

GENERAL INSURANCE READING GUIDE

A INTRODUCTION

A1 Purpose of this guide

The purpose of this Guide is to provide a reading list suitable for actuaries who intend to start practising in the field of general insurance, having not recently been active in that field.

Readers may be coming from a career break, or from abroad, or switching from another specialism. Rather than making a specific recommendation on what should be read, we have tried to include material on every relevant topic, and at different levels, leaving individuals to choose what material to read and in what order.

A2 Structure of this guide

The main part of this Guide consists of a list of some of the available books and papers, classified under broad subject headings, together with a brief description of the content of each and an indication of its length. Where a paper has been discussed at a sessional meeting of the Faculty or the Institute and the discussion is also recorded, the length is given as $m + n$ pages, where m is the length of the paper and n that of the abstract of the discussion. Several of the papers relate to more than one subject area and in such cases the choice of heading has been somewhat arbitrary.

In order to assist readers in selecting material, we have introduced a classification system for documents, indicating the type of reading and its level of technical content. This is defined in Section B.

Before the list of publications, we give a summary of the subject headings used in the main list, maintaining the same numbering system, and a list of the abbreviations used. Information on recommended periodicals and details of Faculty and Institute library services are given in the Appendix.

A3 Caveat lector

The papers listed in this Guide span a period of some 17 years during which actuarial ideas in the field of general insurance have been developing rapidly. The papers reflect the stage of development of actuarial thought and the legislative environment at the time they were written. Furthermore, many of them had not been refereed before publication. Even those that were refereed should not be assumed to be correct in every particular.

A4 A note on spelling

There are some variations between American and British spelling. The spelling of the original text has been preserved in titles and chapter headings but spelling in abstracts has been standardised to conform to British practice.

B CLASSIFICATION OF PAPERS

These definitions, which are for guidance only, are the views of the authors of this Guide and not the official views of the Faculty and the Institute.

Type of reading:	Intro	(I ntr <u>o</u> ductory and background: Assumes little knowledge)
	Core	(C o <u>r</u> e material: Essential for all actuaries working in general insurance - or, in the case of papers relating to a particular area, all actuaries whose work involves that area)
	Spec	(S pe <u>c</u> ialist: Goes beyond essential knowledge)
Level of technical content:	Non	(N o <u>n</u> -technical: A layman can understand this)
	Stan	(S t <u>a</u> ndard: Requires an actuary's technical skills)
	Bey	(B ey <u>o</u> nd: Goes beyond standard actuarial skills)

C SUBJECT HEADINGS

- 1 Texts covering many areas**
- 2 Solvency**
- 3 Technical provisions or reserves**
- 4 Financial control**
- 5 Asset/liability modelling**
- 6 Premium rating: personal lines**
- 7 Premium rating: commercial lines**
- 8 Premium rating: cover for catastrophes**
- 9 Specific classes of business**
- 10 Reinsurance and alternative risk transfer**
- 11 Lloyd's and the London Market**
- 12 The international scene**
- 13 Distributions**

D ABBREVIATIONS

AB	ASTIN Bulletin
AFIR	Report of AFIR Colloquium
BAJ	British Actuarial Journal
CAS	Casualty Actuarial Society
FA	Faculty of Actuaries
Geneva	The Geneva Papers on Risk and Insurance
GI Conv	General Insurance Convention
IA	Institute of Actuaries
IAA	Institute of Actuaries of Australia
IME	Insurance: Mathematics and Economics
JAP	Journal of Actuarial Practice
JIA	Journal of the Institute of Actuaries
NAAJ	North American Actuarial Journal
PCAS	Proceedings of the Casualty Actuarial Society
RPG	Reactions Publishing Group
SAJ	Scandinavian Actuarial Journal
TICA	Transactions of the International Congress of Actuaries

E RECOMMENDED READING

1 TEXTS COVERING MANY AREAS

1.1

Daykin, C D,
Pentikäinen, T
& Pesonen, M
1994
Chapman & Hall

Practical risk theory for actuaries

Type: Spec
Tech level: Stan
Pages: 513

This textbook concentrates on those aspects of risk theory that not only convey an understanding of risk processes but also offer the prospect of being applied to practical problems. It stems from collaboration between actuaries in Finland and the UK that began with the writing of the textbook *Risk Theory* by R E Beard, T Pentikäinen and E Pesonen, first published in 1969, and continued through the work of the Finnish and British solvency working parties in the 1980s.

