates how the company should adjust the standard basis for use in premium rating and even reserving. However, a problem with the A/E value for an individual company is that it may be based on very little data, particularly for the longer deferred periods. If an individual company's A/E value differs significantly from the all companies' value, it may not be clear how its own pricing basis should be determined.

The CMIB has supplied us with claim inceptions A/E values for 18 companies for each of the years 1987 to 1994, inclusive. The purpose of this paper is to analyse and to model these data using two different methods: in Section 3 we use a generalized linear model and in Section 4 we use credibility theory. By doing this we can not only make interesting comparisons between the two methods but also gain some insight into heterogeneity in the data. For example, there is prior evidence that there are considerable differences between insurers in respect of their claim inception experiences, presumably as a result of differences in underwriting standards, claims management, relative pricing and sales strategy. See *C.M.I.R.* **15** (1996, Sickness Experience 1983–86 for Individual PHI policies, Section 3).

A shorter report on an analysis of our data has already been published in the Transactions of the 26th International Congress of Actuaries (Korabinski and Waters (1998)). Some time after that report was published, the CMIB investigated the extent of duplicate policies in its claims inceptions data and found that there were generally more duplicates, particularly for policies with deferred period 1 week, than had been allowed for in our earlier report. Allowing for an increased number of duplicate policies has resulted in changes to the fitted generalized linear model (see Section 3 below) but not to the results of the credibility analysis, as compared with the models and results in Korabinski and Waters (1998).

Although our two methods for analysing our data are different, they have a common underlying element. This can be explained as follows. Let:

- i denote Company.
- d denote Deferred Period.
- s denote Sex.
- j denote calendar Year.
- x denote the policyholder's age last birthday.
- A_{idsjx} denote the actual number of claim inceptions for the combination of factors (i,d,s,j,x).
- T_{idsjx} denote the time spent as healthy by policyholders for the combination of factors (i,d,s,j,x). Note that this is time spent as healthy in the calendar year j displaced by the deferred period d.
- σ_{dx} denote the sickness inception intensity for a policyholder aged x last birthday with a policy with a deferred period d, as given by the standard basis.
- π_{dx} denote the probability that a sickness starting at age x last birthday will last for at least a period d and become a claim. This probability is calculated using the recovery and mortality intensities given by the standard basis.

Note that, according to the standard basis, σ_{dx} and π_{dx} do not depend on Company, Sex or Year.

Using the standard basis, the expected number of claim inceptions for the combination (i,d,s,j,x) is E_{idsjx}, where:

$$E_{idsjx} = T_{idsjx} \cdot \pi_{dx} \cdot \sigma_{dx}$$

Now define A_{idsj} and E_{idsj} as the sum over all ages x, in practice 20 to 64, inclusive, of A_{idsjx} and E_{idsjx}, respectively. If the experience followed the standard basis, then we would have, treating A_{idsj} as a random variable:

$$E[A_{idsj}] = E_{idsj}$$

However, the standard basis is unlikely to be correct in this sense. A key element common to the models in Sections 3 and 4 below is the multiplicative factor f_{idsj} defined by:

$$E[A_{idsj}] = E_{idsj} \cdot f_{idsj}$$

In Sections 3 and 4 we will describe how to estimate f_{idsj} using our two different approaches. These estimates are of interest to individual companies since they indicate how the claim inception rate $\pi_{dx} . \sigma_{dx}$ given by the standard basis should be adjusted to calculate the expected claim inceptions for a given Company, Deferred Period, Sex and Year. Provided we can extrapolate these estimates to future years, i.e. beyond the data available, this enables a company to adjust the claim inception rates used in the calculation of its premiums and reserves.

A final point to note is that the factor f_{idsj} applies to the expected claim inceptions, E_{idsj}, aggregated over all ages. This means that although f_{idsj} can model, for example, differences between companies, it is not able to model differences between an experience and the standard basis at individual ages or within small age groups.

2. THE DATA

2.1 *The structure of the data*

The data give A, the actual number of claim inceptions, and E, the expected number of claim inceptions, and the resulting A/E ratio expressed as a percentage. These are given for 18 companies (labelled 1 to 18), 5 deferred periods (1, 4, 13, 26 and 52 weeks), both sexes (male and female) and 8 years (1987 to 1994). Potentially there are $18 \times 5 \times 2 \times 8 = 1440$ cells in a four-way table for Company by Deferred Period by Sex by Year. However, data are available for only 1030 of these cells as for most companies not all years and deferred periods are covered. For example, the cells for company 7 correspond to only one year (1994) and three deferred periods (13, 26 and 52 weeks). In addition, a further 149 cells are empty due to zero exposure, leaving 881 contributing cells.

In CMIB terminology, our data is 'Standard Experience' data. See *C.M.I.R.* 7 (1984). This means that it includes only UK policies and does not include policies which have occupational or medical ratings/exclusions.

2.2 *The level of inceptions*

The amount of business varies greatly over the different parts of the four-way table. For example, PHI business is dominated by males with nearly 90% of the actual claim inceptions. The differences over Company and Deferred Period are illustrated in Table 1 which is a two-way table of actual claim inceptions aggregated over Sex and Year. Note that an asterisk indicates that there is no business for that cell.

Inceptions for deferred period 1 week are not shown in Table 1. This area of PHI business has some particular features which might make it possible to identify an individual company from its inceptions alone. The data were supplied to us by the CMIB on the understanding that the identity of individual companies should not be disclosed. The total number of inceptions for deferred period 1 week is 30311, which represents over 70% of all the inceptions.

From Table 1 it can be seen that, for deferred periods of 4 weeks and greater,

Table 1. Aggregated claim inceptions by Company and Deferred Period.

Company	DP 4	DP 13	DP 26	DP 52	DP 4-52
1	100	94	151	38	383
2	*	69	41	5	115
3	468	250	178	74	970
4	26	8	14	13	61
5	197	69	34	15	315
6	163	181	119	51	514
7	*	20	14	3	37
8	2,565	772	662	198	4,197
9	1,093	531	423	172	2,219
10	696	121	129	28	974
11	*	141	47	28	216
12	76	38	23	7	144
13	151	78	84	34	347
14	*	0	1	1	2
15	2	34	146	6	188
16	6	688	367	103	1,164
17	124	76	50	28	278
18	40	25	33	7	105
All Co.'s	5,707	3,195	2,516	811	12,229

Note: being aggregated over years, these numbers of inceptions will depend on the number of years contributing to each cell.

two companies together (8 and 9) account for over 50% of the inceptions and five companies (2, 4, 7, 14 and 18) each account for less than 1% of the inceptions.

2.3 *Exploratory data analysis*

Before undertaking any detailed modelling we performed some initial data exploration by producing a variety of plots. Some of these are discussed below.

2.3.1 *Individual company plots*

In practice individual companies submit their own data to the CMIB and in return they receive the aggregated 'all company' data. This allows them to compare their own performance with that of all companies (including their own) or with that of other companies (excluding their own). For such comparisons to be made on a more statistical basis we produced plots, for each Company and for each combination of Deferred Period and Sex available for that company, of $A/E\%$ against Year with approximate two-standard-error limits drawn. For comparison similar plots of the corresponding 'all companies' and 'other companies' figures were drawn on the same graph. The standard errors for $A/E\%$ are calculated using the following formula:

$$s.e. = 100\sqrt{\frac{V_d}{E}} \tag{1}$$

where V_d is the 'variance inflation factor' which allows for duplicate policies in the data and is a function of the deferred period d. See *C.M.I.R.* **12** (1991, Part C). The values of V_d used in this paper are:

3.890	for	DP 1
1.320	for	DP 4
1.210	for	DP 13
1.244	for	DP 26
1.006	for	DP 52

These values were calculated from information supplied by the CMIB following an investigation of the number of duplicate policies in the data for 1987–1994. They are generally higher (in the case of deferred period 1 week policies, much higher) than the corresponding values in *C.M.I.R.* **7** (1984, Appendix F), which were based on data from 1975–1978 and which were used by Korabinski and Waters (1998).

Figures 1a, 1b and 2 show plots for two cases. Figures 1a and 1b are for company 8, males, deferred period 4 weeks. This company provides nearly 45% of the total inceptions for deferred period 4 weeks, so its experience is very similar to the 'all companies' experience. Figure 1b, which incorporates 'other companies' information rather than 'all companies' information, is of more value than Figure 1a. Company 8 would take note of the fact that its own $A/E\%$ values are greater than those for the other companies for seven of the eight years, although less so in the most recent years. However, it should be noted that the size of the standard errors are such that there is considerable overlap in the two standard error intervals in all eight years.

Figure 2 is also for males, deferred period 4 weeks, but in this case for company 1. In contrast to company 8, this company accounts for less than 2% of the total inceptions and this is reflected in the much wider two standard error limits for the company. Note that these limits comfortably contain the all company experience intervals suggesting that there is no significant difference between the experiences of company 1 and of all companies. However, the fact that in five of the six years the experience of company 1 is better than that of all companies may be regarded as interesting. Finally note that company 1 did not contribute any data in respect of 1987 and 1994 for males, deferred period 4 weeks.

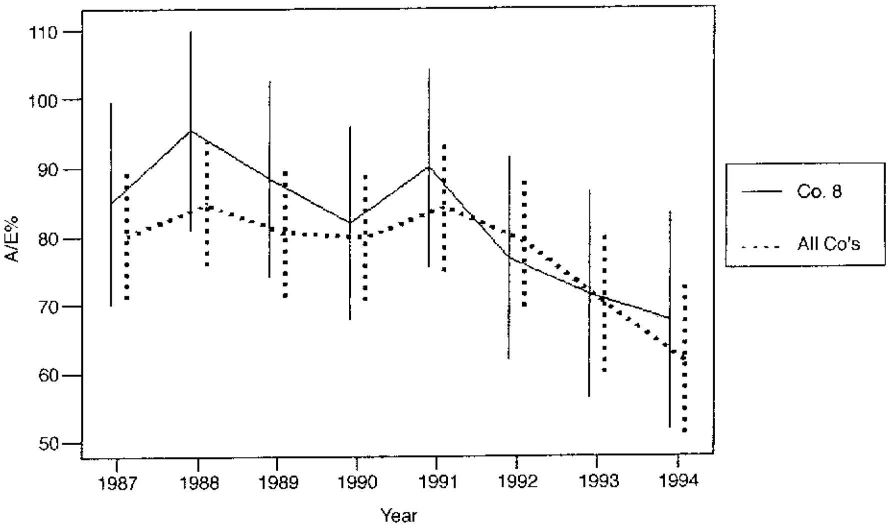


Figure 1a. Co 8/All co's Males, DP4: Inceptions A/E% with 2se limits.

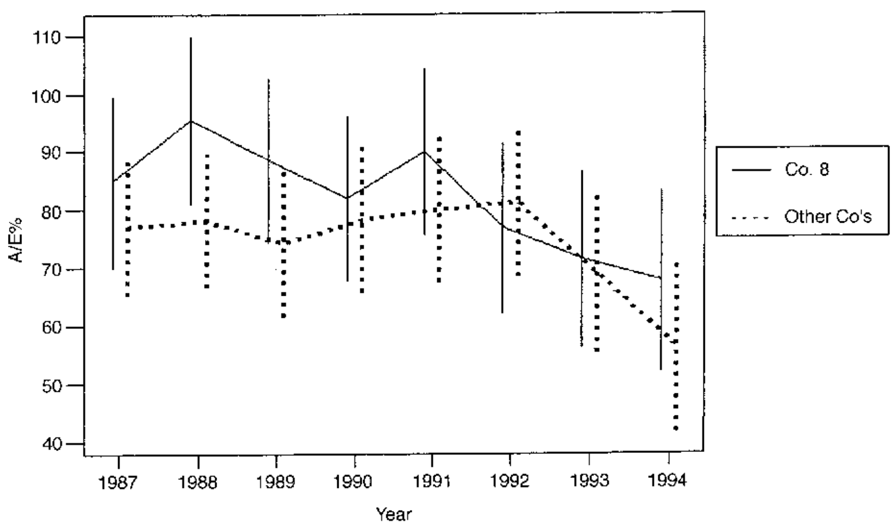


Figure 1b. Co 8/Other co's Males, DP4: Inceptions A/E% with 2se limits.

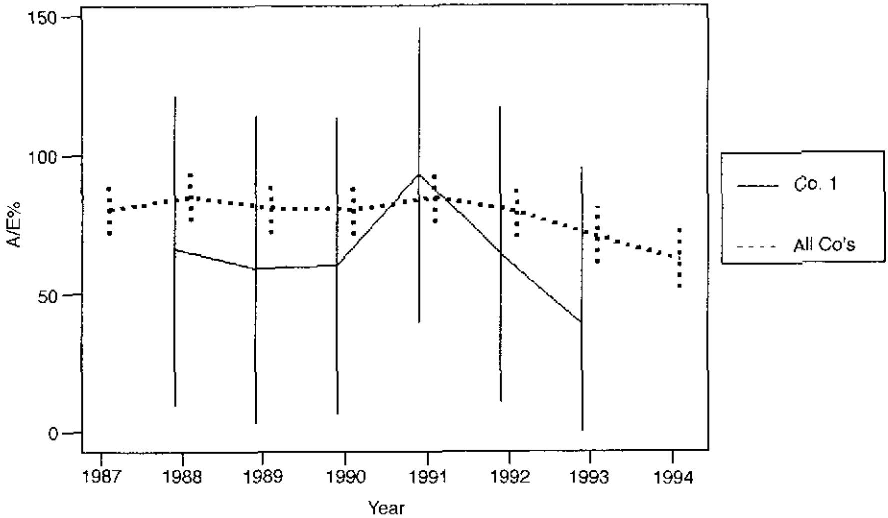


Figure 2. Co 1/All co's Males, DP4: Inceptions A/E% with 2se limits.

2.3.2 *Year effect plot*

Figures 1 and 2 indicate how $A/E\%$ varies by Year. As this feature is of some interest, we show in Figure 3 a plot of the Actual claim inceptions, the Expected claim inceptions (both divided by 50) and the value of $A/E\%$ for each Year, aggregated over Company, Deferred Period and Sex. Both the Actual and the Expected claim inceptions show a decreasing trend, more marked for the former than the latter. The result is a decreasing trend in $A/E\%$. This could be due to a reaction by the companies, in terms of underwriting standards and claims control, to generally worsening claim inception experience from 1979–82 to 1987–90. See *C.M.I.R.* **15** (1996, Claim Inception Rates Under PHI Policies, Individual 1975–90 and Group 1975–86, Figures 1 and 2). A relevant point to bear in mind is that our data should include only those lives who have no occupation rating and no medical ratings or exclusions. Another possible explanation for the decreasing trend in $A/E\%$ is that during the period 1987–94, some companies may have improved their procedures for eliminating from their data submitted to the CMIB policies with an occupation class other than 1 or with a medical rating or exclusion. In a separate study, using less detailed data and different methods, Haberman and Walsh (1997) did not identify any time trends in claim inception rates over the period 1987–94.

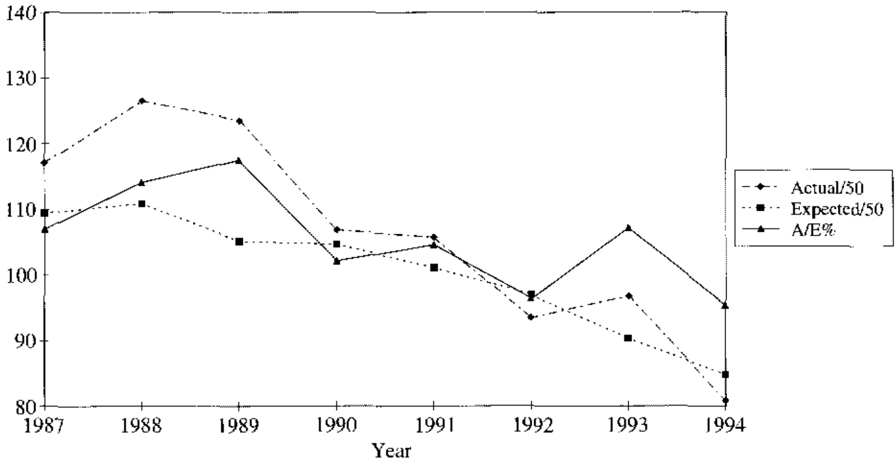


Figure 3. Actual and expected claim inceptions.

The credibility approach in Section 4 requires us to remove any time trend from the data. To do this we fitted a simple regression model, regressing $\log(A/E)$ on Year. This yielded a slope coefficient of -0.0201 (standard error 0.009). The magnitude of the decreasing trend is given by the multiplicative factor $\exp(-0.0201)$, which corresponds to just over a 2% per annum reduction in A/E.

2.3.3 *The effect of company size*

We were interested in the possibility of a relationship between a company's experience (A/E) and its 'size' in a particular segment of the market, i.e. for a particular combination of Deferred Period and Sex. We measured 'size' by the expected number of claim inceptions according to the standard basis, E. We plotted ten graphs of $A/E\%$ against E, one for each combination of Deferred Period and Sex. These graphs generally showed no evidence of any relationship between experience and size. Figure 4 shows the graph for males, deferred period 13 weeks and this is fairly typical of the lack of relationship. One exception was the graph for females, deferred period 1 week, which was dominated by two companies. One had a cluster of points (one for each year) with relatively high A/E values, while the other had a cluster of points with relatively low A/E values. The two companies had clearly different values for their expected claim inceptions. However the corresponding graph for males, deferred period 1 week was also dominated by the same two companies but

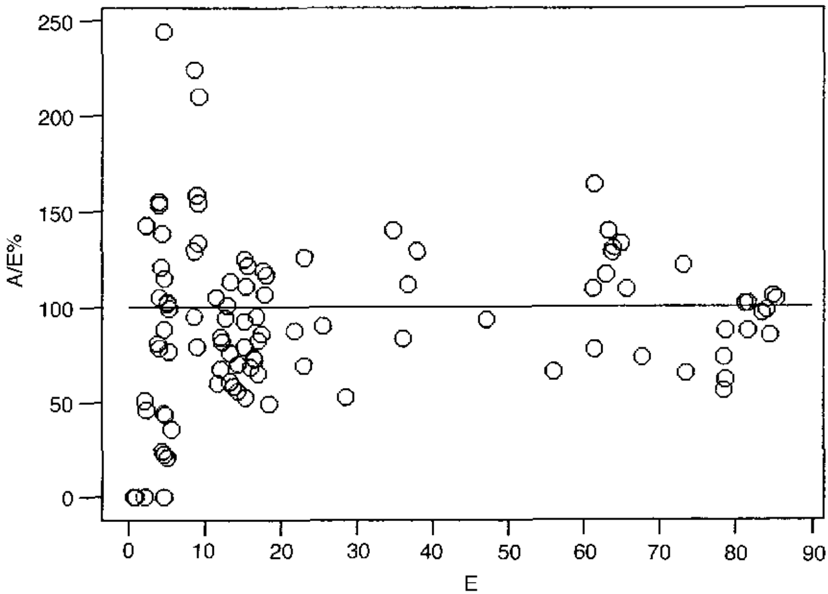


Figure 4. Inceptions A/E% plotted against E for Males, DP13.

the two clusters of points showed the same level of A/E despite also having clearly different E values and much more data than for females. Therefore we concluded that there was no overall evidence that experience was related to size in a given segment of the market.

