

CLAIMS RESERVING MANUAL
Report for the GISG Torquay Conference—October 1987

Progress with the Manual has, regrettably, been slower than hoped. To produce a fully satisfactory work has proved a larger task than at first envisaged. But momentum has been regained, and publication in mid-1988 is now confidently expected. As shown on the enclosed Contents List, the Manual is structured in two main parts, or 'logical volumes'. These are as follows

Logical Volume 1 — Simple Reserving Methods

§§ A–D contain introductory material on the insurance background, data and forecasting methods, company and external influences, and dimensions of choice in claims reserving.

§§ E–J describe the main methods at this level—basically, evaluation of run-off triangles. Included are projection of both paid and incurred claims, the adjustment of case reserves and loss ratio methods. Further sections deal with average cost per claim methods, IBNR estimation and adjusting for inflation.

§§ K–N round off the first volume. Miscellaneous topics such as claims expense are treated, and another section looks at the actuarial approach to claims reserving. Two sections of case studies then follow, plus a final note to tie up the algebra for Volume 1.

To date, §§ A–H are complete, and will be on display in the typeset version at Torquay. The remaining sections, except the case studies, are due for completion later in 1987.

Logical Volume 2 — Mathematical & Statistical Modelling

The work of volume 1 is naive, statistically speaking. It demonstrates the methods by means of arithmetical example, and is deliberately intended for use by those without higher degrees in mathematics or actuarial qualification. The level of the work, however, is not trivial. Pains are taken to show the variability of the estimates which can be produced in claims reserving, and the need to exercise judgment. But there is no formal treatment of the variance and other statistical parameters.

Volume 2 is intended to remedy this deficiency. It will introduce ideas of explicit modelling, curve fitting, time series, Bayesian estimation, and so on. The contents are at present still under discussion, and §§ P–T on the enclosed listing should be regarded as very far from the final form. Recent discussions, however, have identified certain methods which it is essential for the Manual to include. These are as follows:

- a) Craighead's curve fitting method, plus Benjamin & Eagles' developments.
- b) Reid's method and its variations.
- c) Recent formal work on least squares & run-off triangles by Kramer et al.
- d) Methods developed by the Swedish actuary Bjorn Ajn.

Zehnwirth's Bayesian technique using the Kalman filter may also be included. Suggestions for other methods and topics which ought to be in the Manual, especially Volume 2, will be sought at Torquay. This part of the Manual is still in a formative stage, and the views of GISG members will be particularly welcomed as an influence.

CLAIMS RESERVING MANUAL

DRAFT CONTENTS

Preface
Introduction
Acknowledgements

VOL 1. SIMPLE RESERVING METHODS

- A. The Insurance Background**
 - 1. Purpose of Claims Reserving
 - 2. Types of Business — The Primary Market
 - 3. Types of Business — Reinsurance & the London Market
 - 4. Note on Technical Reserves
 - 5. Note on Terminology
- B. Data & Forecasting**
 - 1. The Projection of Past Experience
 - 2. Data Groupings: Principle of Homogeneity
 - 3. The Claims Development Table
 - 4. Data Quantities
 - 5. Simple Breakdowns of the Claims Pattern
 - 6. Data Systems & Validation
 - 7. Forecasting: Simple Averages & Trends
 - 8. Mathematical Trendlines
- C. Company & External Influences**
 - 1. Classification & General Analysis
 - 2. Business Mix & Volume
 - 3. Underwriting, Rating & Policy Conditions
 - 4. Claims Handling & Definition
 - 5. Inflation & Economic Factors
 - 6. Legal, Political & Social Factors
 - 7. Climate & Environmental Factors
- D. Dimensions of Choice**
 - 1. Case Reserves v. Statistical Methods
 - 2. Simple Statistical Methods v. Mathematical & Stochastic Modelling
 - 3. All Claims Together v. Separation of Large and/ or Small Claims
 - 4. Figures Gross v. Net of Reinsurance/ Claims Expense
 - 5. Accident/ Underwriting Year v. Report Year Cohorts
 - 6. Loss Ratio v. Claim Development Patterns
 - 7. Paid Claims v. Incurred Claims Development
 - 8. Claim Amounts v. Use of Claim Numbers & Average Cost per Claim
- E. The Projection of Paid Claims**
 - 1. The Grossing Up Method — Introduction
 - 2. Grossing Up — Variations 1 & 2