The book is in two parts followed by a series of mathematical appendices. Part 1 introduces a standard nomenclature for cash flow and accounting items and proceeds to cover the foundations of practical risk theory, dealing in turn with distributions used for the number of claims and the amount of claims, the calculation of a compound claim distribution function, simulation, and applications involving short-term fluctuations of claims. Part 2 covers the stochastic analysis of insurance business, with chapters on the following topics:

- Inflation
- Investment
- Claims with an extended time horizon
- Premiums
- Expenses, taxes and dividends
- The insurance process
- Applications to long-term processes
- Managing uncertainty
- Life insurance
- Pension schemes

The book includes several exercises for the reader, with solutions at the end, and an extensive bibliography.

1.2

Buchanan, R A, Hart, D G & Howe, B A 1996 IAA	<i>The actuarial practice of general insurance (5th ed)</i>	Type: Core Tech level: Stan Pages: 582
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This book is intended primarily as the basic text for candidates for the general insurance subject of the examinations of the Institute of Actuaries of Australia. It is in three parts:

Nature and operation of general insurance

Five chapters, on the nature of general insurance, insurance regulations, insurance operations, management information and the role of the actuary. The main emphasis is naturally on Australian law and practice.

Actuarial techniques

Eleven chapters, on the statistical basis of insurance, claim frequency and size, distributions, claim cost distributions (introducing convolutions and Panjer's recursion algorithm), risk theory, capital and profit, reinsurance theory, experience rating, risk classification, forecasting in general insurance, run-off techniques and premium rating projections. Frequent use is made of simple illustrative numerical examples.

Actuarial practice

Twenty-four chapters, grouped into eight sections on rating and design, reserving, financial control, reinsurance, appraisal, compensation schemes, risk management and statutory supervision. Nearly all of this part of the book applies just as much to the UK as to Australia and it provides a plentiful source of ideas for any actuaries practising in the general insurance field.

1.3

Various 1998 CAS	<i>Foundations of casualty actuarial science (3rd ed)</i>	Type: Core Tech level: Stan Pages: 598
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This textbook published by the Casualty Actuarial Society covers all the main areas of actuarial activity in property and casualty insurance in the USA. All the authors seek to convey an understanding of the actuarial concepts of the subjects that they cover, using numerical examples and emphasising the practical applications. The book demonstrates clearly how the approach of casualty actuaries has been influenced by the ideas of credibility theory and Bayesian estimation - topics to which members of the CAS have made noteworthy contributions. The chapter on credibility has the greatest mathematical content, but since the purpose is to give an overview the results are in many cases stated without proof or with only an outline of the proof. The chapters and their authors are as follows:

- M Rodermund *Introduction*
- C L McClenahan *Ratemaking*
- M W Tiller *Individual risk rating*
- R F Wiser *Loss reserving*
- R F Finger *Risk classification*
- G S Patrik *Reinsurance*
- G G Venter *Credibility*
- S P D'Arcy *Investment issues in property-liability insurance*
- S P D'Arcy *Special issues*

1.4

Abbott, W M *Actuaries and general insurance* Type: Intro
 1986 Tech level: Non
 JIA 113, 299 Pages: 26 + 15

The paper forms a useful point of reference in that it outlines the history and state of actuarial involvement in general insurance as at 1986, and provides a bibliography of over 100 papers by UK actuaries. It introduced proposals for notes on recommended practice for actuarial reporting in general insurance, which formed the basis for what later became the guidance note GN12 in its original form and can therefore be regarded as superseded.