3. A GENERALIZED LINEAR MODEL FOR A/E

In this section we describe the fitting of a generalized linear model (GLM) to the actual number of claim inceptions for each cell in our data, our primary purpose being to investigate the structure of the data. The fitting process was carried out using the statistical package Splus. As we are dealing with the numbers of claim inceptions it was appropriate to model A, the response, with a Poisson error structure.

3.1 *The modelling process*

The basic form of the model is as follows:

$$A_{idsj} \sim \text{Poisson}(\mu_{idsj}) \qquad (2)$$

where:

$$\mu_{idsj} = E_{idsj} \cdot f_{idsj}$$

Taking logs we have:

$$\log(\mu_{idsj}) = \log(E_{idsj}) + \log(f_{idsj})$$

In GLM methodology, the term log (E_{idsj}) is called an offset and the term $\log(f_{idsj})$ is modelled as a linear expression.

It was anticipated that there would be overdispersion on top of the Poisson variability due to the presence in the data of duplicate policies, i.e. the fact that one life could have more than one policy so that policies may not be independent in their experiences. However, we decided to see if the modelling process itself would suggest that overdispersion was indeed present. We fitted the above form of generalized linear model with Year as a covariate and three potential factors, namely, Company, Sex and Deferred Period. We used 'forward selection' starting with the null model and adding terms (covariate, main effects and interactions) until a satisfactory fit was obtained. However, even after the addition of all six two-factor interactions (between the covariate and the three factors) the fit was still very poor with a residual deviance of 1191 on 757 degrees of freedom (df). Also, the residual mean square (RMS) was 1.56 which is substantially greater than 1 and hence indicates overdispersion. See Chambers and Hastie (1993).

The modelling process was repeated, incorporating overdispersion using weights given by $1/V_d$ where V_d is the 'variance inflation factor', i.e. the factor by which the variance of the actual number of claim inceptions exceeds the mean due to the presence of duplicate policies. See Section 2.3.1.

The first model given serious consideration included Year as a covariate, all three factors and all three two-factor interactions involving Company, Sex and Deferred Period, but no interactions between Year and the three factors. This gave a residual deviance of 925 on 778 df which is still a very poor fit. Despite the lack of fit, this model was considered for its relative simplicity as regards the Year effect and will be used to describe the Year effect in Section 3.3.1. Also the RMS for this model was down to 1.17, much closer to 1 as desired, showing that overdispersion had been incorporated to a reasonable extent. We will refer to this model subsequently as the 'simple model'.

We eventually settled on a model as above plus two further interactions, both involving the covariate Year, one with Company and the other with Deferred Period. We will refer to this model subsequently as the 'fitted model'. This model gave a residual deviance of 874 on 758 df which is still not a very good fit but we had reached the stage where a compromise had to be made between the complexity of the model and its goodness of fit. The addition of a three-factor interaction between Company, Sex and Deferred Period resulted in a slightly better fit with a residual deviance of 791 on 707 df but we felt that this model was unnecessarily complex and did not use it. The addition of a quadratic term in Year did not improve the fit. The RMS for the fitted model was 1.14, closer to 1 as desired.

The fitted model is fully described in the following section. However, its apparent lack of fit did cause some concern. Other features led us to accept the fitted model despite its poor fit. In particular, exactly the same model was selected using weights based on the variance inflation factors from *C.M.I.R.* 7 (1984, Appendix F) but this had a better fit. The fit was most sensitive to the variance inflation factor for deferred period 52 weeks. Using the larger value from *C.M.I.R.* 7 resulted in a good fit (819 on 758 df). Also, deferred period 52 weeks contributed less than 2% of the whole data in terms of the number of inceptions. This suggests that the variance inflation factors may not fully explain the overdispersion. In fact in Part II: Termination Rates, we find that there is evidence of overdispersion despite the fact that duplicates have been removed from these data as far as it was possible to do so. Accordingly, we concluded that there may still be some overdispersion unaccounted for by the variance inflation factors and that this contributes to the lack of fit of the fitted model. These features led us to accept the fitted model despite its poor fit.

3.2 *The fitted model*

As described above the fitted model incorporates:

- the factor Company with 18 levels
- the factor Deferred Period with 5 levels
- the factor Sex with 2 levels
- the covariate Year
- the interaction between Company and Deferred Period
- the interaction between Company and Sex
- the interaction between Company and Year
- the interaction between Deferred Period and Sex
- the interaction between Deferred Period and Year

Symbolically the linear model is of the following form:

$$\log \mu_{idsj} = \log E_{idsj} + \alpha_i + \beta_d + \gamma_s + \phi_0 + \phi_1 \cdot j + (\alpha\beta)_{id} + (\alpha\gamma)_{is} + \psi_i \cdot j + (\beta\gamma)_{ds} + \xi_d \cdot j \qquad (3)$$

where:

α_i	is the Company term: $i = 1, \ldots, 18$
β_d	is the Deferred Period term: $d = 1, \ldots, 5$
γ_s	is the Sex term: $s = 1, 2$
j	represents Year: $j = 1987$ to 1994
ϕ_0	is a constant term
ϕ_1	is the slope coefficient for Year
$(\alpha\beta)_{id}$	is the Company by Deferred Period interaction term
$(\alpha\gamma)_{is}$	is the Company by Sex interaction term
ψ_i	is the Company i slope coefficient for Year
$(\beta\gamma)_{ds}$	is the Deferred Period by Sex interaction term
ξ_d	is the Deferred Period d slope coefficient for Year

We used the most common parameterisation in which the sums of various parameters are zero. For example:

$$\sum_{i=1}^{18} \alpha_i = 0; \quad \sum_{i=1}^{18} \psi_i = 0; \quad \sum_{d=1}^{5} (\alpha\gamma)_{id} = 0 \text{ for each } i = 1, \ldots, 18$$

There are potentially 134 estimable parameters and a further 52 which are determined from these using the above summation conditions. However 11 of these parameters are aliased due to the data being incomplete (recall from Section 2.1 that data are available for only 881 of the 1440 possible cells). The complete set of parameters is given in Appendix A.

With so many interaction terms, the model is too complex to allow a simple description of the different effects which influence the response A/E. Note that, for example, there is no simple Company effect as Company is involved in interactions with all the other terms, namely, Sex, Deferred Period and Year. However, we describe these effects in the following subsections in the most convenient way possible.

3.2.1 *The Year effect*

First we describe the overall Year effect using the simple model referred to in Section 3.2. As Year appears in the model only as a covariate and not in any interactions, the Year effect is simply described by referring to the fitted slope coefficient ϕ_1 which is given by:

$$\hat{\phi}_1 = -0.02051 \text{ with s.e. } 0.00351$$

It is clear that Year is highly significant and the negative sign indicates the decreasing trend already discussed. The slope coefficient confirms the simple estimate calculated in Section 2.3.

The Year effect is more complex in the fitted model. Here Year appears as a covariate and in interactions with both Company and Deferred Period. As a result the model incorporates the Year effect with a different slope for each Company and Deferred Period combination. However, due to the complex nature of the model we cannot describe the effects using the various slope coefficients, ϕ_1, ψ_i and ξ_d, in isolation from the other model parameters. This can be seen especially for the smaller companies such as company 7, for which $\psi_7 = -0.53190$. When multiplied by 1994 this gives -1060.61, an extremely large value, the large part of which cancels with the Company parameter $\alpha_7 = 1060.58$.

3.2.2 *The Company, Deferred Period and Sex effects*

The presence of so many interactions in the fitted model means that the effects of the three factors cannot be described individually but only through the use of two-way tables. Even this is not wholly adequate (as witnessed in the comments on the Year effect above) but it still gives an informative description. The three corresponding two-way tables are Tables 2a, 2b and 2c. The figures tabulated are the A/E percentages after aggregation as calculated from the fitted values from the model. The fitted values in these tables have been calculated as at 1 January 1991, the mid-point of the data collection period. When interpreting these tables account should be taken of the differing amounts of data in the cells. Refer back to Section 2.2 for details. In particular note that companies 8 and 10 between them account for over 40% of the inceptions for deferred periods of 4 weeks or greater, whereas company 14 accounts for very few inceptions. An asterisk in Table 2a indicates that there are no data for that cell. Individual company values for DP 1 are not shown in Table 2a in order to preserve the anonymity of the companies.

From Table 2a for the Company by Deferred Period interaction, first note that several cells for DP 1 and DP 4 are empty due to the lack of data. This is naturally complicated to describe being an 18 by 5 table. Some features concerning Company and Deferred Period obtained from this table are:

- The overall A/E is 106% and for individual companies A/E ranges from 36% to 135%.
- The overall A/E profile with respect to Deferred Period is a drop between 1 week and 4 weeks and an increase thereafter.
- The initial drop between DP 1 and DP 4 is essentially due to two of the larger companies. None of the other companies show this drop.
- One company (10) has an overall A/E which is close to the overall average for all companies but has the greatest values for A/E for both DP 13 and DP 26.

- All but three companies show the general increase between DP 26 and DP 52 and these are three of the smaller companies.

From Table 2b for the Company by Sex interaction, note the following points:

- The overall A/E for males is 102% (very close to 100%) while the overall A/E for females is much greater at 153%.
- for *all* companies, except company 14, which has very little data, the female A/E is greater than the male A/E but to quite varying extents over the companies.
- two of the larger companies (9 and 16) show quite large differences but another of the larger companies (10) shows the least difference.

From Table 2c for the Deferred Period by Sex interaction, the main feature to note is that the A/E value for females does not drop between DP 1 and DP 4, unlike the value for males.

Table 2a. Fitted A/E percentages for Company by Deferred Period.

Company	DP 1	DP 4	DP 13	DP 26	DP 52	All DPs
1	*	66	90	112	182	93
2	-	*	96	135	101	107
3	-	109	113	208	342	113
4	*	53	80	271	992	92
5	-	87	82	148	268	86
6	-	65	104	186	316	88
7	*	*	59	150	130	81
8	-	91	139	156	242	113
9	-	78	82	157	322	93
10	-	99	159	287	416	104
11	-	*	93	132	345	110
12	-	62	102	134	277	79
13	*	67	84	139	226	88
14	*	*	0	37	192	36
15	-	14	81	151	66	111
16	-	80	104	130	243	116
17	-	93	132	211	465	125
18	*	114	122	173	228	135
All Co.'s	106	87	105	154	269	106

Table 2b. Fitted A/E percentages for Company by Sex.

Company	Male	Female	Both Sexes
1	85	156	93
2	98	213	107
3	104	183	113
4	79	160	92
5	78	149	86
6	85	147	88
7	62	177	81
8	107	174	113
9	76	215	93
10	103	120	104
11	99	224	110
12	74	168	79
13	83	216	88
14	38	3	36
15	99	357	111
16	110	226	116
17	105	228	125
18	121	419	135
All Co.'s	102	153	106

Table 2c. Fitted A/E percentages for Deferred Period by Sex.

Deferred Period	Male	Female	Both Sexes
1	104	132	106
4	78	151	87
13	97	186	105
26	136	380	154
52	241	611	269
All DPs	102	153	106

3.3 *Prediction using the fitted GLM*

As indicated earlier, the primary purpose of the GLM is to investigate the structure of the data as regards how the various factors influence the response A/E. This has been done as described above. In Section 5 the fitted GLM will be used to predict the A/E values for particular cases. It should be noted that prediction is a secondary purpose of the GLM, especially when it is being used to predict in cells for which there are no data. Effectively it is being used for extrapolation and as the fitted model is quite complex this may result in wild unreliable values. The size of the associated standard errors will also be indicative of values that are unreliable. Further comment will be made on these features in Section 5.

4. A CREDIBILITY MODEL FOR A/E

4.1 *General points*

In this section we take a different approach to the problem of estimating the A/E value for a given Company, Deferred Period, Sex and Year, namely, a credibility approach. Our primary purpose here is to predict future values of A/E. The credibility approach fits very well with the service provided by the CMIB to individual companies. Loosely speaking, for a given Deferred Period and Sex the CMIB provides each company with values for A/E based on its own experience, say A_{own}/E_{own}, and on all companies' experience, say A_{all}/E_{all}. Since an individual company's experience may be based on very little data, it is intuitively appealing for a given company to assume that a better estimate of its A/E value is given by the weighted average:

$$A/E = Z \,.\, A_{own}/E_{own} + (1-Z) \,.\, A_{all}/E_{all}$$

for some credibility factor, Z, where $0 \leq Z \leq 1$.

4.2 *Model specification*

For company i, $i = 1,2,\ldots,18$, year j, $j = 1987,1988,\ldots,1994$, and a given combination of Deferred Period and Sex, let:

A_{ij} denote the actual number of claim inceptions summed over all ages,

and,

E_{ij} denote the expected number of claim inceptions summed over all ages.

In the notation of Section 1, these are A_{ijds} and E_{ijds}, respectively. However, since we are restricting our attention to a given combination of Deferred Period and Sex, we have dropped the subscripts d and s. Now define:

$$E'_{ij} = E_{ij}\exp(-0.0201(1990.5-j)), \text{ and,}$$
$$X_{ij} = 100 \times A_{ij}/E'_{ij}$$

so that X_{ij} is the A/E percentage with the time trend, as estimated in Section 2, taken out and stabilised at the 1 January 1991 level.

We assume that the data $\{\{X_{ij}, E'_{ij}\}_{j=1}^{8}\}_{i=1}^{18}$ satisfy all the assumptions for the Bühlmann-Straub credibility model. See Bühlmann and Straub (1970) or Klugman, Panjer and Willmot (1997). In summary these are as follows:

A.1 For each company i, the distribution of X_{ij} depends on the value of an unknown *risk parameter* θ_i.

A.2 Given θ_i, the X_{ij}s are independent.

A.3 There are functions $m(\theta_i)$ and $s^2(\theta_i)$ such that:

$$m(\theta_i) = E[X_{ij} \mid \theta_i] \text{ and } s^2(\theta_i) = E'_{ij}.V[X_{ij} \mid \theta_i].$$

A.4 The risk parameters $\{\theta_i\}_{i=1}^{18}$ are independent and identically distributed.

A.5 For $i \neq k$, the pairs $\{\theta_i, X_{ij}\}$ and $\{\theta_k, X_{km}\}$ are independent.

Standard credibility theory, see, for example, Klugman, Panjer and Willmot (1997), shows that the credibility estimate of $A/E\%$ for company i at the 1 January 1991 level for the given combination of Deferred Period and Sex is given by:

$$Z_i.\overline{X}_i + (1 - Z_i) . E[m(\theta_i)] \tag{5}$$

where:

$$\overline{X}_i = \frac{\sum_{j=1}^{8} E'_{ij} X_{ij}}{\sum_{j=1}^{8} E'_{ij}} \tag{6}$$

$$Z_i = \frac{\sum_{j=1}^{8} E'_{ij}}{\sum_{j=1}^{8} E'_{ij} + E[s^2(\theta_i)]/V[m(\theta_i)]} \tag{7}$$

Unbiased estimates of the structural parameters, $E[m(\theta_i)]$, $E[s^2(\theta_i)]$ and $V[m(\theta_i)]$, are computed from the data for the given Deferred Period and Sex, $\{\{X_{ij}, E'_{ij}\}_{j=1}^{8}\}_{i=1}^{18}$. The formulae for the estimators for $E[s^2(\theta_i)]$ and $V[m(\theta_i)]$ are given for completeness in Appendix B. The estimator for $E[m(\theta_i)]$ is $\overline{X}$, where:

$$\overline{X} = \frac{\sum_{i=1}^{18} \sum_{j=1}^{8} E'_{ij} X_{ij}}{\sum_{i=1}^{18} \sum_{j=1}^{8} E'_{ij}} \tag{8}$$

which can easily be shown to be unbiased.

It is clear from (6) and (8) that $\overline{X}_i$ is an estimate of $A/E\%$ based on the company's own experience and $\overline{X}$, the estimator for $E[m(\theta_i)]$, is an estimate of $A/E\%$ based on the experience of all 18 companies. Substituting (8) into (5) shows that (5) is in the form of (4), as required.

4.3 *Standard errors*

The credibility estimate (5) is an estimate of $m(\theta_i)$, which is the true underlying A/E ratio for company i. The mean squared error of this estimate is:

$$E[(m(\theta_i) - Z_i \,.\, \overline{X}_i - (1 - Z_i) \,.\, E[m(\theta_i)])^2]$$

which, after a little algebra, can be shown to be:

$$Z_i^2 \frac{E[s^2(\theta)]}{\sum_{j=1}^{8} E'_{ij}} + (1 - Z_i)^2 V[m(\theta)] \tag{9}$$

Since the credibility estimate is unbiased, its standard error can be calculated as the square root of (9).