3. Grossing Up — Variations 3 & 4
 4. Comparison of Results
 5. The Link Ratio Method — Introduction
 6. Link Ratios with Simple Average
 7. Link Ratios with Weighted Average
 8. Original Weightings — the Chain Ladder Method
 9. Link Ratios with Trending
 10. Comparison of Link Ratio Results
 11. Link Ratios v. Grossing Up
 12. Paid Claim Projections & the Claim Settlement Pattern
- F. Case Estimates & the Projection of Incurred Claims
1. Nature of Case Estimates
 2. The Incurred Claims Function
 3. Incurred Claims — Grossing Up
 4. Incurred Claims — Link Ratio Method
 5. Grossing Up of Case Reserves
 6. Adequacy & Consistency of Case Reserves
 7. Adjustment of Incurred Claims Projection
- G. Methods Using Loss Ratio & Loss Ratio Projections
1. Concept of the Loss Ratio
 2. Naive Loss Ratio Method
 3. Bornhuetter-Ferguson Method — Introduction
 4. Bornhuetter-Ferguson on Incurred Claims
 5. Bornhuetter-Ferguson on Paid Claims
 6. Comparison of Results
 7. Taking Stock of the Methods
 8. Sensitivity Testing & Choice of Estimate
 9. Paid Loss Ratio and its Projection
 10. Stepwise Projection of Paid Loss Ratio
 11. Incurred Loss Ratio and its Projection
 12. Comparison of Results
- H. Methods Based on Claim Numbers & Average Cost per Claim
1. Projection of Paid Averages
 2. Projection of Incurred Averages
 3. Stepwise Paid Average Projection
 4. Bennett & Taylor (Method A)
 5. Projection of Average Developing Claims
- I. Methods for IBNR
1. Definitions of IBNR
 2. Exposure Bases (Premiums/ Claims/ Reserves)
 3. Delay Table Method
 4. Tarbell's Method
 5. IBNR Claim Set & Emergence Data
 6. Projections of IBNR Claims Emergence
- J. Dealing with Inflation
1. Indices of Inflation
 2. Factoring Out Past Inflation

3. Forecasts of Future Inflation
4. Effect on Projections
5. Inflation Adjusted Chain Ladder
6. The Separation Method — Introduction
7. Arithmetic Separation Method
8. Geometric Separation Method

K. Miscellaneous Topics

1. Reserves for Reopened Claims
2. Average Claim Methods for Small Claims
3. Use of Standard Tables
4. Direct Claims Expense
5. Indirect Claims Expense
6. Missing Data — de Vylder's Method

L. Actuarial Considerations

1. Cash Flow Analysis
2. Discounting of Claims Reserves
3. Analysis of Errors
4. Tracking the Performance

M Practical Examples — I

1. Volume & Mix of Business
2. Premium Rates
3. Changes in Deductibles & Retention Limits
4. Developments in Policy Cover
5. Claims Processing Rate
6. Inconsistency in Case Reserves
7. Claims Closed without Payment
8. Partial Payments on Open Claims

N. Practical Examples — II

1. Claims Inflation
2. Motor Safety Legislation
3. Court Judgments in Industrial Disease
4. Seasonal Effects
5. New Lines of Business & New Companies
6. Monthly/ Quarterly Review of Reserves

O. Towards a Formalised Approach

1. The History of a Claim
2. Cohorts of Claims
3. Claim Amounts & Numbers of Claims
4. Overall Loss & the Claims Reserve
5. Division of Claims Reserve/ Ibnr & Ibner
6. The Full Analysis of Loss
7. Average Cost per Claim
8. Exposure Measures & Loss Ratio
9. Time Axes
10. Claim Development Functions
11. The Triangular Array
12. Development Factors & Trend Analysis

VOL 2. MODELLING & STATISTICAL TECHNIQUES

P. Basic Concepts

1. The Explicit Model
2. Statistical Variance
3. Stochastic Processes
4. Adaptive Control

Q. Mathematical Models — I

1. Chain Ladder (Explicit Form)
2. Inflation Adjusted Chain Ladder
3. Other Chain Ladder Variations
4. De Vylder's Method
5. Cumpston's Method
6. Verbeek's Separation Method
7. Taylor's Developments of Separation

R. Mathematical Models — II

1. Craighead's Method for Loss Ratio Curve Fitting
2. Benjamin & Eagles' Method
3. McClenahan's Model
4. Fisher & Lange's Method
5. Reduced Reid Method

S. Stochastic Methods

1. Pollard's Method (Payments per Unit of Risk)
2. Taylor's See-saw Method
3. Reid's Method
4. Stochastic Chain Ladder (Buhlmann et al)
5. Stochastic Separation Method (Linnemann)
6. Claim Status Markov Chain (Hachemeister)