1.5

Klugman, S A, *Loss models: from data to decisions* Type: Spec
 Panjer, H H Tech level: Stan
 & Willmot, G E Pages: 644
 1998
 Wiley

This substantial textbook covering statistical models and probability distributions goes into considerably more detail than would normally be required by an actuary who is just embarking on a career in general insurance. It nevertheless provides a convenient work of reference for topics with which the reader is already familiar and a basis of study for more specialist topics. It consists of six chapters and nine appendices:

		<u>Pages</u>
1	<i>Introduction – a model-based approach to actuarial science</i>	21
2	<i>Loss distributions – models for the amount of a single payment</i>	175
3	<i>Frequency distributions – models for the number of payments</i>	92
4	<i>Aggregate loss models</i>	93
5	<i>Credibility theory</i>	126
6	<i>Long-term models</i>	57
A	<i>An inventory of continuous distributions</i>	17
B	<i>An inventory of discrete distributions</i>	8
C	<i>The simplex method</i>	3
D	<i>Frequency and severity relationships</i>	3
E	<i>Limited expected value calculations</i>	2

F	<i>The recursive formula</i>	2
G	<i>Discretization of the severity distribution</i>	4
H	<i>Simulation</i>	4
I	<i>Answers to selected exercises</i>	13

The treatment is rigorous throughout. Although some of the topics go well beyond what actuaries are likely to need in their practical work, there are many with which they ought to become familiar. The formulae and methods are illustrated by frequent numerical examples and at the end of each chapter after the first there are exercises for the reader to work through.

2 SOLVENCY

2.1

Daykin, C D et al 1984 JIA 111, 279	<i>The solvency of general insurance companies</i>	Type: Intro Tech level: Non Pages: 41 + 17
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This paper was prepared by a working party formed in 1982 following the publication that year of the Finnish report on Solvency of Insurers and Equalisation Reserves. It discusses the purposes of solvency margins and the need to relate the size of the statutory solvency margin requirement to the degree of caution expected in the level of technical reserves. The authors suggest that the required margin might be built up out of five independent components. Although thoughts on the most appropriate solvency regime have moved on since this paper was written, it remains a clear exposition of the principal factors that need to be taken into account.

2.2

Daykin, C D et al 1987 JIA 114, 227	<i>Assessing the solvency and financial strength of a general insurance company</i>	Type: Intro Tech level: Stan Pages: 84 + 15
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This paper follows on from the corresponding one in JIA 111 by describing the development of a comprehensive simulation model of a general insurance company, intended not simply for consideration of solvency but more generally to provide for the assessment of an insurer's financial strength. The paper itself, comprising 44 pages, includes examples of the results of simulations, while the technical details and more extensive numerical results are given in the 40 pages of appendices. The paper concludes by putting forward the case for requiring each general insurance company to have an appointed actuary responsible for reporting on the company's financial condition.

2.3

Hooker, N D et al 1996 BAJ 2, 265	<i>Risk-based capital in general insurance</i>	Type: Intro Tech level: Non Pages: 43 + 16
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The paper reviews the various types of risk that give rise to capital requirements for non-life insurers, and discusses the advantages and disadvantages of using a risk-based capital (RBC) formula to determine the capital requirements to be specified as part of the system for the control of solvency. The RBC formula that had then been recently introduced in the USA is used as a case

study, and brief reference is made to the proposals that had then just been made to introduce RBC at Lloyd's. Part of the background to the paper was the review being carried out of the solvency margin requirements in the EU. The paper also discusses the application of RBC concepts to the internal allocation of capital, to assist in measuring an insurer's rate of return to shareholders by business unit.