4.4 *Comments on the models of Sections 3 and 4*

The credibility model specified above can be related to the simple generalized linear model in Section 3.2. To see this, let us re-employ the notation of Section 1. In terms of this notation, two of the assumptions of Section 3 are:

$$E[A_{ijds}] = E_{ijds} \cdot f_{ijds} \tag{10}$$

$$V[A_{ijds}] = V_d \,.\, E_{ijds} \cdot f_{ijds} \tag{11}$$

and one of the results of the simple model described in Section 3.2 is that f_{ijds} can be written:

$$f_{ijds} = \exp(-0.02051(1990.5 - j)) \,.\, g_{ids} \tag{12}$$

where g_{ids} is some function of Company, Deferred Period and Sex only. This last relationship follows from the fact that, for this simple model, Year is modelled as an exponential term with no interactions with any of the other factors. It can be easily checked that formulae (10), (11) and (12) are consistent with Assumption **(A.3)** in Section 4.2, apart from the slight difference in the values of the slope coefficient for Year. (Recall that in Section 4.2 we are considering a given combination of Deferred Period and Sex, so that the factors d and s are constant.)

The credibility model is more general than the generalized linear model in the sense that the latter assumes A_{ijds} has an overdispersed Poisson distribution whereas the former makes no distributional assumptions.

5. NUMERICAL RESULTS

In this section we present detailed results for males, deferred period 4 weeks in order to illustrate the application of the credibility analysis outlined above and to be able to make comparisons with the GLM approach of Section 3. We also comment on the results for the other combinations of Deferred Period and Sex. Summary results, in the form of Tables and Figures, for these other combinations are shown in Appendix C.

5.1 *Males, deferred period 4 weeks*

Table 3a shows the actual number of claim inceptions for each of the 18 companies in each of the eight years, 1987 to 1994, inclusive. Table 3b shows the corresponding values of X_{ij}. In each table an asterisk indicates that no data were available from that company for that year.

The points to note from Tables 3a and 3b are:

- There is considerable variation between companies in terms of their numbers of claims. Company 8 is responsible for 45% of all claims, whereas three companies (4, 15 and 16) are in total responsible for 1.3% of all claims. This point has already been made in respect of Table 1, which includes females as well as males.
- For individual companies, even the larger ones, there is considerable variation in the values of X_{ij}. For example, the values of X_{ij} for company 10 range from 78.3% (1994) to 112.2% (1988).
- Four companies (2, 7, 11 and 14) have no data at all for males, deferred period 4 weeks.
- Company 17 has data only for 1993 and 1994. Companies contribute data to the CMIB on a voluntary basis and it may be that company 17 became a contributor as from 1993 or that it entered the deferred period 4 weeks market at that time.
- Several companies (3, 4, 5, 6, 13 and 18) have data for a few years and then no data for the remaining years. This feature may be caused by the company's deciding to stop contributing data to the CMIB but is more likely to be caused by the data's being unavailable at the time when the CMIB sent us the data (early 1997). There can be several years' delay before a company submits data to the CMIB. The CMIB checks all submitted data carefully and asks the contributing company to investigate any apparent errors. This investigation can in turn take several years!

Table 3a. Actual claim inceptions, males, deferred period 4 weeks.

Company	1987	1988	1989	1990	1991	1992	1993	1994	Total
1	*	14	13	14	22	15	8	0	86
2	*	*	*	*	*	*	*	*	*
3	52	60	67	66	68	72	*	*	385
4	8	2	6	4	*	*	*	*	20
5	33	18	21	28	29	33	*	*	162
6	79	67	*	*	*	*	*	*	146
7	*	*	*	*	*	*	*	*	*
8	260	303	290	273	292	235	207	184	2,044
9	85	102	94	109	100	116	97	70	773
10	75	92	75	78	75	62	63	58	578
11	*	*	*	*	*	*	*	*	*
12	10	7	8	7	11	15	9	2	69
13	24	33	12	21	22	16	17	*	145
14	*	*	*	*	*	*	*	*	*
15	0	1	0	0	0	1	0	0	2
16	0	1	1	3	1	0	0	0	6
17	*	*	*	*	*	*	49	41	90
18	8	5	10	4	6	*	*	*	33
All Co's	634	705	597	607	626	565	450	355	4,539

The estimates of the three structural parameters from this data set are:

$E[m(\theta_i)]$	77.8%
$E[s^2(\theta_i)]$	9,000
$V[m(\theta_i)]$	180

Recall that $E[m(\theta_i)]$ is the estimate of A/E based on the combined experience of all the companies. $E[s^2(\theta_i)]$ can be interpreted as a measure of the variability *within each company's experience*. $V[m(\theta_i)]$ can be interpreted as a measure of the variability *between companies*.

Table 3c shows the results of the credibility analysis for the individual companies. For each company the following values are given:

$\bar{X}_i$ This is the estimate of $A/E\%$ based on the company's own experience. See (6).

$\sum_{j=1}^{8} E'_{ij}$ This is the sum of the expected number of inceptions for the company, after adjusting for the time trend in A/E. This factor appears in the formula for Z_i. Noting that $E[s^2(\theta_i)]/V[m(\theta_i)]$ is estimated to be 50, it can be seen from formula (7) that an individual company's experience will be given a credibility factor of, for example, 0.5 or higher if and only if its expected claims in the period were 50 or more.

Z_i — This is the credibility factor for company i.

Cred. Est. This is the credibility estimate of $A/E\%$ for the company calculated from (5).

C.E.S.E. This is the standard error of the credibility estimate.

GLM Est. This is the estimate of $A/E\%$ calculated from the fitted model described in Section 3. These values should be compared with the corresponding values in the column *Cred. Est.* An asterisk against the value is a reminder that there are no data for this company. The values of *GLM Est.* for these companies have not been included in Figure 5.

S.E. This is the standard error of *GLM Est.* Note that in cases where the ratio of *S.E.* to *GLM Est.* is high, say greater than 0.5, the distribution of the corresponding *GLM* estimator will be far from normal and highly skewed to the right.

Table 3b. Values of X_{ij}, males, deferred period 4 weeks.

Company	1987 %	1988 %	1989 %	1990 %	1991 %	1992 %	1993 %	1994 %
1	*	62.5	57.3	59.6	93.9	65.8	40.4	*
2	*	*	*	*	*	*	*	*
3	80.2	95.4	102.0	101.1	114.2	118.9	*	*
4	75.0	18.7	55.2	36.3	*	*	*	*
5	96.5	53.3	63.5	84.8	85.8	96.9	*	*
6	62.1	54.2	*	*	*	*	*	*
7	*	*	*	*	*	*	*	*
8	79.1	90.8	85.8	81.1	90.9	79.1	75.1	72.5
9	62.1	70.8	62.2	68.4	61.3	73.9	65.3	49.0
10	92.1	112.2	90.6	94.3	91.8	79.5	83.7	78.3
11	*	*	*	*	*	*	*	*
12	60.8	43.7	51.8	46.3	74.8	104.5	70.8	17.5
13	62.2	90.3	34.2	64.1	74.2	61.7	70.2	*
14	*	*	*	*	*	*	*	*
15	0.0	52.6	0.0	0.0	0.0	56.7	0.0	0.0
16	0.0	84.5	99.7	361.3	132.4	0.0	0.0	0.0
17	*	*	*	*	*	*	93.0	77.5
18	107.4	66.7	136.2	61.3	102.9	*	*	*

Figure 5 displays graphically some key features from Table 3c; it shows for each company the values of $\overline{X}_i$, *Cred. Est.*, *GLM Est.* and, as a horizontal line, the estimated value of $E[m(\theta_i)]$.

Points to note about Table 3c and Figure 5 are:

(a) For those companies with no data for males, deferred period 4 weeks (2, 7, 11 and 14), their credibility factor, Z_i, is zero and their value for *Cred. Est.* is 77.8%, the estimate of $E[m(\theta_i)]$. In such cases, the generalized linear model of Section 3 may produce a 'wild' predicted value which is clearly nonsense. Examples of this are companies 2, 7 and 11. The corresponding standard errors indicate how much notice should be taken of these predicted values! Another predicted value which should be treated cautiously, because of its relatively large standard error, is the value for company 14, 50.5%. The problem is that there are no data in these four cells, so that the fitted GLM, which has a complicated structure, is not 'tied down' at these points. It would be unfair to criticise the GLM for producing these wild values. A simpler GLM may have been more suitable for the purpose of prediction since it may have produced smoother values, at the expense of a less satisfactory fit to the data. A main effects only model does give sensible predictions in cases where there are no data. However, the model is a very bad fit (residual deviance of 1423 on 857 df).

(b) For those companies with data for males, deferred period 4 weeks, there is considerable variability in the values of $\overline{X}_i$, *Cred. Est.* and *GLM Est.* as indicated below:

Estimate	Low %	High %
$\overline{X}_i$	13.7	101.6
Cred. Est.	61.4	98.8
GLM Est.	13.3	114.6

That *Cred. Est.* should show less variability than $\overline{X}_i$ is not surprising. It is somewhat surprising that *GLM Est.* should have a wider range than $\overline{X}_i$. This variability is, presumably, a consequence of different underwriting standards, marketing strategies and claims control between the companies. The most extreme difference is between companies 3 and 6, both of whom have contributed a reasonable amount of data, i.e. have reasonably large values of $\sum_{j=1}^{8} E'_{ij}$. Loosely speaking, our analysis shows that company 3 should be using the standard basis to calculate its expected number of claims whereas company 6 could reasonably expect its claim numbers to be only 60% of the number calculated using the standard basis.

(c) For most companies the values of *Cred. Est.* and *GLM Est.* are reasonably close, taking account of the values of *C.E.S.E.* and *S.E.*

(d) For each company the values of *C.E.S.E.* and *S.E.* are fairly close, with the former generally being a little less than the latter. At first sight this feature may be surprising. Since the GLM uses all the data rather than just the data for the given deferred period and sex, we might expect it to have a smaller standard error than the credibility estimate. However, an important point to bear in mind is that in both cases the standard errors are calculated from certain model assumptions. If the model itself is not a good fit to the data, the value of the standard error of a particular predicted value could be misleading. In this situation a further contribution to the error is present in the form of a bias representing the difference between the model being used, which does not fit well, and some true model which does fit the data. The associated standard errors for the main effects only model (see point (a) above) are misleadingly small; indeed, smaller than those for the predictions from either the fitted model or the credibility model.

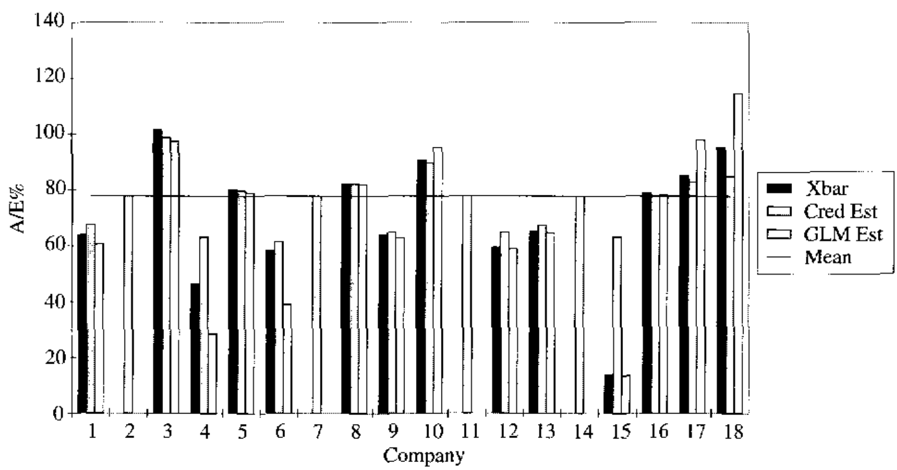


Figure 5. Males, deferred period 4 weeks, inceptions.

Table 3c. Credibility and GLM analysis, males, deferred period 4 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	63.9	134.624	0.729	67.6	7.0	60.5	7.2
2	0.0	0.000	0.000	77.8	13.4	*11,766	4×10^5
3	101.6	378.850	0.883	98.8	4.6	97.4	5.9
4	46.3	43.222	0.463	63.2	9.8	28.3	10.6
5	80.2	201.894	0.801	79.7	6.0	79.0	7.5
6	58.2	250.966	0.834	61.4	5.5	38.9	12.0
7	0.0	0.000	0.000	77.8	13.4	*1.9	76.7
8	82.3	2,484.642	0.980	82.2	1.9	82.0	2.0
9	64.2	1,203.239	0.960	64.8	2.7	62.8	2.5
10	90.6	637.995	0.927	89.7	3.6	95.2	4.2
11	0.0	0.000	0.000	77.8	13.4	*5,610	1×10^5
12	59.4	116.209	0.699	64.9	7.4	58.9	8.0
13	65.1	222.732	0.816	67.4	5.7	64.7	6.3
14	0.0	0.000	0.000	77.8	13.4	*50.5	77.0
15	13.7	14.594	0.226	63.3	11.8	13.3	10.8
16	78.9	7.601	0.132	77.9	12.5	78.3	36.8
17	85.3	105.543	0.678	82.9	7.6	97.9	40.6
18	95.3	34.638	0.409	84.9	10.3	114.6	25.0

5.2 *Further numerical results*

Results for the remaining nine combinations of Deferred Period and Sex are shown in Appendix C as Figures C1–C9 and Tables C1–C7. The Figures correspond to Figure 5 and the Tables correspond to Table 3c. The two tables for deferred period 1 week have been omitted to preserve the anonymity of the individual companies. Estimates of the structural parameters needed for the calculation of the credibility factor are shown at the foot of each table.

Points to note from these results are:

(a) Some companies contribute little or no data to an experience. In such cases the GLM may produce a wild predicted value, as indicated by its standard error. An interesting example of this is company 7, females, deferred period 52 weeks. The predicted value in this case is 2003%. The standard error of this estimate is 2×10^4%, a clear indication of the usefulness of the estimate! The problem in this case is that not only does company 7 have very little data for females, deferred period 52 weeks but also that for all combinations of Deferred Period and Sex, company 7 has data for only one year, 1994. This means that the predicted value for 1 January 1991 is very unreliable. This is due to the extrapolation referred to in Section 3.4. The fitted value for company 7 as at the mid-point of 1994 is 317.3% (s.e. 214%) so a more sensible estimate of the value for 1 January 1991 would have been 317.3 × exp(3.5 × 0.0201) = 340.4%. Companies which have contributed no data are indicated by an asterisk in the *GLM Est.* column; companies which have contributed little data and for which the GLM produces a clearly wild value are indicated by a hash. *GLM Est.* values marked with an asterisk or a hash have been omitted from the corresponding Figure.

(b) The estimated value of $E[s^2(\theta_i)]/V[m(\theta_i)]$ is different for each combination of Deferred Period and Sex, and this value has a considerable influence on the credibility factor for a given company, as explained in Section 5.1. For example, the estimated value of $E[s^2(\theta_i)]/V[m(\theta_i)]$ for females, deferred period 52 weeks is 0.79. This means that any company expecting one or more claims from its females, deferred period 52 weeks policies in the eight year period 1987–1994 will have a credibility factor in excess of 0.5.

6. CONCLUSIONS

The statistical modelling revealed the following main features of our data:

- No simple model adequately describes the data; several interaction terms were needed before a satisfactory fit was obtained. (See Section 3.1.)
- There had been a decreasing trend in Actual/Expected claim inceptions over the period 1987–94. Care needs to be taken over this conclusion. First of all, Year is included in the fitted model as a single covariate *and* in interactions with Company and Deferred Period. Secondly, there is evidence (Haberman and Walsh (1997)) that this feature may not have been present if we had analysed data from a longer time interval. (See Sections 2.3.2 and 3.2.1.)
- There was no indication of a relationship between the *A*/*E* value and a company's size for any combination of Deferred Period and Sex. (See Section 2.3.3.)
- Since Company is included in our model as a single factor and in interactions with all the other factors, we are not able to identify and quantify a Company effect for PHI business. A crude exercise to illustrate this is to take the *Cred. Est.* values from Tables 3c, C2 and C3, to rank them in ascending order and to compare the rankings for any company. These rankings are shown in Table 4. While many companies maintain a stable 'market position', for example, companies 2, 8 and 13, others do not, for example, com-

panies 1, 5 and 6. When considering the information in Table 4, it should be borne in mind that some companies contributed little or no data to one or more of these three experiences.

Table 4. Rankings for *Cred. Est.* values.

Company	Males D4	Males D13	Males D26
1	7	10	1
2	8	7	6
3	18	15	16
4	2	6	13
5	13	3	8
6	1	12	17
7	8	2	9
8	14	17	14
9	4	1	5
10	17	18	18
11	8	9	2
12	5	11	10
13	6	5	4
14	8	8	7
15	3	4	11
16	12	13	3
17	15	16	15
18	16	14	12

The two approaches we have taken to modelling our data do share some common ground, as explained in Section 4.3. However, there are some important differences between them, and where there are differences each approach has its strengths. The strengths of our GLM approach are:

- It uses all the available data in a unified way. (See Section 3.1.)
- It tests, statistically, whether the data are consistent with a given model structure. (See Section 3.1.)
- It can be used to calculate predicted values and standard errors for these predicted values. As the fitted model fits the data reasonably well, the standard errors are reliable. In cases where the standard error is small relative to the predicted value, normality can be assumed in order to produce approximate confidence limits. (See Section 3.3.)

The major weakness of our fitted GLM is that it can produce clearly inappropriate predicted values for cells where there is little or no data. This is a consequence of fitting a complicated model and having a large number of empty cells in the data. From an actuarial point of view this feature is unfortunate. For example, if company 2 were to decide to enter the males, deferred period 4 weeks market, the generalized linear model fitted in Section 3 would not predict a sensible value for its anticipated claim inceptions experience as compared to the standard basis. (In practice, company 2's reinsurer would have some useful advice to offer!) This difficulty could be reduced, or even eliminated, by choosing a simpler model, for example a model including main effects only. (See Section 5.1 points (a) and (d).)

The strengths of our credibility approach are:

- It does not make any distributional assumptions. (See Section 4.2.)
- It is intuitively appealing and can be easily accepted by non-experts. (See Section 4.1.)
- It produces an estimate of the underlying claim inception experience for all combinations of Company, Deferred Period, Sex and Year, together with the standard error of this estimate. This estimate will always appear to be reasonable since, from its very construction, it has to lie between the individual company mean and the overall mean for a given Deferred Period and Sex. (See Section 5.1.)