T. Methods with Adaptive Control

1. Autoregressive Type (Lemaire)
2. Kalman Filter (de Jong & Zehnwirth)
3. Balzer & Benjamin

Comparative Tables
Annotated Bibliography
Index

Section A

THE INSURANCE BACKGROUND

Preamble

Before embarking on the methods and techniques for claims reserving, which make up the greater part of the Manual, it is important to establish the background to the work. Why is claims reserving such a vital topic in General Insurance, and what purposes does it serve in the industry? What are the characteristics of the main classes of business to which the reserving relates? And what is the place of the claims reserve within the technical reserves as a whole? The present section provides answers for these questions, but in summary form only. The Manual is not, and cannot be, a study of the whole of general insurance. The crucial point to establish is that the methods do not operate in a vacuum. In themselves, they are but abstractions. The reserver should take as starting point the concrete world of business which the methods are intended to serve, and keep such a view in mind. Claims reserving methods are of little value unless they become good practice as well as good theory.

Contents

- A1. Purpose of Claims Reserving
 - A2. Types of Business — The Primary Market
 - A3. Types of Business — Reinsurance & the London Market
 - A4. Note on Technical Reserves
 - A5. Note on Terminology
- A-Ref. Selected References/ Reading List

Section B

DATA & FORECASTING

Preamble

This section introduces some of the main building blocks for claims reserving. To begin with, there is the important idea of making a projection of past experience forward on to the future. Since the future never takes the trouble to conform properly with the past, any projection whatsoever will be subject to error. One needs, therefore, to understand the principles which can lessen the likely degree of error, and so bring credibility to the work.

Apart from those principles which make for stability, there is the matter of the data itself and the actual means for forecasting. These are not intrinsically difficult matters, but there is a fair amount of detail to be mastered. On the data side, a number of different quantities can be used in the projections, or as supporting evidence — not only claim amounts, but such items also as claim numbers, premium income and loss ratios. They can often be displayed in different ways in the search for pattern and regularity, and the concept of the development table is particularly important here. Then there is the question of data validation, and of how the classification of the risk groupings is to be made.

On the forecasting side, there are some surprisingly simple means available. It is straightforward, almost intuitively obvious, to look for the average or trend which is present in a sequence of figures. The really vital question to ask is to whether the available evidence supports the continuation of such average or trend into future periods. Although far more elaborate types of projection can be devised, it is these simple foundations on which they rest, and which should therefore first be thoroughly understood.

Contents

- B1. The Projection of Past Experience
- B2. Data Groupings: Principle of Homogeneity
- B3. The Claims Development Table
- B4. Data Quantities
- B5. Simple Breakdowns of the Claims Pattern
- B6. Data Systems & Validation
- B7. Forecasting: Simple Averages & Trends
- B8. Mathematical Trendlines

Section C

COMPANY & EXTERNAL INFLUENCES

Preamble

If we lived in a world where nature and human artifice were well behaved and gave no cause for upset or surprise, then claims reserving would be a simple matter scarcely requiring the services of the expert. One would need to assess the values of at most three quantities for each class of business: a) the exposure to risk, b) the frequency of claim, and c) the average loss per claim. Past and present trends for these factors could be assumed to hold equally in the future, and the known patterns could be projected forward with confidence.

In such a world, however, insurance itself would scarcely be necessary at all. The world we do inhabit has a sufficient degree of natural cussedness and human fallibility that the long-term prospects for insurance remain bright. The cussedness and fallibility affects the claims reserving process as it does everything else. The projections are seldom straightforward to make. For protection, the reserver needs to arm himself with a knowledge of the influences which are most likely to disturb the picture. Only in this way can he hope to produce figures in which theory is properly tempered by reality. The present section outlines the main influences, both internal and external to the company, which usually need to be taken into account.

Contents

- C1. Classification & General Analysis
- C2. Business Mix & Volume
- C3. Underwriting, Rating & Policy Conditions
- C4. Claims Handling & Definition
- C5. Inflation & Economic Factors
- C6. Legal, Political & Social Factors
- C7. Climate & Environmental Factors

Section D

DIMENSIONS OF CHOICE

Preamble

Embarking on the claims reserving exercise, there are a number of underlying choices which have to be made. Often, they will be constrained by the availability of data, but on other occasions there will be considerable freedom. Again, the choices may not all be made consciously - they may be implicitly made through an office's established procedures for claims reserving. In this case, a periodic review of their propriety should still be made.

To make the choices clear, they are here brought out as a series of 'either/ or' dimensions. But often the right answer will not be 'either/ or' but 'both'. The reserver is likely to build up a fuller and more reliable picture if he approaches the problem in a number of different ways.