The disadvantages of our credibility approach are:

- It ignores all data except those for the particular Deferred Period and Sex being considered. (See Section 4.2.)
- It does not check whether the data are consistent with its assumptions. As the discussion in Section 4.4 shows, the credibility model adopted in Section 4 is consistent with a GLM which includes Year as a covariate, but not in any interaction terms. This model, which incorporates an overdispersed Poisson error structure, does not fit the data very well. Consequently the standard errors associated with the credibility estimates may be misleadingly small. (See Sections 4.4 and 5.1 point (d).)

APPENDIX A

PARAMETERS FOR THE FITTED GLM

Note: all parameters are quoted to 5dp except for the slope parameters which are quoted to 8dp as these are multiplied by 1990.5 in our predictions.

Table A1. The Company terms: α_i: $i = 1, 2, \ldots, 18$.

Term	Parameter	Value
Company 1	α_1	+8.99290
Company 2	α_2	+144.91393
Company 3	α_3	−37.52056
Company 4	α_4	+370.07172
Company 5	α_5	−89.05827
Company 6	α_6	+203.11987
Company 7	α_7	+1060.58362
Company 8	α_8	−55.01789
Company 9	α_9	−22.63863
Company 10	α_{10}	+5.92986
Company 11	α_{11}	−116.27866
Company 12	α_{12}	−160.69583
Company 13	α_{13}	−153.11365
Company 14	α_{14}	−961.36975
Company 15	α_{15}	+81.70374
Company 16	α_{16}	−62.63190
Company 17	α_{17}	+0.20714
Company 18	α_{18}	−217.19756

Table A2. The Deferred Period terms: β_d: $d = 1, 2, \ldots, 5$.

Term	Parameter	Value
DP 1	β_1	+11.34988
DP 4	β_2	+63.79259
DP 13	β_3	+3.36050
DP 26	β_4	−17.11169
DP 52	β_5	−61.39127

Table A3. The Sex terms: γ_s: $s = 1, 2$.

Term	Parameter	Value
Males	γ_1	−0.26131
Females	γ_2	+0.26131

Table A4. The Year (covariate) terms: ϕ_i: $i = 0, 1$.

Term	Parameter	Value
Constant	ϕ_0	−51.81881
Slope	ϕ_1	−0.02583780

Table A5. The Company by Deferred Period interaction terms: $(\alpha\beta)_{id}$: $i = 1, \ldots, 18$; $d = 1, \ldots, 5$.

$(\alpha\beta)_{id}$	DP1($d = 1$)	DP4($d = 2$)	DP13($d = 3$)	DP26($d = 4$)	DP52($d = 5$)
Company 1	−0.44593	+0.00912	+0.50827	*aliased*	−0.07146
Company 2	−4.92904	+5.28851	+0.39027	*aliased*	−0.74974
Company 3	−0.25294	−0.03870	+0.21723	+0.01841	+0.05601
Company 4	+0.52155	−1.04236	−0.38401	*aliased*	+0.90482
Company 5	−1.34582	+0.27222	+0.45416	+0.24240	+0.37703
Company 6	−0.72036	−0.34171	+0.41903	+0.28793	+0.35511
Company 7	+6.17498	−5.41009	−0.07254	*aliased*	−0.69235
Company 8	+0.17622	−0.17907	+0.46923	−0.18360	−0.28278
Company 9	−0.56093	−0.07775	−0.20287	+0.09818	+0.33763
Company 10	−0.21180	−0.32662	−0.33965	+0.17250	+0.02627
Company 11	−5.18541	−4.39848	+0.38471	*aliased*	+0.40222
Company 12	−0.84104	−0.08457	+0.59276	+0.07785	+0.25500
Company 13	−0.04971	−0.17352	+0.25506	*aliased*	−0.03183
Company 14	+3.32160	*aliased*	−4.46064	*aliased*	+1.13904
Company 15	−5.24967	+0.28739	+2.14081	+2.08194	+0.73954
Company 16	−6.44136	+1.53294	+1.96872	+1.44314	+1.49656
Company 17	−0.62947	*aliased*	+0.44121	*aliased*	+0.18827
Company 18	−16.66914	−4.11426	−3.86678	−4.23877	−4.44934

Table A6. The Company by Sex interaction terms: $(\alpha\gamma)_{is}: i = 1, \ldots, 18;$ $s = 1, 2.$

$(\alpha\gamma)_{is}$	Males ($s = 1$)	Females ($s = 2$)
Company 1	−0.04360	+0.04360
Company 2	−0.10777	+0.10777
Company 3	+0.01181	−0.01181
Company 4	−0.04428	+0.04428
Company 5	−0.03778	+0.03778
Company 6	+0.05215	−0.05215
Company 7	−0.23437	+0.23437
Company 8	−0.07554	+0.07554
Company 9	−0.30242	+0.30242
Company 10	+0.06366	−0.06366
Company 11	−0.16071	+0.16071
Company 12	−0.12276	+0.12276
Company 13	−0.18842	+0.18842
Company 14	+1.94826	−1.94826
Company 15	−0.27996	+0.27996
Company 16	−0.05667	+0.05667
Company 17	−0.08202	+0.08202
Company 18	−0.33959	+0.33959

Table A7. The Company by Year interaction terms: ψ_i; $i = 1, 2, \ldots, 18$.

Term	*Parameter*	Value
Company 1	ψ_1	−0.00467965
Company 2	ψ_2	−0.07293689
Company 3	ψ_3	+0.01892341
Company 4	ψ_4	−0.18593349
Company 5	ψ_5	+0.04457887
Company 6	ψ_6	−0.10230017
Company 7	ψ_7	−0.53189582
Company 8	ψ_8	+0.02774164
Company 9	ψ_9	+0.01140395
Company 10	ψ_{10}	−0.00279826
Company 11	ψ_{11}	+0.05838435
Company 12	ψ_{12}	+0.08064263
Company 13	ψ_{13}	+0.07695843
Company 14	ψ_{14}	−0.48173004
Company 15	ψ_{15}	−0.04198963
Company 16	ψ_{16}	+0.03067420
Company 17	ψ_{17}	*aliased*
Company 18	ψ_{18}	+0.11149640

APPENDIX C

FURTHER RESULTS

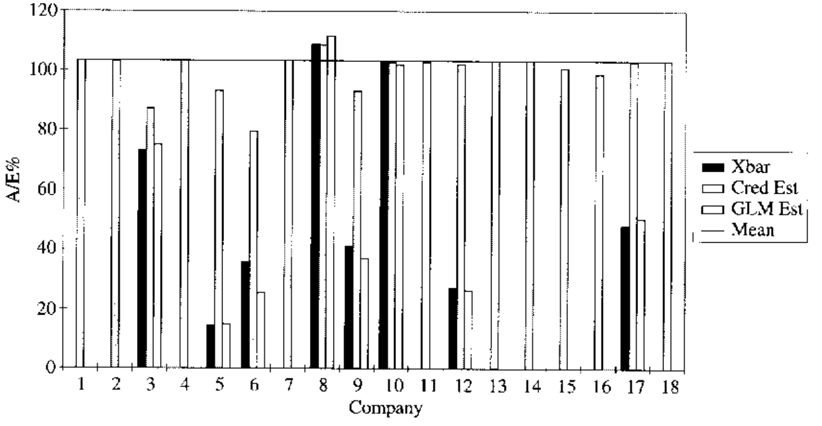


Figure C1. Males, deferred period 1 week, inceptions.

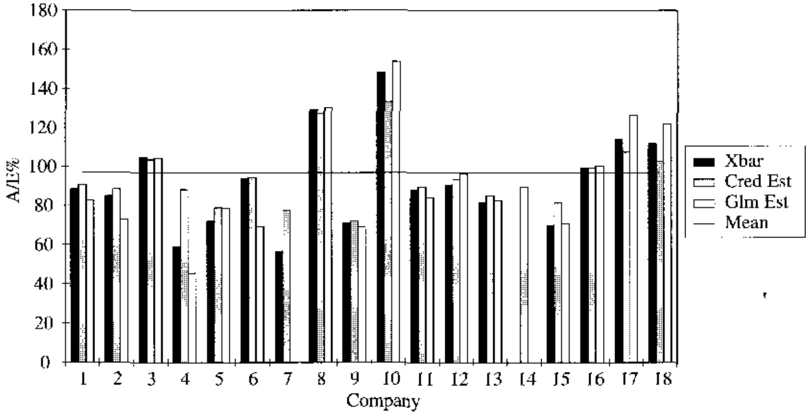


Figure C2. Males, deferred period 13 weeks, inceptions.

Table C1. Credibility and GLM analysis, males, deferred period 13 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est. %*	*C.E.S.E. %*	*GLM Est. %*	*S.E. %*
1	88.6	90.243	0.756	90.6	10.7	82.7	9.8
2	84.8	68.401	0.701	88.3	11.8	72.8	17.4
3	104.5	195.194	0.870	103.5	7.8	104.4	8.1
4	58.7	8.524	0.226	88.1	19.0	45.4	22.2
5	72.0	77.819	0.727	78.7	11.3	78.6	10.9
6	93.8	174.872	0.857	94.2	8.2	69.1	21.0
7	56.4	26.593	0.477	77.5	15.6	#333.8	2804
8	129.0	508.472	0.946	127.3	5.0	130.1	5.3
9	70.6	571.065	0.951	71.8	4.8	69.0	3.5
10	*148.3*	*70.121*	*0.706*	*133.1*	*11.7*	*153.8*	*15.5*
11	88.0	138.692	0.826	89.5	9.0	84.1	8.3
12	90.4	35.415	0.548	93.2	14.5	96.1	17.4
13	81.4	89.726	0.755	85.1	10.7	82.4	10.4
14	0.0	2.401	0.076	89.3	20.8	#0.5	4.6
15	69.7	38.733	0.571	81.3	14.1	70.6	13.7
16	99.3	626.381	0.956	99.2	4.6	100.4	4.3
17	114.2	45.538	0.610	107.4	13.5	126.3	53.7
18	111.7	19.696	0.403	102.7	16.7	121.8	30.3

Estimates of the Structural Parameters

$E[m(\theta_i)]$	96.7%
$E[s^2(\theta_i)]$	1.359
$V[m(\theta_i)]$	0.047

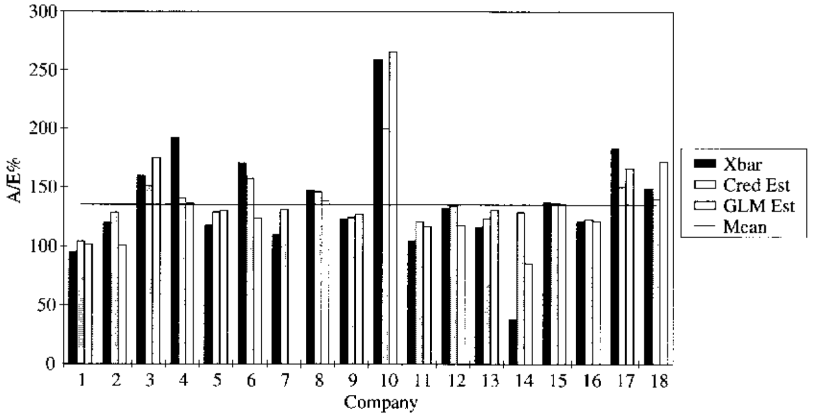


Figure C3. Males, deferred period 26 weeks, inceptions.

Table C2. Credibility and GLM analysis, males, deferred period 26 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	94.9	125.447	0.770	104.1	12.2	101.6	9.5
2	119.9	29.179	0.438	128.5	19.1	100.7	26.4
3	159.5	72.705	0.660	151.2	14.9	174.8	16.1
4	191.8	4.171	0.100	140.7	24.2	136.2	58.8
5	117.3	20.456	0.353	128.8	20.5	130.0	25.8
6	170.3	64.600	0.633	157.3	15.5	123.8	38.4
7	109.8	7.287	0.163	131.0	23.4	#733.3	6163
8	147.2	390.075	0.912	146.1	7.6	138.3	6.3
9	122.6	248.047	0.869	124.2	9.3	126.9	7.3
10	259.1	40.909	0.522	199.8	17.7	265.9	26.4
11	104.5	33.506	0.472	120.6	18.5	116.9	19.4
12	132.1	15.899	0.298	134.2	21.4	117.4	28.0
13	116.2	58.539	0.609	123.5	15.9	130.4	16.3
14	38.1	2.625	0.065	128.7	24.7	85.6	129.4
15	137.0	92.710	0.712	136.4	13.7	136.0	13.3
16	121.0	269.472	0.878	122.7	8.9	121.3	7.2
17	183.5	17.436	0.317	150.4	21.1	166.0	73.5
18	149.1	18.783	0.334	139.7	20.8	171.5	39.5

Estimates of the Structural Parameters

$E[m(\theta_i)]$	135.1%
$E[s^2(\theta_i)]$	2.443
$V[m(\theta_i)]$	0.065

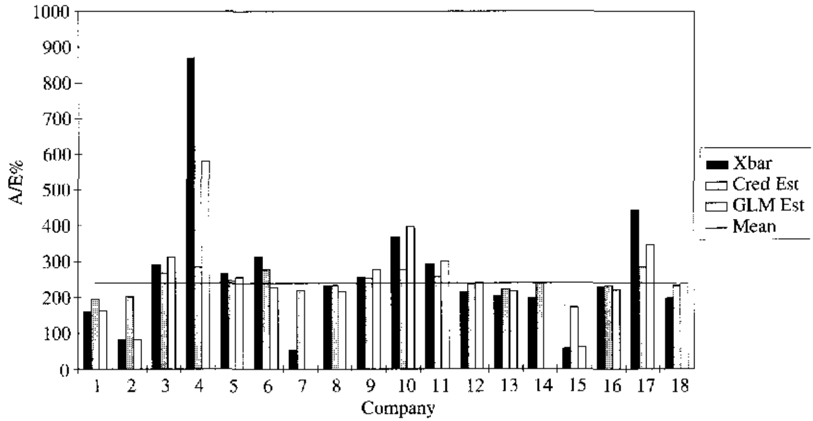


Figure C4. Males, deferred period 52 weeks, inceptions.

Table C3. Credibility and GLM analysis, males, deferred period 52 weeks, inceptions.

Company	$\overline{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	159.8	18.774	0.553	195.6	37.3	163.2	27.1
2	82.4	4.852	0.242	201.7	48.5	82.1	40.2
3	289.9	19.319	0.560	267.9	37.0	313.0	38.4
4	868.5	1.151	0.071	284.2	53.7	580.3	233.7
5	265.2	5.279	0.258	246.4	48.0	256.5	67.2
6	312.7	16.309	0.518	277.6	38.7	228.3	74.4
7	54.1	1.848	0.109	219.7	52.6	#632.8	5327
8	232.6	74.814	0.831	233.8	22.9	216.0	16.0
9	256.9	50.211	0.768	253.0	26.8	278.1	22.0
10	367.8	6.253	0.292	277.2	46.9	396.1	75.3
11	292.5	7.522	0.332	257.3	45.6	301.5	58.5
12	215.2	2.324	0.133	236.6	51.9	241.6	92.7
13	204.5	14.667	0.492	222.5	39.7	217.8	37.8
14	198.2	0.505	0.032	238.5	54.8	#460.8	659.9
15	56.7	8.817	0.368	172.5	44.3	61.2	25.1
16	228.4	38.959	0.720	231.6	29.5	220.7	22.4
17	443.2	4.287	0.220	284.7	49.2	345.6	159.4
18	197.7	3.034	0.167	232.8	50.9	239.6	94.8

Estimates of the Structural Parameters

$E[m(\theta_i)]$	239.8%
$E[s^2(\theta_i)]$	4.710
$V[m(\theta_i)]$	0.311

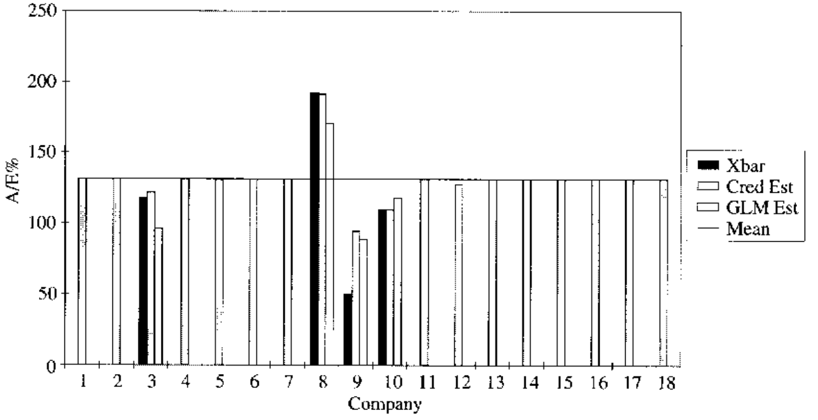


Figure C5. Females, deferred period 1 week, inceptions.

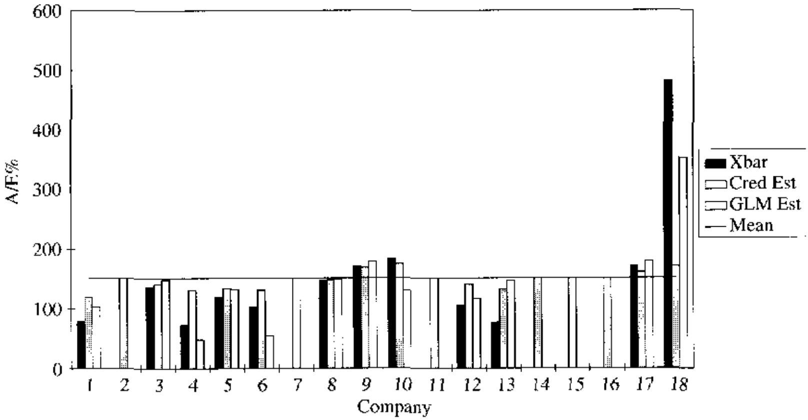


Figure C6. Females, deferred period 4 weeks, inceptions.

Table C4. Credibility and GLM analysis, females, deferred period 4 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	78.4	17.854	0.430	119.9	20.1	102.8	17.5
2	0.0	0.000	0.000	151.2	26.6	*2×10^4	7×10^5
3	136.7	60.734	0.719	140.7	14.1	148.1	13.8
4	72.6	8.261	0.258	130.9	22.9	48.2	20.7
5	119.9	29.195	0.552	133.9	17.8	132.7	21.0
6	102.6	16.567	0.411	131.2	20.4	54.6	19.1
7	0.0	0.000	0.000	151.2	26.6	*4.8	191.0
8	147.8	352.482	0.937	148.0	6.7	148.5	6.5
9	170.8	187.382	0.888	168.6	8.9	179.1	9.7
10	183.4	64.349	0.731	174.7	13.8	130.6	10.2
11	0.0	0.000	0.000	151.2	26.6	*1×10^4	2×10^5
12	105.1	6.661	0.219	141.1	23.5	117.2	34.2
13	76.8	7.816	0.248	132.7	23.1	146.8	32.1
14	0.0	0.000	0.000	151.2	26.6	*1.6	13.8
15	0.0	0.000	0.000	151.2	26.6	*36.3	30.8
16	0.0	0.007	0.000	151.1	26.6	#136.6	66.2
17	171.8	19.786	0.455	160.6	19.6	179.7	77.2
18	481.5	1.454	0.058	170.3	25.8	351.9	122.3

Estimates of the Structural Parameters

$E[m(\theta_i)]$	151.2%
$E[s^2(\theta_i)]$	1.678
$V[m(\theta_i)]$	0.071

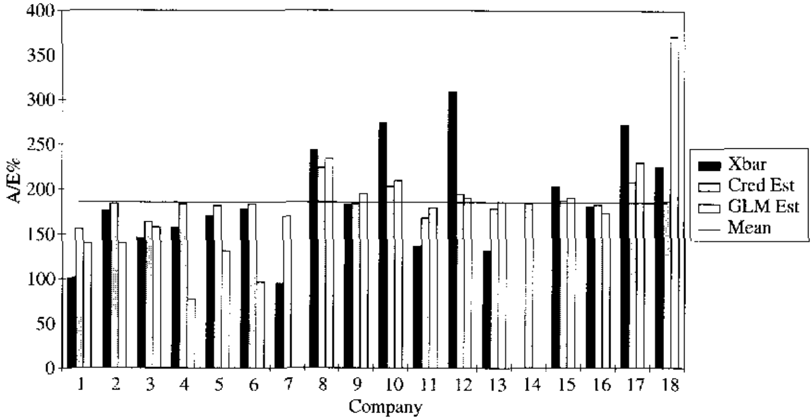


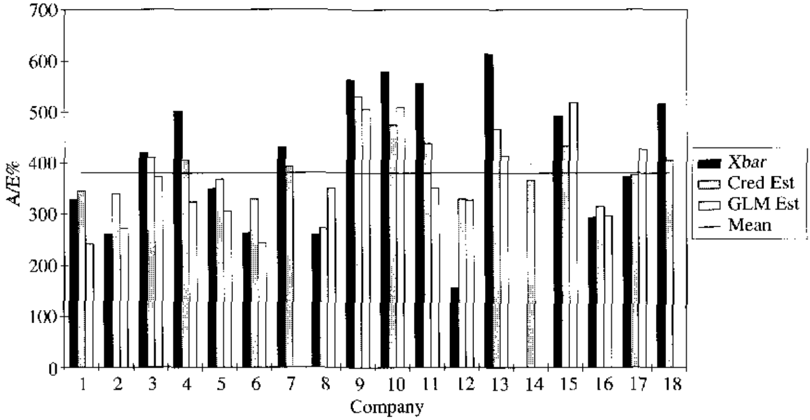
Figure C7. Females, deferred period 13 weeks, inceptions.

Table C5. Credibility and GLM analysis, females, deferred period 13 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	101.1	13.849	0.357	155.4	23.4	139.5	23.4
2	176.2	6.242	0.200	183.6	26.1	139.7	47.0
3	145.7	31.581	0.558	163.2	19.4	157.6	17.0
4	156.6	1.916	0.071	183.4	28.1	76.7	40.5
5	169.7	7.659	0.235	181.8	25.5	131.1	26.2
6	177.5	9.575	0.277	183.3	24.8	96.2	33.4
7	95.0	5.265	0.174	169.7	26.5	#824.6	6930
8	243.8	47.571	0.656	223.7	17.1	233.9	16.8
9	182.9	69.982	0.737	183.6	15.0	195.3	14.1
10	274.0	6.205	0.199	203.1	26.1	209.4	27.0
11	136.5	13.924	0.358	167.9	23.4	179.3	33.7
12	308.7	1.944	0.072	194.4	28.1	190.0	60.6
13	131.4	3.805	0.132	178.3	27.2	185.6	43.2
14	0.0	0.163	0.006	184.3	29.1	#0.0	0.2
15	204.0	3.431	0.121	187.7	27.3	191.0	51.6
16	181.6	36.341	0.592	183.2	18.6	173.9	19.0
17	272.5	8.806	0.261	208.1	25.1	230.1	101.3
18	225.8	1.329	0.050	187.5	28.4	371.2	130.9

Estimates of the Structural Parameters

$E[m(\theta_i)]$	185.5%
$E[s^2(\theta_i)]$	2.124
$V[m(\theta_i)]$	0.085



Female C8. Females, deferred period 26 weeks, inceptions.

Table C6. Credibility and GLM analysis, females, deferred period 26 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	329.2	9.721	0.689	345.0	58.3	241.5	38.4
2	260.4	2.304	0.345	338.8	84.7	272.0	94.9
3	419.0	14.796	0.772	410.1	50.0	371.7	41.1
4	502.1	1.195	0.214	406.2	92.7	323.9	144.9
5	349.6	2.861	0.395	368.0	81.4	305.3	71.0
6	262.7	3.426	0.439	328.6	78.4	242.8	85.3
7	430.0	1.395	0.242	392.2	91.1	#2551	2×10^4
8	258.7	34.017	0.886	272.5	35.3	350.3	25.5
9	562.5	21.156	0.828	531.2	43.3	506.0	39.8
10	580.0	3.966	0.475	475.1	75.8	509.7	63.6
11	556.6	2.156	0.330	438.3	85.7	351.1	83.3
12	155.1	1.289	0.227	328.9	92.0	326.7	109.4
13	613.4	2.608	0.373	467.2	82.8	413.9	92.4
14	0.0	0.166	0.036	366.2	102.7	#3.8	32.6
15	492.4	3.858	0.468	432.7	76.3	518.2	114.1
16	293.1	13.988	0.762	313.9	51.1	295.9	35.2
17	372.6	4.831	0.524	376.2	72.2	425.9	191.1
18	516.5	0.968	0.181	404.8	94.7	736.4	248.9

Estimates of the Structural Parameters

$E[m(\theta_i)]$	380.1%
$E[s^2(\theta_i)]$	4.796
$V[m(\theta_i)]$	1.095

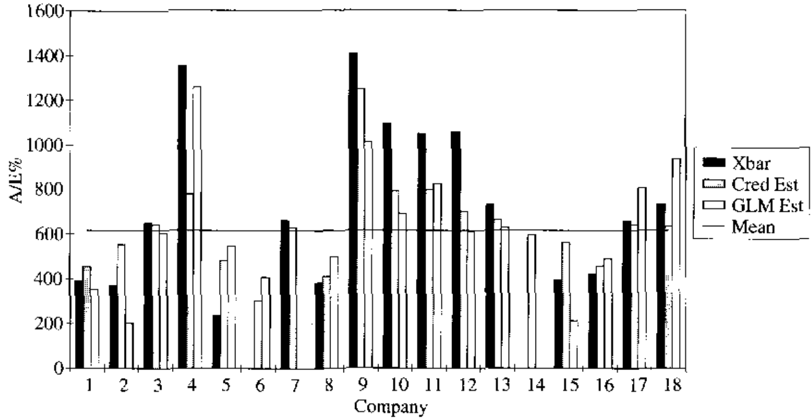


Figure C9. Females, deferred period 52 weeks, inceptions.

Table C7. Credibility and GLM analysis, females, deferred period 52 weeks, inceptions.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E'_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	392.2	2.040	0.722	454.7	165.8	352.7	75.6
2	370.2	0.270	0.256	553.6	271.1	201.6	111.6
3	649.4	2.772	0.779	642.2	147.8	605.5	92.4
4	1350.4	0.222	0.220	778.2	277.5	1255.8	561.3
5	235.4	0.425	0.351	483.0	253.2	547.9	167.3
6	0.0	0.812	0.508	303.4	220.4	407.4	151.6
7	662.3	0.302	0.277	629.3	267.1	#2003	2×10^4
8	383.9	6.252	0.888	409.9	105.1	497.7	56.4
9	1407.4	3.055	0.795	1245.5	142.2	1008.6	117.1
10	1093.2	0.457	0.368	791.8	249.9	690.8	150.0
11	1047.0	0.573	0.421	798.0	239.0	823.6	214.8
12	1057.4	0.189	0.194	702.1	282.1	611.8	277.2
13	731.6	0.547	0.410	663.8	241.4	628.9	168.0
14	0.0	0.026	0.032	596.9	309.2	#18.5	159.4
15	394.6	0.253	0.244	562.5	273.3	212.3	99.5
16	420.1	3.332	0.809	457.7	137.3	489.6	74.3
17	659.6	1.364	0.634	643.9	190.0	806.5	377.2
18	735.2	0.136	0.147	634.1	290.1	935.9	446.4

Estimates of the Structural Parameters

$E[m(\theta_i)]$	616.6%
$E[s^2(\theta_i)]$	7.768
$V[m(\theta_i)]$	9.874

CMIR 18 (2000) 151–179

AN ANALYSIS OF THE PHI EXPERIENCE OF INDIVIDUAL COMPANIES IN THE UNITED KINGDOM II: CLAIM TERMINATION RATES

BY A A KORABINSKI AND H R WATERS

ABSTRACT

This paper is Part II of a series of two papers. In Part I we analysed Permanent Health Insurance claim inception rates. In this paper we analyse the PHI claim recovery and mortality rates for 18 UK insurers for the years 1987 to 1994, inclusive. The data relate to policies on individual lives, males and females, with deferred periods ranging from 1 week to 52 weeks. The data are described in Section 2. In Section 3 we analyse the mortality experiences of the companies. However, the mortality data are so sparse (only 966 deaths in total) that no significant differences between companies are detected. In Section 4 we fit a generalized linear model to the values of A/E for the whole data set, where A is the actual number of recoveries and E is the expected number of recoveries according to a standard basis, in both cases aggregated over age. The modelling shows that Sex is not a significant factor for recovery rates, but that all the other main effects – Company, Deferred Period and Year – are significant, as are the following interactions: Company by Deferred Period and Company by Year. In Section 5 we consider separately the data for recoveries for each Deferred Period and we use the Bühlmann-Straub credibility model to estimate the correct A/E value for a given company. In Section 6 we discuss our numerical results for recovery rates. In Section 7 we discuss some conclusions from our modelling of claim terminations. Finally, in Section 8 we present some pricing implications and other applications of the results in this paper and in Part I.

1. INTRODUCTION

In this paper we model the experiences of individual insurance companies in respect of their PHI claim termination rates. This paper follows broadly the same pattern as Part I, where we modelled PHI claim inception rates.

Our data, supplied by the CMI Bureau, are described in Section 2. A feature of PHI business in the UK is the prevalence of duplicate policies, i.e. two or more policies on a single life. This feature had to be allowed for in our modelling of claim inception rates. See Part I, Sections 2 and 3. One of the important differences between this paper and Part I is that, as far as is possible, duplicate policies have been removed from the data for claim terminations. However, our modelling in Section 4 indicated that there may still be some duplicate policies present in the recoveries data.

In general terms, our assumptions and aims in this paper are the same as those in Part I in respect of PHI claim inceptions. In particular, we assume that for a given company (i), deferred period (d), sex (s), and calendar year (j), there is a multiplicative factor, f_{idsj}, such that:

$$E[A_{idsj}] = f_{idsj} \cdot E_{idsj}$$

where:

A_{idsj} is the actual number of recoveries or deaths for the combination ($idsj$), summed over all ages, and,

E_{idsj} is the corresponding expected number of recoveries or deaths, calculated according to the basis in *C.M.I.R.* **12** (1991), based on the experience of individual policyholders, males, Standard experience in the years 1975–78.

Our aim in this paper is to estimate the factors f_{idsj}. These factors are clearly relevant since they determine how an individual company should adjust the standard basis to take account of its own, possibly very limited, experience and the experience of other companies. As in Part I, we will use generalized linear models and credibility theory to estimate the factors.

In Section 3 we analyse and model the mortality experience of the companies. The data are so sparse that they do not reveal any significant differences between the eighteen companies in respect of the mortality experience of their PHI policyholders.

In Section 4 we fit a generalized linear model to the recovery rates. This is particularly useful as it indicates the structure of our data, i.e. which factors and interactions are significant. Our most important finding is that Sex is not a significant factor. This means that there is no difference between the recovery rates for males and females, or, more plausibly, that we have insufficient data to reveal a significant difference between the recovery rates for males and females. The other main effects, Company, Deferred Period and Year, are all significant, as are the following two interactions: Company by Deferred Period and Company by Year.

In Section 5 we consider the recovery data for each deferred period separately and use credibility theory to estimate the factors f_{idsj} for each company. Following the preliminary data analysis in Section 2 and the more detailed modelling in

Section 4, it was decided that, for the purposes of the credibility analysis, the data should be aggregated over Year and Sex.

The numerical results of the modelling in Sections 4 and 5 are presented in Appendix B, Tables B1–4 and Figures B1–5, and discussed in Section 6. In Section 7 we discuss our conclusions from the modelling of claim termination rates in Sections 2–6. In Section 8 we present some applications of the results in this paper and in Part I; in particular, we illustrate briefly the implications of our results for premium rates for individual companies.

2. THE DATA

2.1 *The structure of the data*

For both deaths and recoveries the data give the values of A, the actual number, E, the expected number, and the resulting A/E ratio expressed as a percentage. As in Part I these are given for 18 companies, 5 deferred periods, both sexes and 8 years. Potentially there are 1440 cells in a four-way table for Company by Deferred Period by Sex by Year. However there are only 777 cells which contribute data for deaths and 828 cells which contribute data for recoveries.

2.2 *The amount of data*

There is a total of only 966 deaths over the 777 cells. Nearly half of the cells have no deaths and only 50 cells have more than five deaths. The sparsity of the mortality data is such that any analysis of deaths is very limited. (See Section 3.)

There is a total of 18678 recoveries over the 828 cells. This will permit a reasonable analysis and so the bulk of this paper will concentrate on the recoveries data. The number of recoveries varies greatly over the different parts of the four-way table. We illustrate these differences over Company and Deferred period in the same way as in Part I using Table 1 which is a two-way table of actual recoveries aggregated over Sex and Year. As before an asterisk indicates that there is no business for that cell and the figures for deferred period 1 week are excluded from Table 1 to preserve the anonymity of companies. The total number of recoveries for deferred period 1 week is 12409, which represents over 66% of all the recoveries.

From Table 1 it can be seen that, for deferred periods of 4 weeks and greater, two companies together (8 and 9) account for nearly 50% of the recoveries and five companies (2, 4, 14, 15 and 18) each account for less than 1% of the recoveries.

2.3 *Exploratory data analysis*

Before the detailed modelling we performed some initial data exploration for recoveries by producing similar plots as in Part I. These are discussed below.

Table 1. Aggregated claim recoveries by Company and Deferred Period.

Company	DP 4	DP 13	DP 26	DP 52	DP 4-52
1	93	70	82	27	272
2	*	28	9	2	39
3	382	145	42	8	577
4	13	2	1	1	17
5	167	48	10	1	226
6	91	88	24	2	205
7	*	70	12	1	83
8	1,462	256	106	11	1,835
9	775	246	75	18	1,114
10	377	29	16	3	425
11	*	71	20	3	94
12	56	16	4	2	78
13	104	39	22	7	172
14	*	*	0	0	0
15	2	17	36	2	57
16	11	613	198	48	870
17	99	45	11	3	158
18	28	11	8	0	47
All Co.'s	3,660	1,794	676	139	6,269

Note: being aggregated over years, these numbers of recoveries will depend on the number of years contributing to each cell.

2.3.1 *Individual company plots for recoveries*

These plots allow the comparison of the performance of an individual company with the performance of other companies, including and excluding its own. This is achieved by plotting $A/E\%$ against Year with approximate two-standard-error limits. The approximate standard errors for $A/E\%$ are calculated using the following formula:

$$s.e. = \frac{100}{\sqrt{E}}$$

which is based on a Poisson model of recoveries without the use of any 'variance inflation factors'. For cases in which the observed number of recoveries is small, the use of these approximate two-standard-error limits is very crude but still instructive for exploratory purposes.

The figures displayed here are for companies 16 and 7, which are different companies to those used in Part I. They have been chosen to represent a large company and a smaller company for males deferred period 13 weeks which again is a different segment from that used in Part I. Figures 1a and 1b are for company 16, which is the largest company for males, deferred period 13 weeks. Accordingly Figure 1b, which incorporates 'other companies' rather than 'all companies', will be of greater value as company 16 will make a consid-

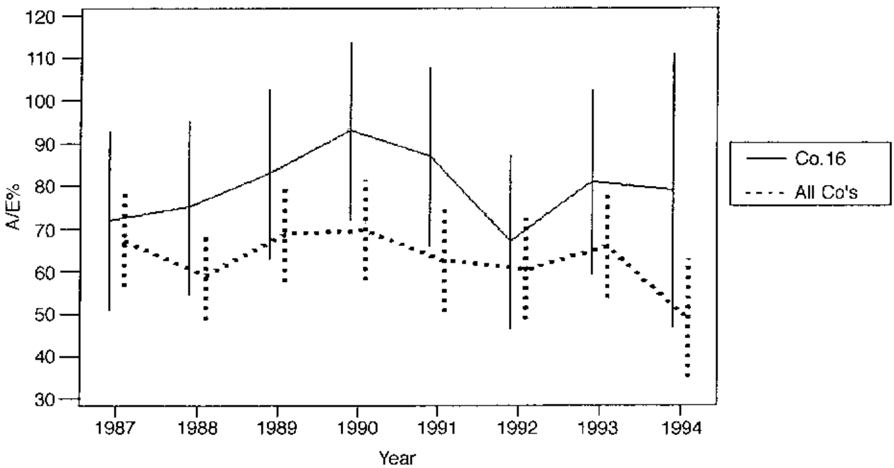


Figure 1a. Co 16/All co's: Males, DP13: Recoveries A/E% with 2se limits.