Contents

- D1. Case Reserves v. Statistical Methods
- D2. Simple Statistical Methods v. Mathematical Modelling & Stochastic Techniques
- D3. All Claims Together v. Separation of Large and/ or Small Claims
- D4. Figures Gross v. Net of Reinsurance / Claims Expense / Salvage & Subrogation
- D5. Accident/ Underwriting Year v. Report Year Cohorts
- D6. Loss Ratio v. Claim Development Patterns
- D7. Paid Claims v. Incurred Claims Development
- D8. Claim Amounts v. Use of Claim Numbers & Average Cost per Claim

Section E

THE PROJECTION OF PAID CLAIMS

Preamble

As a starting point for the simpler statistical methods, the projection of paid claim amounts is ideal. The idea underlying the method is a simple one, but it is quite fundamental. Thus, we can watch the claims for a given accident or report year developing to the ultimate value, and see the pattern that is established over the intervening years. The pattern can be expressed in terms of the proportion of the final amount which is paid out as the years progress. If subsequent accident years can be shown or assumed to follow a similar pattern, then we have a simple and direct means for arriving at the claims estimate.

When projecting claims in this way, there are two main techniques which can be followed. These are respectively the Grossing Up and Link Ratio methods, and on each a number of variations can be played. In fact, the two methods are opposite sides of the same coin, and will normally give very similar results. The skill comes in the choice of variation, and in the assessment as to how far the data conforms to the basic assumption of a stable claim payment pattern. The methods are easy to follow in principle, and are illustrated in the text by means of an extended numerical example.

Contents

- E1. The Grossing Up Method — Introduction
- E2. Grossing Up — Variations 1 & 2
- E3. Grossing Up — Variations 3 & 4
- E4. Comparison of Results

- E5. The Link Ratio Method — Introduction
- E6. Link Ratios with Simple Average
- E7. Link Ratios with Weighted Average
- E8. Original Weightings — the Chain Ladder Method
- E9. Link Ratios with Trending
- E10. Comparison of Link Ratio Results

- E11. Link Ratios v. Grossing Up
- E12. Paid Claim Projections & the Claim Settlement Pattern

[E3]
GROSSING-UP — VARIATIONS 3 & 4

In spite of producing a variety of estimates, the method as used so far is still open to objection. In fact, the work has been based on information from *old* accident years. There has been no attempt to use the data from later years, as appear in the paid claims triangle, apart that is from accident year 1 itself. But claims payment patterns may be changing, and the reserver should be abreast of the *current* situation. Hence it is time to drop the earlier accident years, and concentrate on what may be discovered from the paid claims triangle itself.

To recap, the triangle is:

		0	1	2	<i>d</i>	3	4	5
	1	1001	1855	2423		2988	3335	3483
	2	1113	2103	2774		3422	3844	
<i>a</i>	3	1265	2433	3233		3977		
	4	1490	2873	3880				
	5	1725	3261					
	6	1889						

To make use of the information, one convenient way is to work back through the triangle, starting from the top right hand corner. This will be done in Variations 3 & 4.

Variation 3 — Averaging

For Year 1 the ultimate value of the claims is estimated at 3705, and analysis of its payment pattern gives the vector:

<i>d</i>	0	1	2	3	4	5	<i>ult</i>
<i>pC%</i>	27.0	50.1	65.4	80.6	90.0	94.0	100

This can be applied to the latest development value for Year 2, ie: 3844, attained at *d*=4. The appropriate grossing factor is 90.0%, giving a final estimated loss for Year 2 of:

$$3844 / .900 = 4271$$

Using this value, the whole payment pattern can be derived for Year 2 as well:

<i>d</i>	0	1	2	3	4	<i>ult</i>
<i>pC</i>	1113	2103	2774	3422	3844	4271
%	26.1	49.2	64.9	80.1	90.0	100

THE PROJECTION OF PAID CLAIMS

(Note: it is not necessary to write down the $pC\%$ value for $d=5$, although if needed it would be taken as 94.0% directly from the Year 1 vector).