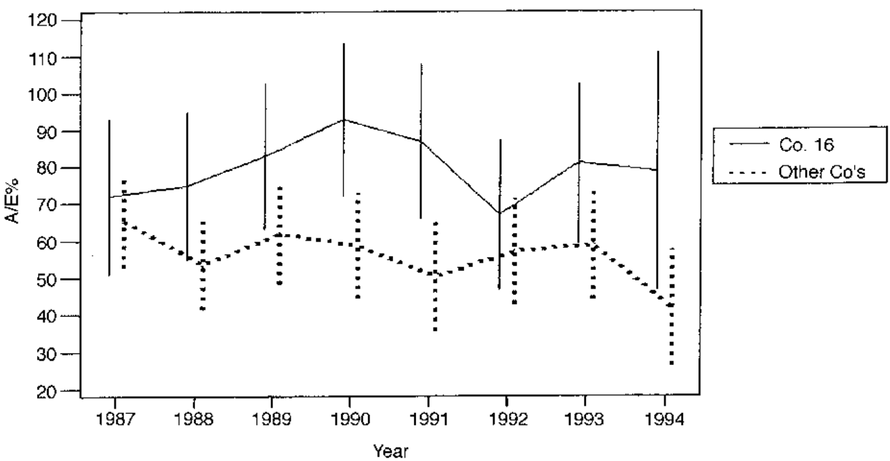


Figure 1b. Co 16/Other co's: Males, DP13: Recoveries A/E% with 2se limits.

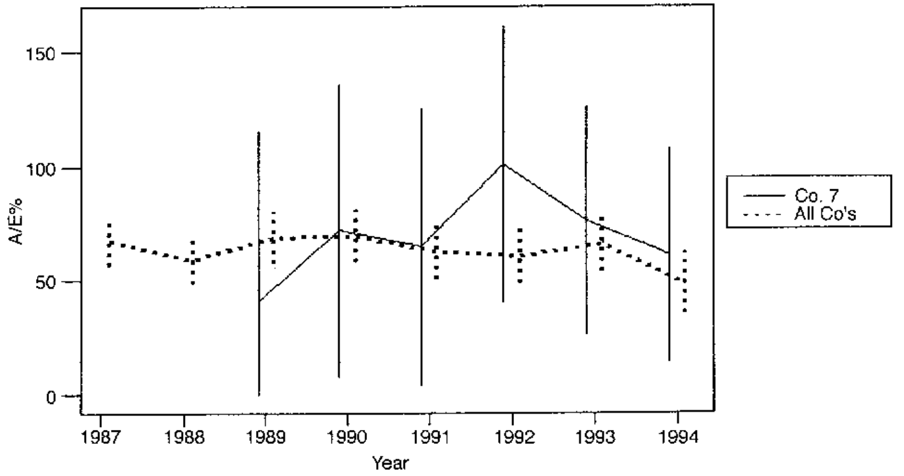


Figure 2. Co 7/All co's: Males, DP13: Recoveries A/E% with 2se limits.

erable contribution to the 'all companies' data. Company 16 would note that its own $A/E\%$ values are consistently greater than those for the other companies throughout the eight year period. This is a strong effect as there is very little overlap in the two-standard-error intervals for several years.

The next figure (Figure 2) is for company 7, again for males, deferred period 13 weeks. In contrast company 7 is one of the smaller companies and this is reflected in the much wider two-standard-error limits for its own data. The fact that the 'all company' intervals all lie comfortably within those for company 7 suggests that company 7 shares the same experience as all companies.

2.3.2 *Year effect plot for recoveries*

Figures 1 and 2 indicate how $A/E\%$ varies by Year. We investigate this further and see whether there may be a time trend that needs to be removed in the credibility approach in Section 5. Figure 3 gives a plot of the Actual recoveries, the Expected recoveries (both divided by 30 for the convenience of the plot) and the value of $A/E\%$ for each Year, aggregated over Company, Deferred Period and Sex. While both A and E show a decreasing trend, $A/E\%$ does not display any evidence of a time trend, unlike the decreasing trend found for the inceptions data in Part I. As a result the credibility approach in Section 5 will not require any trend removal. We also produced similar plots for each of the ten Deferred Period and Sex combinations but there was no evidence of a time trend in any case.

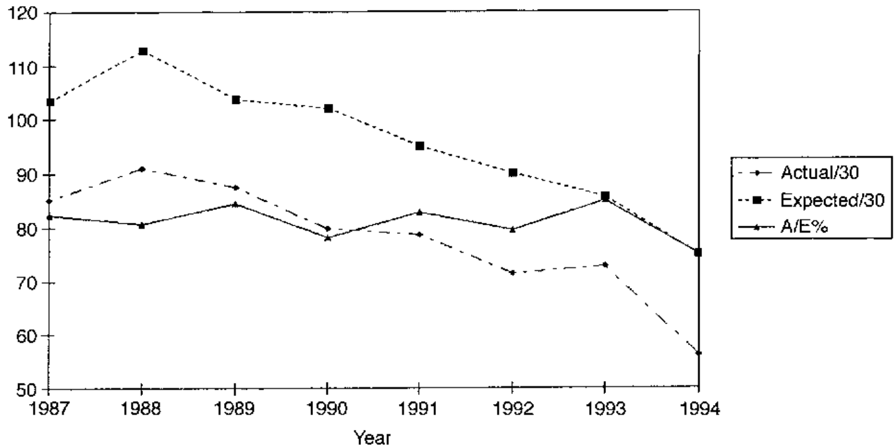


Figure 3. Actual and Expected Recoveries.

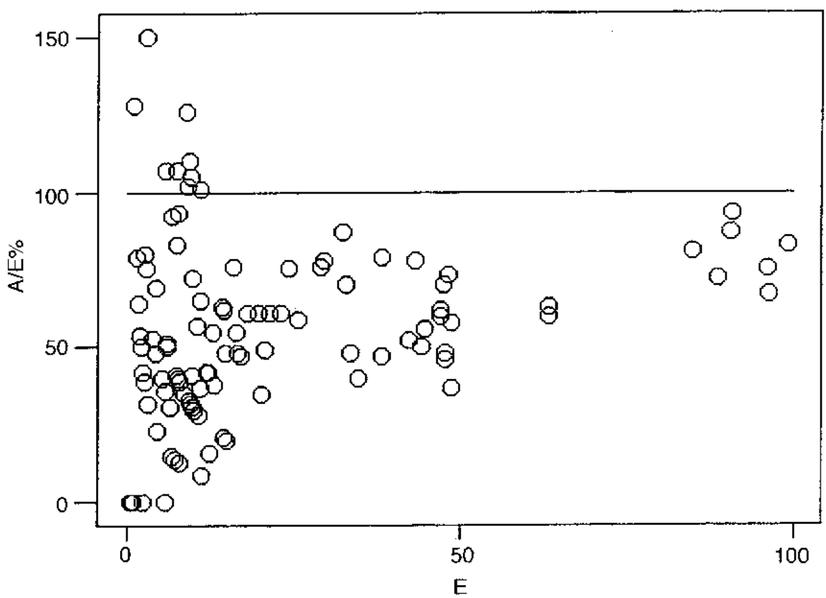


Figure 4. Recoveries A/E% plotted against E for Males, DP13.

2.3.3 *The effect of company size for recoveries*

As in Part I we explored the possibility of a relationship between a company's experience (A/E) and its 'size' in a particular segment of the market, i.e. for a particular combination of Deferred Period and Sex. We measured 'size' by the expected number of claim inceptions according to the standard basis, E. We plotted ten graphs of $A/E\%$ against E, one for each combination of Deferred Period and Sex. These graphs generally showed little evidence of any relationship between experience and size. In three cases there was a slight suggestion that A/E increased with E. Figure 4 shows the graph for one of these cases, males, deferred period 13 weeks. However the slight evidence of a relationship here is due to the cluster of 7 points on right hand side of the plot and these all relate to company 16. Without these points there is no evidence at all of a relationship. Also the approximate standard errors associated with these points will be very wide (as in Figures 1 and 2) and so the evidence of a relationship is very weak. Therefore we concluded that there was no real evidence that experience was related to size in a given segment of the market.

3. A GENERALIZED LINEAR MODEL FOR A/E FOR DEATHS

3.1 *The modelling process*

As in Part I the basic form of the model for claim terminations by death is as follows:

$$A_{idsj} \sim Poisson(\mu_{idsj})$$

where:

$$\mu_{idsj} = E_{idsj} \cdot f_{idsj}$$

Taking logs we have:

$$\log(\mu_{idsj}) = \log(E_{idsj}) + \log(f_{idsj})$$

where $\log(f_{idsj})$ is modelled as a linear expression.

In the GLM modelling of the mortality data the first point to note is that the null model (i.e. with no factors included) gave a good fit with a residual deviance of 686 on 776 degrees of freedom (df). However inclusion of the two factors, Sex and Deferred Period, and the covariate, Year, significantly improved the fit. Therefore the final fitted model incorporated these three terms and gave a very good fit with a residual deviance of 645 on 770 df. There was no evidence of overdispersion with the residual mean square (RMS) being below 1 at 0.97.

Since Company is not a significant factor in the analysis of mortality and since the main objective of our analysis concerns the comparison of companies, there is no need to report further on the mortality experience. However we will use a simple model for mortality in the final section in which we consider premium rates. To this end we must specify a GLM for deaths which can be used for these calculations. Before doing so we note that the addition of a quadratic term for Year also improved the fit. Table 2 is a one-way table of aggregated A/E percentages for each Year calculated from the observed mortality data. Note that the general trend is a decrease but with a sizeable increase in the final year which accounts for the quadratic term. We decided to adopt the simpler model with a linear term for Year. This will be adequate for our requirement of calculations as at 1 January 1991 in Section 8 but we would caution against the use of this model, or the quadratic model, for predictions beyond 1994.

Table 2. Deaths – observed A/E percentages for Year.

1987	1988	1989	1990	1991	1992	1993	1994	All Years
88	65	69	51	58	58	48	74	63

3.2 *The fitted model*

As described above the fitted model incorporates:

- the factor Deferred Period with 5 levels
- the factor Sex with 2 levels
- the covariate Year

Symbolically the linear model is of the following form:

$$\log \mu_{idsj} = \log E_{idsj} + \alpha_d + \beta_s + \phi_0 + \phi_1 \,.\, j \qquad (1)$$

where:

α_d is the Deferred Period term: $d = 1, \ldots, 5$
β_s is the Sex term: $s = 1, 2$
j represents Year: $j = 1987$ to 1994
ϕ_0 is a constant term
ϕ_1 is the slope coefficient for Year

As before we use the common (summation) parameterisation. The complete set of parameters is given in Appendix A.

Table 3a. Deaths – fitted A/E percentages for Sex.

Male	Female	Both Sexes
66	46	63

Table 3b. Deaths – fitted A/E percentages for Deferred Period.

DP 1	DP 4	DP 13	DP 26	DP 52	All DPs
47	62	69	68	74	63

3.3 *Description of the effects*

To complete our description of the GLM modelling of mortality we describe the effects due to the two factors, Sex and Deferred Period, by giving the two one-way tables of aggregated A/E percentages calculated using the fitted values from the model. These are given as Tables 3a and 3b. The figures speak for themselves.

4. A GENERALIZED LINEAR MODEL FOR A/E FOR RECOVERIES

In this section we describe the fitting of a generalized linear model to the actual number of recoveries for each cell in our data, our primary purpose being to investigate the structure of the data. As in Part I for inceptions this was carried out using Splus. However due to the presence of over-dispersion we had to use a negative binomial error structure instead of the Poisson error structure.

4.1 *The modelling process*

The data provided were such that duplicates should have been eliminated as far as possible. Accordingly we set out to model using a Poisson error structure as in Part I for inceptions but without any "variance-inflation factors". However the modelling quickly showed that there was still substantial over-dispersion present. In particular a model including two interaction terms resulted in a residual deviance of 869 on 735 degrees of freedom (which is a bad fit) and a residual mean square of 1.32 (which, being considerably greater than 1, indicates the over-dispersion). A common solution for modelling over-dispersed Poisson data is to use a negative binomial error structure. This is based on a Poisson distribution for A_{idsj} conditional on some unobserved random variable B which has a (one-parameter) gamma distribution incorporating a parameter θ. See Venables and Ripley (1994). Thus the form of the model is:

$$A_{idsj}\, B \sim Poisson(\mu_{idsj} B)$$

where:

$$\theta B \sim gamma(\theta)$$

which results in:

$$A_{idsj} \sim neg.bin.(\theta,\, \mu_{idsj})$$

In order to permit the same form of model selection procedure it was necessary to pre-determine the parameter θ for the negative binomial distribution being used. We did this by fitting a main effects model (with no interactions) using the Poisson error structure and examining the resulting residuals. If the Poisson structure were valid, the variance of the residuals should be the same as the mean throughout the range. We subdivided the data into about twenty equal-sized groups using the scale of the fitted values and computed the variance of the residuals and the mean of the fitted values for each group. This indicated clearly that the variance exceeded the mean as required for the Poisson and that a negative binomial with parameter $\theta = 240$ fitted the pattern quite well. Accordingly we proceeded to select a model using forward selection with this error structure.

This led to a chosen model which included Company, Deferred Period and Year (but not Sex) and two interactions, Company by Deferred Period and Company by Year. This model gave a residual deviance of 781 on 735 which represents quite a good fit.

4.2 *The fitted model*

As described above the fitted model incorporates:

- the factor Company with 18 levels
- the factor Deferred Period with 5 levels
- the covariate Year
- the interaction between Company and Deferred Period
- the interaction between Company and Year

Symbolically the linear model is of the following form:

$$\log \mu_{idsj} = \log E_{idsj} + \gamma_i + \delta_d + \psi_0 + \psi_1 . j + (\gamma\delta)_{id} + \xi_i . j \qquad (2)$$

where:

- γ_i is the Company term: $i = 1, \ldots, 18$
- δ_d is the Deferred Period term: $d = 1, \ldots, 5$
- j represents Year: $j = 1987$ to 1994
- ψ_0 is a constant term
- ψ_1 is the slope coefficient for Year
- $(\gamma\delta)_{id}$ is the Company by Deferred Period interaction term
- ξ_i is the Company i slope coefficient for Year

As in Part I we used the common (summation) parameterisation. Here there are 108 estimable parameters but 15 are aliased due to the data being incomplete (only 828 of the 1440 possible cells have data). The complete set of parameters is given in Appendix A. Again the complexity of the model does not allow a simple description of the different effects which influence the response A/E, but we describe these effects in the following subsections in the most convenient way possible.

4.3 *The Year effect*

The Year effect is complex due to the presence of a Company by Year interaction. If we adopt the same strategy as in Part I and describe the year effect using a simpler model without the interaction term, this results in a decreasing trend of less than 1% per year. Exploring the Year effect for separate companies we find that 10 companies indicate a decreasing trend and 7 an increasing trend (excluding company 14 which had no recoveries). Company 1 has the strongest evidence of a trend and it is a decreasing trend of about 20% per year. However this is based on only 272 recoveries over the eight year period and this represents less than 1.5% of the total recoveries. Companies 8 and 10 account for nearly 77% of the total recoveries between them but there is no real evidence of a trend in either.

4.4 *The Company and Deferred Period effects*

The Company and Deferred Period effects are described using Table 4 which is a two-way table of aggregated A/E percentages calculated using the fitted values from the model. As in Part I these have been calculated as at 1 January 1991, the mid-point of the data collection period. As before care should be taken when interpreting this table due to the differing amounts of data in the cells. In particular note that companies 8 and 10 between them account for over 36% of the recoveries for deferred periods of 4 weeks or greater, whereas companies 2, 4, 14, 15 and 18 account for less than 1% between them. An asterisk in Table 4 indicates that there is no data for that cell. Individual company values for DP 1 are not shown in Table 4 in order to preserve the anonymity of the companies.

Some features concerning Company and Deferred Period obtained from Table 4 are:

- The overall A/E is 81% and for individual companies A/E ranges from 0% to 98%.
- The overall A/E profile with respect to Deferred Period is a substantial drop from DP 1 to the other DP values.
- Concentrating on the largest five companies, three show a sizeable decrease from DP 4 to DP 13 while the other two show little change, and two show a sizeable increase from DP 26 to DP 52 while another shows a sizeable decrease. This is the "interaction".

4.5 *Prediction using the fitted GLM*

We reiterate the point made in Part I that prediction is a secondary purpose of the GLM especially when it is being used to predict in cells for which there is little or no data. Such extrapolation may result in unreliable values, which will be indicated by the relatively large size of the associated standard errors.

Table 4. Fitted A/E percentages for Company by Deferred Period.

Company	DP 1	DP 4	DP 13	DP 26	DP 52	All DPs
1	*	40	55	63	107	53
2	*	*	43	35	56	41
3	-	61	56	41	36	61
4	*	27	22	11	29	24
5	-	57	66	40	17	57
6	-	46	64	54	21	54
7	*	*	60	42	111	57
8	-	73	58	45	24	83
9	-	58	58	40	45	56
10	-	73	34	32	44	98
11	*	*	51	63	36	52
12	-	55	42	30	80	51
13	*	60	57	46	59	57
14	*	*	*	0	0	0
15	*	200	50	42	80	46
16	*	145	81	74	98	80
17	-	49	62	36	41	51
18	*	59	49	57	1	55
All Co.'s	97	63	62	51	56	81

5. A CREDIBILITY MODEL FOR *A/E* FOR RECOVERIES

We used the Bühlmann-Straub credibility model to estimate, separately for each deferred period, the value of A/E for recovery rates for a given company. The basic model assumptions, method and parameter estimation are all as described in Part I, Section 4, and are not repeated here. Slight differences between our credibility analysis of recovery rates in this paper and the analysis of claim inception rates in Part I are:

(a) The expected number of recoveries has not been adjusted to take account of any time trend, as was the case for expected claim inceptions in Part I, Section 4. This is because our preliminary data analysis in Section 2 did not indicate any significant time trend in recovery rates.
(b) For each deferred period, the data for males and females have been aggregated for the credibility analysis. This is because the modelling in Section 4 showed that there was no significant difference between the experiences of the two sexes in respect of recovery rates.