Coming to Year 3, we now have 2 different payment patterns to choose from. The vital value is that for $d=3$, and the available figures are 80.6% from Year 1, and 80.1% from Year 2. The obvious step is to take an average, which gives 80.4% as the grossing factor. (80.35% could be used, but 3-figure accuracy will be quite sufficient in the example). Hence the estimated final loss for Year 3 is:

$$3977 / .804 = 4947$$

This leads immediately to the payment pattern for Year 3, this time taken only to $d=3$:

d	0	1	2	3	<i>ult</i>
pC	1265	2433	3233	3977	4947
%	25.6	49.2	65.4	80.4	100

We now have 3 values for the $pC\%$ at $d=2$: 65.4, 64.9, 65.4%. The average is 65.2%, which can be applied to the latest claims figure for Year 4, ie 3880. The process continues automatically until the whole triangle has been covered, and all claims projected to their ultimate values. It is most convenient to set the procedure out in a single display, as follows:

	d						
	0	1	2	3	4	5	<i>ult</i>
1	1001 27.0	1855 50.1	2423 65.4	2988 80.6	3335 90.0	3483 94.0%	3705
2	1113 26.1	2103 49.2	2774 64.9	3422 80.1	3844 90.0%		4271
3	1265 25.6	2433 49.2	3233 65.4	3977 80.4%			4947
4	1490 25.0	2873 48.3	3880 65.2%				5951
5	1725 26.0	3261 49.2%					6628
6	1889 25.9%						7293
							32,795
Overall Values:	$\sum L-ult$		32,795				
	$\sum pC^*$		20,334				
	Reserve		12,461				

THE PROJECTION OF PAID CLAIMS

Overall Values:	$\sum L_{-ult}$	33,285
	$\sum pC^*$	<u>20,334</u>
	Reserve	<u>12,951</u>

The value obtained for the reserve is appreciably higher than that with simple averaging, by some 3.9%. A full comparison of the grossing up results appears in the next section.



Section F

CASE ESTIMATES & THE PROJECTION OF INCURRED CLAIMS

Preamble

At a given reserving date, more is usually known than the bare fact of the actual claim payments. For each class of business, there will be a number of claims still outstanding, and to these individual estimates will be attached by the Claims Department. Hence the reserver will have a further source of information towards producing his final figure for the liability. The question that arises will be as to the adequacy of these case estimates — if they are compounded with the paid amounts on settled claims, how close will the figure be to the ultimate loss on the business?

The quantity obtained by adding the case reserves to the paid claims is commonly called the 'incurred claims'. It turns out that the set of methods derived for projecting paid claims to the ultimate can be applied in just the same way to the incurred claims. Comparison of the results with the paid claim projections can be instructive. But this time, there are more possible disturbing influences at work — as well as the settlement pattern, the reporting pattern of the claims has to be considered. And as well as the adequacy of the case reserves, their consistency over time is of prime importance. One useful development of the projection techniques enables the reserver to assess this consistency. The example of the previous section is extended here to continue the illustration by numerical means.

Contents

- F1. Nature of Case Estimates
- F2. The Incurred Claims Function
- F3. Incurred Claims — Grossing Up
- F4. Incurred Claims — Link Ratio Method

- F5. Grossing Up of Case Reserves
- F6. Adequacy & Consistency of Case Reserves
- F7. Adjustment of Incurred Claims Projection

Section G

METHODS USING LOSS RATIO & LOSS RATIO PROJECTIONS

Preamble

Introduction of the loss ratio into claims reserving methods at first sight seems paradoxical. If one were to know the loss ratio for a class of business with confidence, then the reserving procedure would become almost trivial. But of course the loss ratio is subject to uncertainty, just like other quantities used in claims reserving. Here again the past is no sure guide to the future. But though the reserver cannot have full knowledge of the future for the loss ratio, some familiarity with its past history and the current expectations of underwriters and ratemakers will be of great service to him.

This familiarity, in fact, should help to provide him with a kind of standard, or benchmark, against which the results of other projections can be assessed. It should help to stabilise results where data are volatile, and provide a first guide to reserves where data are scanty or even non-existent. The loss ratio, and the techniques associated with it, thus form an important part of the reserver's toolkit. The only additional data element required for this work is the premium income (earned or written) for the class of business in question. Being a valid measure of the risk exposure, it gives *scale* to the loss data, and hence enables the loss ratio benchmarking to begin.

Contents

- G1. Concept of the Loss Ratio
- G2. Naive Loss Ratio Method
- G3. Bornhuetter-Ferguson Method — Introduction
- G4. Bornhuetter-Ferguson on Incurred Claims
- G5. Bornhuetter-Ferguson on Paid Claims
- G6. Comparison of Results

- G7. Taking Stock of the Methods
- G8. Sensitivity Testing & Choice of Estimate

- G9. Paid Loss Ratio & Its Projection
- G10. Stepwise Projection of Paid Loss Ratio
- G11. Incurred Loss Ratio & Its Projection
- G12. Comparison of Results