Hence, for the purposes of our credibility analysis, the multiplicative factors f_{idsj}, in the notation of Section 1, are functions of company (i) and deferred period (d) only, i.e. they do not depend on sex (s) or calendar year (j).

6. NUMERICAL RESULTS FOR RECOVERIES

The numerical results of the GLM and credibility modelling for recoveries are summarised in Appendix B as Figures B1–B5 and Tables B1–B4. These figures and tables are in the same format as the corresponding results for claim inceptions in Part I, i.e. Figures C1–C9 and Tables C1–C7. A detailed explanation of these figures and tables is given in Section 5.1 of Part I.

As in Part I, no table of results for recoveries is given in Appendix B for deferred period 1 week; results for deferred period 1 week are shown only in Figure B1. This is to preserve the anonymity of the contributing companies.

Note that the results for recoveries in Appendix B are for males and females combined. This is because the modelling in Section 4 failed to reveal significant differences between the sexes in terms of recovery rates.

Finally, note that in Tables B1–B4 an asterisk against the *GLM Est.* value indicates that the company has no data for the given deferred period and a hash indicates that it has little data. In these cases the GLM may produce a wild value, as indicated by its standard error, and the *GLM Est.* value has not been included in the corresponding figure.

7. CONCLUSIONS FROM THE MODELLING OF CLAIM TERMINATION RATES

The statistical modelling of mortality rates revealed the following main features of our data:

- A model incorporating Deferred Period and Sex as factors and Year as a (linear) covariate term, with a Poisson error structure, adequately described the data. (See Section 3.1.)
- The data did not indicate significant differences between the companies in terms of their mortality experiences. (See Section 3.1.)

The exploratory data analysis and statistical modelling of the data for recoveries revealed the following main features of our data:

- Our exploratory data analysis did not indicate any time trend for recovery rates. However, our fitted model included Year as a covariate and an interaction term between Company and Year. (See Sections 2.3.2 and 4.3.)
- There was no real evidence of a relationship between a Company's share of a given segment of the market and its A/E experience for recoveries. (See Section 2.3.3.)
- A Poisson error structure was found to be inappropriate for the data and so we used a negative binomial error structure. This could be because the data still contain substantial numbers of duplicate policies. (See Section 4.1.)
- A satisfactory fit to the data was achieved by a model with Company and Deferred Period as factors, Year as a covariate and interaction terms between Company and Deferred Period and between Company and Year. (See Section 4.1.)
- The data did not indicate any significant differences between males and females in respect of recovery rates. (See Section 4.1.)

The strengths and weaknesses of generalized linear models and credibility models in terms of explaining the structure of the data and in terms of prediction have been discussed in detail in Section 6 of Part I. The points made there, in relation to our modelling of claim inception rates, remain valid here in relation to our modelling of recoveries. One of the weaknesses of the credibility approach was that it did not check whether its model assumptions were reasonable. In Part I, our credibility model was consistent with a model, the 'simple model', which did not fit the data very well. The same 'simple model' was considered in the model selection process for recoveries and found to be a very poor fit.

8. APPLICATIONS

In this Section we present some applications of the results in Parts I and II.

8.1 *Premium rates*

As a simple illustration of the relevance of the work in this paper and in Part I, Table 5 shows net premium rates for a policy with deferred period 4 weeks for a male and for three different ages at entry. For all calculations:

- the policy ceases at age 65, or on death, if earlier,
- the premium rate shown is for a benefit amount of £1,000 *per annum* payable continuously,
- premiums are paid continuously while benefits are not being paid,
- the interest rate is 6% *per annum*,
- all premium rates have been calculated as at 1 January 1991, the mid-point for our data set. Recall that our models for both claim inceptions and mortality incorporate a time trend, whereas our credibility model for recovery rates does not.

All the premium rates in Table 5 have been calculated using the multiple state model described in *C.M.I.R* **12** (1991). The parameterisation of that model given in *C.M.I.R.* **12** (1991, Parts B and C) is our standard basis and this standard basis has been adjusted to take account of the experiences of all companies or of individual companies. More details of the calculation of the premium rates in Table 5 are provided in Appendix C.

The *All Co's experience* premium rates in Table 5 have been calculated by adjusting the sickness inception intensity so that claim inceptions are 77.8% of standard (see Part I, Section 5.1) and the recovery intensity is 63% of standard (see Table B1). These adjustments are based on the experience of all companies in the period 1987–1994. Corresponding figures are published by the CMI Bureau as *A/E* ratios for claim inceptions and recoveries (see *C.M.I.R.* **15**, Tables 2, 3, 4, 5 and 6).

Now consider company 4. From Table 3c in Part I and from Table B1, it can be seen that Company 4's claim inceptions have been 46.3% of standard and its recoveries have been 27% of standard. Using these adjustments we obtain the premium rates shown as *Co. 4's own experience* in Table 5. These premium rates are considerably higher than the *All Co's experience* premium rates, the reason being Company 4's very poor experience for recoveries. However, Company 4 expected only 43 claims (see Part I, Table 3c) and 48 recoveries (see Table B1) in the period 1987–1994. This is not a large amount of data on which to establish a premium basis. The credibility analysis in this paper and in Part I shows us how to weight the all Companies experience with Company 4's own experience to obtain more reasonable adjustments for Company 4. These adjustments are: claim inceptions 63.2% of standard (Part I, Table 3c) and recoveries 51.8% of standard (Table B1). Using these adjustments we obtain the *Co. 4 credibility weighted* premium rates in Table 5, which are much closer to the *All Co's experience* rates.

Company 16 provides an extreme example. The adjustments based on its own experience are: inceptions 78.9% of standard and recoveries 144.7% of standard. Using these adjustments results in very low premium rates, as can be seen in Table 5. These adjustments are based on almost no data: 8 expected claim inceptions and 8 expected recoveries in an 8-year period. In these circumstances it would be reasonable for Company 16 to use a premium basis closer to the experience of all companies. The credibility based adjustments for Company 16 – inceptions 77.9% of standard and recoveries 68.4% of standard – meet this need and give premium rates much closer to the *All Co's experience* rates in Table 5.

Finally, consider company 8. This company has a large amount of data in relation to the data for all companies (2,485 expected inceptions and 2,016 expected recoveries) and so the credibility based adjustments (inceptions 82.2% of standard and recoveries 72.0% of standard) are very close to the adjustments based on its own experience (inceptions 82.3% of standard and recoveries 72.5% of standard). The result is that the *Co. 8 credibility weighted* premium rates are much closer to the *Co. 8's own experience* premium rates than to the *All Co's experience rates.*

Table 5. Premium rates for males, deferred period 4 weeks.

Initial age	30	40	50
	£	£	£
All Co.'s experience	25.11	38.80	55.61
Co. 4's own experience	43.32	57.31	69.14
Co. 4 credibility weighted	27.95	41.44	56.55
Co. 16's own experience	4.28	7.45	13.12
Co. 16 credibility weighted	21.79	34.23	50.08
Co. 8's own experience	20.67	32.86	48.48
Co. 8 credibility weighted	20.91	33.20	49.25

8.2 *Correlations between claim inception and claim recovery experiences*

It is of some interest to explore the relationship between the claim inception and claim recovery experiences for individual companies for a given deferred period. Table 6 shows for each of the five deferred periods the correlation coefficient between the *Cred. Est.* values for claim inceptions for males (Part I, Tables 3c and C1–4) and for recoveries for males *and* females (Part II, Tables B1–4). (Note that the relevant *Cred. Est.* values for deferred period 1 week have not been presented in either Part I or Part II.) Also shown in Table 6 for each deferred period are the number of companies contributing to the calculation of the correlation coefficient; companies with no data for either inceptions or recoveries have been excluded.

There are good reasons for treating the correlation coefficients in Table 6 with some caution: the companies have very different amounts of data so that the *Cred. Est.* values have varying accuracies; because we are using the *Cred. Est.* values, different pairs of observations are not independent of each other; the experience for deferred period 1 week is dominated by a very small number of companies, so that most of the eight companies contributing to this correlation coefficient will have *Cred. Est.* values close to the average for all companies (see Figure C1 in Part I and Figure B1 in Part II). In particular we would caution against any inference concerning these "sample" correlation coefficients.

Nevertheless, the values in Table 6 give some idea of the association between the claim inception and recovery experiences for individual companies. A positive value for the correlation coefficient indicates that a higher (resp. lower) than average A/E ratio for claim inceptions is associated with a higher (resp. lower) than average A/E ratio for recovery rates. Similarly, a negative value for the correlation coefficient indicates that a higher (resp. lower) than average A/E ratio for claim inceptions is associated with a lower (resp. higher) than average A/E ratio for recovery rates.

Table 6. Correlations between claim inception and claim recovery experiences.

Deferred period	Corr. coeff.	No. of co.'s
1 week	+0.68	8
4 weeks	+0.48	14
13 weeks	−0.26	17
26 weeks	−0.49	18
52 weeks	−0.48	18

An interesting feature of Table 6 is that the correlation coefficients decrease as the deferred period increases. This is consistent with an interpretation that insurers with a liberal approach to claims admittance on short deferred periods will tend to admit extra "minor ailments" which will tend to have high recovery rates whilst insurers with a more liberal approach to claims admittance on longer deferred periods are likely to admit the type of ailments that can cause difficulties in terms of early recovery. Examples of the latter will include mental illness, heart conditions and back problems, where there can be a debate about whether an individual is sufficiently disabled to be a valid claim. However, once these claims are admitted it is very difficult to prove that an individual's condition has improved sufficiently to enable the insurer to terminate the claim.

9. ACKNOWLEDGEMENTS

The authors are grateful to the Faculty of Actuaries and the Institute of Actuaries for financial support, to the CMI Bureau for supplying the data for this project and to the PHI Sub-Committee of the CMI Bureau, Mr Roger Blackwood, Dr Iain Currie, Professor Ragnar Norberg and Professor David Wilkie for very helpful comments at various stages of this project.

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APPENDIX A

PARAMETERS FOR THE FITTED GLMS

Note: all parameters are quoted to 5dp except for the slope parameters which are quoted to 8dp as these are multiplied by 1990.5 in our predictions.

A1. *GLM for deaths*

Table A1. The Deferred Period terms: α_d: $d=1, 2, \ldots, 5$.

Term	Parameter	Value
DP 1	α_1	−0.32144
DP 4	α_2	−0.01442
DP 13	α_3	+0.08032
DP 26	α_4	+0.08452
DP 52	α_5	+0.17102

Table A2. The Sex terms: β_s: $s = 1, 2$.

Term	Parameter	Value
Male	β_1	+0.19880
Female	β_2	−0.19880

Table A3. The Year (covariate) terms: ϕ_i: $i= 0, 1$.

Term	Parameter	Value
Constant	ϕ_0	+67.50424
Slope	ϕ_1	−0.03422271

A.2 *GLM for recoveries*

Table A4. The Company terms: γ_i: $i = 1, 2, \ldots, 18$.

Term	Parameter	Value
Company 1	γ_1	+350.18284
Company 2	γ_2	−185.98821
Company 3	γ_3	−15.92445
Company 4	γ_4	−678.12446
Company 5	γ_5	+32.99223
Company 6	γ_6	−51.06378
Company 7	γ_7	−18.46636
Company 8	γ_8	−5.72617
Company 9	γ_9	−33.87385
Company 10	γ_{10}	−31.73040
Company 11	γ_{11}	+99.69474
Company 12	γ_{12}	−37.39239
Company 13	γ_{13}	+64.63243
Company 14	γ_{14}	−154.99386
Company 15	γ_{15}	+209.01712
Company 16	γ_{16}	−35.71410
Company 17	γ_{17}	+383.89203
Company 18	γ_{18}	+108.58664

Table A5. The Deferred Period terms: δ_d: $d = 1, 2, \ldots, 5$.

Term	Parameter	Value
DP 1	δ_1	−3.63484
DP 4	δ_2	+0.99899
DP 13	δ_3	+1.24239
DP 26	δ_4	+0.72847
DP 52	δ_5	+0.66499

Table A6. The Year (covariate) terms: ψ_i: $i = 0, 1$.

Term	Parameter	Value
Constant	ψ_0	+22.65540
Slope	ψ_1	−0.01229255

Table A7. The Company by Deferred Period interaction terms: $(\gamma\delta)_{id}$: $i = 1, \ldots, 18$; $d = 1, \ldots, 5$.

$(\gamma\delta)_{id}$	DP1(d=1)	DP4(d=2)	DP13(d=3)	DP26(d=4)	DP52(d=5)
Company 1	+0.76642	−0.66332	−0.65416	*aliased*	+0.55107
Company 2	+2.20368	−2.43007	−0.30303	*aliased*	+0.52941
Company 3	+3.96696	−0.82504	−1.16080	−0.95673	−1.02439
Company 4	−1.83470	+0.70961	+0.24093	*aliased*	+0.88416
Company 5	+4.11989	−0.76696	−0.87206	−0.83380	−1.64706
Company 6	+3.88538	−0.98352	−0.90494	−0.56698	−1.42996
Company 7	−0.88358	*aliased*	−0.15328	*aliased*	+1.03686
Company 8	+4.18332	−0.68960	−1.16368	−0.88435	−1.44569
Company 9	+3.78724	−0.88581	−1.11979	−0.07568	−0.80597
Company 10	+4.31679	−0.64400	−1.66361	−1.19811	−0.81108
Company 11	+1.19286	*aliased*	−0.72301	*aliased*	−0.46985
Company 12	+4.79084	−1.15661	−1.67316	−1.49804	−0.46303
Company 13	+0.02339	−0.02337	−0.30566	*aliased*	+0.30564
Company 14	−6.06578	*aliased*	+4.88566	*aliased*	+1.18011
Company 15	−1.56345	+1.28491	−0.28372	*aliased*	+0.56226
Company 16	−0.33852	+0.40983	−0.41710	*aliased*	+0.34580
Company 17	−0.17612	*aliased*	*aliased*	*aliased*	+0.17612
Company 18	−22.37462	+6.66395	+6.27140	+6.91369	+2.52558

Table A8. The Company by Year interaction terms: ξ_i: $i = 1, 2, \ldots, 18$.

Term	Parameter	Value
Company 1	ξ_1	−0.17563243
Company 2	ξ_2	−0.09352893
Company 3	ξ_3	+0.00857379
Company 4	ξ_4	+0.34040784
Company 5	ξ_5	−0.01607346
Company 6	ξ_6	+0.02619191
Company 7	ξ_7	+0.00939034
Company 8	ξ_8	+0.00347085
Company 9	ξ_9	+0.01759378
Company 10	ξ_{10}	+0.01651401
Company 11	ξ_{11}	−0.04977676
Company 12	ξ_{12}	+0.01947632
Company 13	ξ_{13}	−0.03232612
Company 14	ξ_{14}	+0.07557186
Company 15	ξ_{15}	−0.10491517
Company 16	ξ_{16}	+0.01833251
Company 17	ξ_{17}	−0.19250701
Company 18	ξ_{18}	−0.05782118

APPENDIX B

NUMERICAL RESULTS

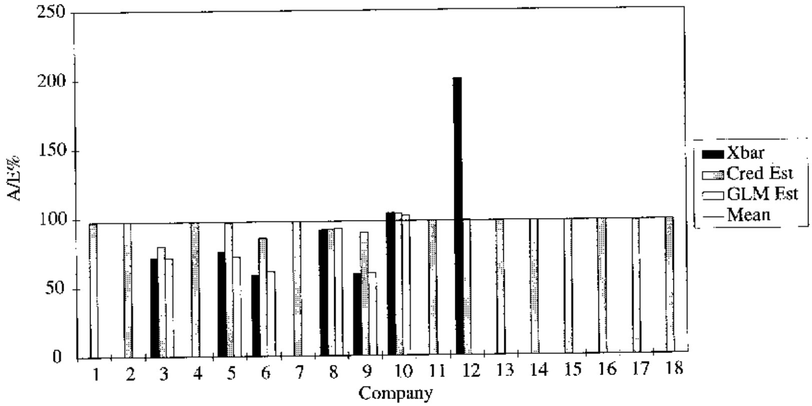

Figure B1. Males and females, deferred period 1 week, recoveries.

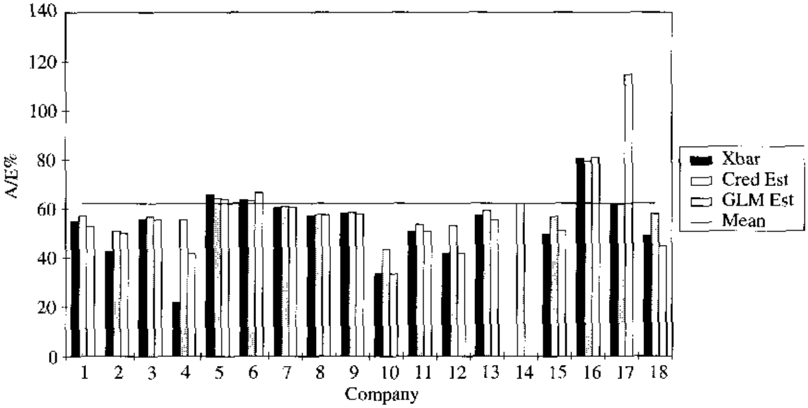

Figure B2. Males and females, deferred period 4 weeks, recoveries.

Table B1. Credibility and GLM analysis, males and females, deferred period 4 weeks, recoveries.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	40.0	232.400	0.686	47.2	5.8	41.0	4.8
2	0.0	0.000	0.000	63.0	10.3	*4.7	24.7
3	60.9	626.900	0.855	61.2	3.9	60.8	3.9
4	27.0	48.100	0.311	51.8	8.5	52.4	26.8
5	56.5	295.800	0.735	58.2	5.3	55.8	5.0
6	46.4	196.000	0.648	52.2	6.1	48.4	22.6
7	0.0	0.000	0.000	63.0	10.3	*55.5	28.3
8	72.5	2015.800	0.950	72.0	2.3	72.5	2.5
9	57.6	1344.800	0.927	58.0	2.8	57.5	2.5
10	72.2	522.100	0.831	70.6	4.2	72.8	4.4
11	0.0	0.000	0.000	63.0	10.3	*81.9	35.4
12	54.9	102.000	0.489	59.0	7.3	55.1	8.3
13	60.2	172.800	0.619	61.2	6.3	57.7	6.9
14	0.0	0.000	0.000	63.0	10.3	*0.5	5.8
15	200.0	1.000	0.009	64.2	10.2	#192.4	150.2
16	144.7	7.600	0.067	68.4	9.9	#145.2	48.3
17	49.6	199.700	0.652	54.2	6.1	89.8	49.6
18	58.8	47.600	0.309	61.7	8.5	51.9	15.7

Estimates of the Structural Parameters

$E[m(\theta_i)]$	63.0%
$E[s^2(\theta_i)]$	1.121
$V[m(\theta_i)]$	0.011

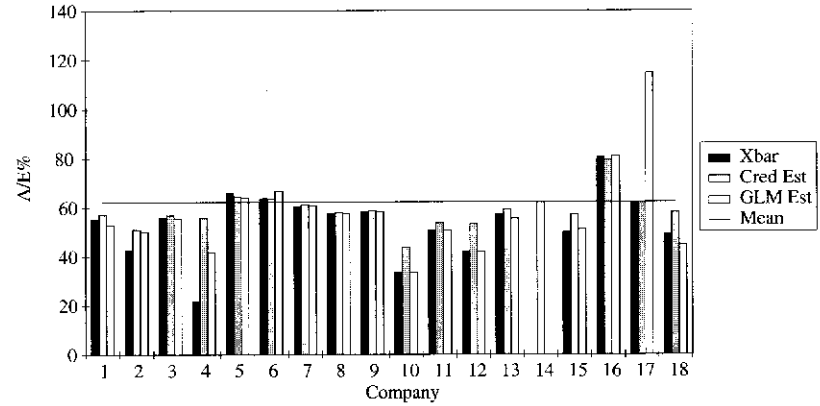

Figure B3. Males and females, deferred period 13 weeks, recoveries.

Table B2. Credibility and GLM analysis, males and females, deferred period 13 weeks, recoveries.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	55.2	126.800	0.727	57.1	6.1	52.8	7.1
2	42.7	65.500	0.579	51.0	7.6	50.0	18.2
3	55.9	259.300	0.845	56.9	4.6	55.5	5.6
4	21.7	9.200	0.162	55.7	10.8	41.8	36.4
5	65.8	73.000	0.605	64.4	7.4	64.1	10.5
6	63.7	138.100	0.744	63.4	5.9	66.7	31.0
7	60.5	115.700	0.708	61.0	6.3	60.7	11.3
8	57.4	445.900	0.904	57.9	3.6	57.6	4.1
9	58.2	423.000	0.899	58.6	3.7	58.1	4.2
10	33.5	86.600	0.645	43.7	7.0	33.5	6.9
11	50.7	140.000	0.746	53.7	5.9	50.7	6.7
12	42.0	38.100	0.445	53.3	8.8	42.0	11.6
13	57.2	68.200	0.589	59.3	7.5	55.5	10.0
14	0.0	0.000	0.000	62.3	11.7	*77.7	1099
15	49.9	34.100	0.417	57.1	9.0	51.1	13.7
16	80.6	760.500	0.941	79.5	2.9	81.0	4.1
17	61.7	72.900	0.605	62.0	7.4	114.6	66.6
18	48.9	22.500	0.321	58.0	9.7	44.7	16.5

Estimates of the Structural Parameters

$E[m(\theta_i)]$	62.3%
$E[s^2(\theta_i)]$	0.657
$V[m(\theta_i)]$	0.014

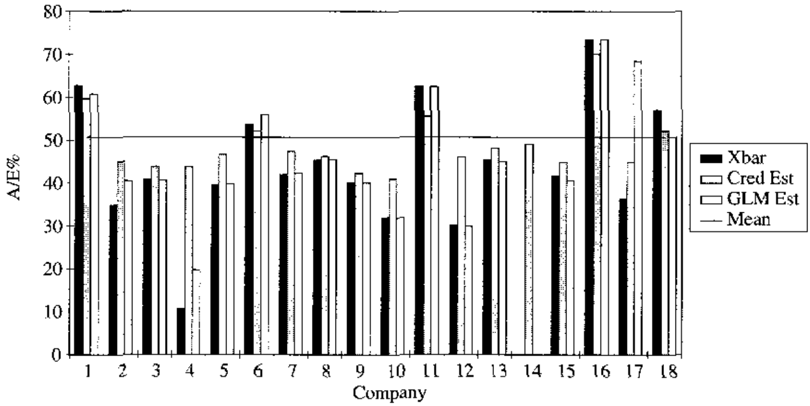

Figure B4. Males and females, deferred period 26 weeks, recoveries.

Table B3. Credibility and GLM analysis, males and females, deferred period 26 weeks, recoveries.

Company	$\bar{X}_i$ %	$\sum_{j=1}^{8} E_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	62.8	130.500	0.740	59.7	6.0	60.8	7.6
2	34.9	25.800	0.360	45.0	9.4	40.5	18.8
3	40.8	102.900	0.692	43.9	6.5	40.7	7.1
4	10.6	9.400	0.170	43.9	10.7	19.6	22.9
5	39.5	25.300	0.356	46.7	9.4	39.8	13.9
6	53.7	44.700	0.494	52.2	8.3	56.0	27.8
7	42.0	28.600	0.384	47.4	9.2	42.3	15.5
8	45.4	233.500	0.836	46.3	4.7	45.6	5.0
9	40.2	186.600	0.803	42.3	5.2	40.1	5.2
10	32.0	50.000	0.522	41.0	8.1	31.9	8.8
11	62.5	32.000	0.411	55.6	9.0	62.5	15.4
12	30.1	13.300	0.225	46.1	10.3	29.9	16.5
13	45.5	48.300	0.513	48.1	8.2	45.1	10.6
14	0.0	1.500	0.032	49.1	11.5	#0.4	4.4
15	41.8	86.100	0.653	44.9	6.9	40.6	7.6
16	73.4	269.800	0.855	70.1	4.5	73.5	6.0
17	36.4	30.200	0.397	45.0	9.1	68.5	45.1
18	57.1	14.000	0.234	52.2	10.3	50.8	22.3

Estimates of the Structural Parameters

$E[m(\theta_i)]$	50.7%
$E[s^2(\theta_i)]$	0.630
$V[m(\theta_i)]$	0.014

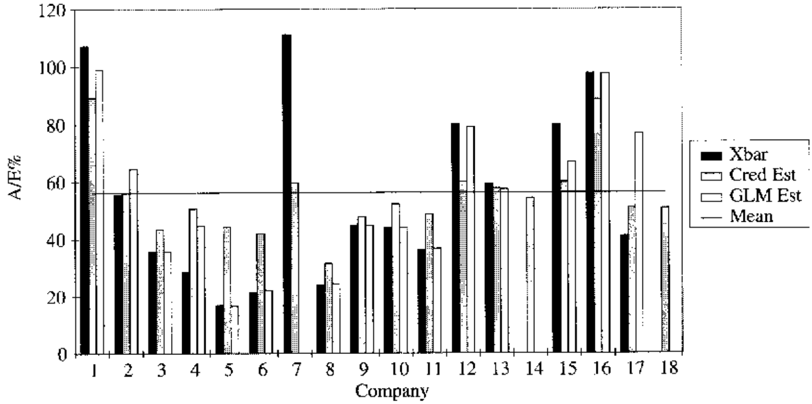

Figure B5. Males and females, deferred period 52 weeks, recoveries.

Table B4. Credibility and GLM analysis, males and females, deferred period 52 weeks, recoveries.

Company	$\overline{X}_i$ %	$\sum_{j=1}^{8} E_{ij}$	Z_i	*Cred. Est.* %	*C.E.S.E.* %	*GLM Est.* %	*S.E.* %
1	107.1	25.200	0.648	89.2	14.1	99.0	21.3
2	55.6	3.600	0.208	56.1	21.1	64.6	53.5
3	35.7	22.400	0.620	43.5	14.6	35.7	13.9
4	28.6	3.500	0.203	50.6	21.2	44.6	50.6
5	16.9	5.900	0.301	44.4	19.8	16.6	18.3
6	21.3	9.400	0.407	42.0	18.3	22.2	19.8
7	111.1	0.900	0.062	59.6	23.0	#112.1	126.3
8	24.1	45.600	0.769	31.5	11.4	24.4	8.1
9	44.8	40.200	0.746	47.7	12.0	44.6	11.6
10	44.1	6.800	0.332	52.2	19.4	44.1	28.0
11	36.1	8.300	0.377	48.7	18.7	36.7	23.3
12	80.0	2.500	0.154	59.9	21.8	79.0	62.1
13	59.3	11.800	0.463	57.7	17.4	57.4	24.0
14	0.0	0.500	0.035	54.3	23.3	#1.1	19.9
15	80.0	2.500	0.154	59.9	21.8	66.9	52.6
16	97.6	49.200	0.782	88.6	11.1	97.5	15.6
17	41.1	7.300	0.347	51.0	19.2	76.7	65.0
18	0.0	1.500	0.099	50.7	22.5	#0.6	4.1

Estimates of the Structural Parameters

$E[m(\theta_i)]$	56.3%
$E[s^2(\theta_i)]$	0.771
$V[m(\theta_i)]$	0.056

APPENDIX C

PREMIUM CALCULATIONS IN SECTION 8

Using the notation of *C.M.I.R.* **12** (1991, Part D, Section 7), let:

$\bar{a}^{HH}_{x:\overline{n}|}$ denote the expected present value of an annuity payable continuously while healthy at rate 1 *per annum* from age x for at most n years to a healthy life aged x.

$\bar{a}^{HS(a/b)}_{x:\overline{n}|}$ denote the expected present value of an annuity payable continuously while sick with duration of sickness between a and $a+b$ weeks at rate 1 *per annum* from age x for at most n years to a healthy life aged x.

Then the annual premium rate for a policy with deferred period 4 weeks and benefit rate £1,000 *per annum* is P, where:

$$P = 1{,}000 \times \frac{\bar{a}^{HS(4/\infty)}_{x:\overline{65-x}|}}{\bar{a}^{HH}_{x:\overline{65-x}|} + \bar{a}^{HS(0/4)}_{x:\overline{65-x}|}}$$

To calculate these annuities we must specify the transition intensities. We will use the following notation for the parameterisations of the transition intensities produced in *C.M.I.R* **12** (1991, Parts B and D):

σ_x the sickness inception intensity at age x,

μ_x the mortality from healthy intensity at age x,

$\rho_{x,z}$ the recovery intensity at age x and current duration of sickness z years, and,

$\nu_{x,z}$ the mortality from sick intensity at age x and current duration of sickness z years.

These intensities, and the given parameterisations, have formed our "standard basis" throughout this paper and Part I.

Now suppose we wish to calculate the premium rate for a single company or for all companies where claim inceptions should be 100 α_I % of standard and recoveries should be 100 α_R % of standard. Then the annuity values in the formula for P should be calculated using the transition intensities σ^*_x, μ^*_x, $\rho^*_{x,z}$ and $\nu^*_{x,z}$, where:

$$
\begin{aligned}
\sigma^*_x &= \alpha_I \, \sigma_x \\
\mu^*_x &= \mu_x \\
\rho^*_{x,z} &= \rho_{x,z} && \text{for } z \leq 4/52.18 \\
\rho^*_{x,z} &= \alpha_R \, \rho_{x,z} && \text{for } z > 4/52.18 \\
\nu^*_{x,z} &= \nu_{x,z} && \text{for } z \leq 4/52.18 \\
\nu^*_{x,z} &= k_{d,s,y} \, \nu_{x,z} && \text{for } z > 4/52.18
\end{aligned}
$$

Note that to produce the required recovery intensity, $\rho^*_{x,z}$, the standard intensity is multiplied by the factor α_R for durations of sickness beyond the deferred period only. Note also that the mortality from sick intensity, $\nu^*_{x,z}$, is a multiple of the standard intensity for durations of sickness beyond the deferred period. In this case the multiple, $k_{d,s,y}$, is a function of deferred period, sex and calendar year, but not of individual company. This follows from the modelling described in Section 3. For deferred period 4 weeks, males as at 1 January 1991, the value of $k_{d,s,y}$ is 0.9857, and this factor has been used to adjust the standard mortality from sick intensity for the calculation of all the premium rates in Table 5.

CORRIGENDA

C.M.I.R. **17**, 219 Table B1 should read:

Table B1. Retirement annuitants, males – RMD92 and RMC92 values of q_x

Age x	Deferred RMD92	Combined RMC92
17	0.000400	0.000401
18	0.000399	0.000401
19	0.000398	0.000401
20	0.000398	0.000403
21	0.000398	0.000405
22	0.000400	0.000408
23	0.000402	0.000413
24	0.000406	0.000419
25	0.000411	0.000426
26	0.000418	0.000435
27	0.000426	0.000446
28	0.000437	0.000459
29	0.000450	0.000475
30	0.000466	0.000494
31	0.000486	0.000516
32	0.000509	0.000543
33	0.000536	0.000573
34	0.000569	0.000609
35	0.000607	0.000650
36	0.000651	0.000697
37	0.000703	0.000752
38	0.000763	0.000815
39	0.000832	0.000887
40	0.000912	0.000969
41	0.001003	0.001064
42	0.001107	0.001171
43	0.001226	0.001293
44	0.001362	0.001432

Table B1. (Continued).

Age x	Deferred RMD92	Combined RMC92
45	0.001515	0.001589
46	0.001688	0.001767
47	0.001883	0.001969
48	0.002103	0.002196
49	0.002349	0.002452
50	0.002625	0.002741
51	0.002933	0.003065
52	0.003276	0.003430
53	0.003656	0.003839
54	0.004078	0.004296
55	0.004544	0.004809
56	0.005058	0.005381
57	0.005624	0.006019
58	0.006244	0.006731
59	0.006924	0.007523
60	0.007665	0.008404
61	0.008474	0.009381
62	0.009352	0.010466
63	0.010303	0.011666
64	0.011333	0.012995
65	0.012442	0.014462
66	0.013637	0.016081
67	0.014918	0.017865
68	0.016290	0.019828
69	0.017754	0.021985
70	0.019313	0.024353
71	0.020969	0.026947
72	0.022722	0.029787
73	0.024575	0.032891
74	0.026526	0.036279
75	0.028577	0.039971
76		0.043988
77		0.048353
78		0.053089
79		0.058219

Table B1. (Continued).

Age x	Deferred RMD92	Combined RMC92
80		0.063767
81		0.069756
82		0.076213
83		0.083160
84		0.090623
85		0.098625
86		0.107189
87		0.116337
88		0.126091
89		0.136470
90		0.147491
91		0.159170
92		0.171520
93		0.184549
94		0.198265
95		0.212671
96		0.227764
97		0.243539
98		0.259986
99		0.277089
100		0.294827
101		0.313175
102		0.332100
103		0.351567
104		0.371532
105		0.391947
106		0.412761
107		0.433916
108		0.455349
109		0.476996
110		0.498787
111		0.520651
112		0.542516
113		0.564306
114		0.585948
115		0.607369
116		0.628496
117		0.649259
118		0.669594
119		0.689438
120		1.000000

C.M.I.R. **17**, 222 Table B2 should read:

Table B2. Retirement annuitants, females RFD92 and RFC92 values of q_x

Age x	Deferred RFD92	Combined RFC92
17	0.000188	0.000189
18	0.000192	0.000195
19	0.000196	0.000201
20	0.000200	0.000208
21	0.000206	0.000216
22	0.000212	0.000224
23	0.000219	0.000234
24	0.000227	0.000245
25	0.000236	0.000256
26	0.000247	0.000270
27	0.000259	0.000284
28	0.000273	0.000301
29	0.000289	0.000319
30	0.000307	0.000339
31	0.000327	0.000362
32	0.000350	0.000387
33	0.000376	0.000415
34	0.000405	0.000447
35	0.000438	0.000482
36	0.000476	0.000520
37	0.000517	0.000563
38	0.000565	0.000612
39	0.000617	0.000665
40	0.000676	0.000725
41	0.000742	0.000791
42	0.000815	0.000865
43	0.000897	0.000947
44	0.000988	0.001039
45	0.001089	0.001141
46	0.001201	0.001255
47	0.001324	0.001381
48	0.001461	0.001522
49	0.001612	0.001679

Table B2. (Continued).

Age *x*	Deferred RFD92	Combined RFC92
50	0.001777	0.001853
51	0.001960	0.002048
52	0.002160	0.002264
53	0.002379	0.002505
54	0.002619	0.002773
55	0.002880	0.003072
56	0.003166	0.003404
57	0.003476	0.003774
58	0.003813	0.004186
59	0.004179	0.004645
60	0.004576	0.005155
61	0.005004	0.005723
62	0.005466	0.006355
63	0.005964	0.007058
64	0.006500	0.007841
65	0.007075	0.008712
66	0.007691	0.009681
67	0.008350	0.010758
68	0.009054	0.011957
69	0.009804	0.013290
70	0.010602	0.014772
71	0.011450	0.016420
72	0.012349	0.018252
73	0.013300	0.020288
74	0.014305	0.022551
75	0.015364	0.025064
76		0.027855
77		0.030953
78		0.034391
79		0.038206
80		0.042436
81		0.047125
82		0.052319
83		0.058070
84		0.064432

Table B2. (Continued).

Age x	Deferred RFD92	Combined RFC92
85		0.071467
86		0.079238
87		0.087816
88		0.097273
89		0.107689
90		0.119146
91		0.131732
92		0.145535
93		0.160648
94		0.177163
95		0.195171
96		0.214760
97		0.236014
98		0.259005
99		0.283793
100		0.310422
101		0.338912
102		0.369254
103		0.401405
104		0.435283
105		0.470757
106		0.507643
107		0.545701
108		0.584630
109		0.624066
110		0.663591
111		0.702735
112		0.740987
113		0.777821
114		0.812707
115		0.845149
116		0.874707
117		0.901033
118		0.923893
119		0.943192
120		1.000000

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Typeset and printed in Great Britain at The Alden Group, Oxford