3 TECHNICAL PROVISIONS OR RESERVES

3.1

Various 1989/1997 IA & FA	<i>Claims reserving manual, Vol 1</i>	Type: Intro & Core Tech level: Non & Stan Pages: 302
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This textbook should be regarded as essential reading and an essential source of reference by any actuary working in general insurance. Volume 1 of the Manual is devoted to simple reserving methods. After a short introduction, it is divided into nine sections under the following headings:

- A *The insurance background*
- B *Data and forecasting*
- C *Company and external influences*
- D *Dimensions of choice*
- E *The projections of paid claims*
- F *Case estimates and the projection of incurred claims*
- G *Methods using loss ratio and loss ratio projections*
- H *Methods based on claim numbers and average cost per claim*
- I *Methods for IBNR*

3.2

Various 1989/1997 IA & FA	<i>Claims reserving manual, Vol 2</i>	Type: Core & Spec Tech level: Stan & Bey Pages: 110
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This volume of the Manual is devoted to more advanced methods of reserving than those given in Volume 1. It introduces the concept of stochastic modelling and focuses much more on the variability surrounding the estimates. The bulk of Volume 2 consists of papers by individual authors, as follows:

- | | | |
|----|----------------------------|--|
| 1 | B Zehnwirth | <i>The chain ladder technique - a stochastic model</i> |
| 2 | B Ajne | <i>Exponential run-off</i> |
| 3a | S Benjamin &
L M Eagles | <i>A curve fitting method</i> |
| 3b | S Benjamin &
L M Eagles | <i>A regression method</i> |
| 4 | D H Reid | <i>Reid's method</i> |
| 5 | S Christofides | <i>Regression models based on log-incremental payments</i> |

6	T Mack	<i>Measuring the variability of chain ladder reserve estimates</i>
7	T S Wright	<i>Probability distribution of outstanding liability from individual payments data</i>

A diskette is supplied with Volume 2, giving computerised illustrations of material in two of these papers.

Included in this volume are précis of a number of other actuarial papers on reserving.

3.3

Craighead, D H	<i>Techniques of reserving - the London Market</i>	Type: Core
1986		Tech level: Stan
JIA 113, 411		Pages: 47

This paper was written to introduce actuaries to working in the London Market in a reserving capacity. It provides assistance with the practical difficulties of applying known reserving methods to that market. Examples are given throughout to illustrate every point made and to emphasise difficulties that arise in practice. The Craighead modelling process is covered in some detail.

3.4

Wright, T S	<i>A stochastic method for claims reserving in general insurance</i>	Type: Spec
1990		Tech level: Bey
JIA 117, 677		Pages: 55

This paper sets out the details of a stochastic model designed to yield a best estimate and standard error of total claim payments for each year of origin.

A brief introduction leads into an examination of the mathematical structure of the model and a worked example follows. The plausibility of the assumptions underlying the method is discussed. The advantages claimed for the model are that it requires few assumptions and minimal data; the main limitation is the complexity of the method.

Because of its high technical content, the paper will be of most interest to those who are carrying out detailed research into stochastic models or who have time to spend on looking into different reserving methods.

3.5

Nye, R P et al	<i>Prudential margins</i>	Type: Intro
1993		Tech level: Non
GI Conv, 127		Pages: 23

This paper reviews the general philosophy underlying the concept of margins held within technical reserves, and goes on to consider why a margin may be needed, what might be regarded as an adequate margin, the influence of current regulations and the ways in which a margin may be expressed.

3.6

Czapiewski, C J W et al *Reserving for outwards reinsurance*
1993
GI Conv, 439

Type: Intro
Tech level: Non
Pages: 46

This paper reviews most of the forms of reinsurance protection that may be found in practice, and uses diagrams to illustrate how they operate and how they interact with one another. The topics covered include reinstatement premiums, variable covers (such as top and drops, middle and drops, cascades, stepdowns and shortfalls), franchises and warranties, and umbrella covers. The section on reserving outlines the methods that may be used to project future payments and estimate reinsurance recoveries, and lists their advantages and disadvantages. There is then a section on limitations of data, followed by a short discussion on allowing for lack of security of reinsurers. The paper ends with reference to some specific considerations that may need to be taken into account.

3.7

Craighead, D H *Reserving for catastrophe reinsurance*
1994
JIA 121, 135

Type: Intro
Tech level: Stan
Pages: 26

The paper describes an approach to the statistical estimating of the reserves required for catastrophe losses that have occurred. Although the paper is based on the author's experience in advising Lloyd's syndicates and London Market companies, the approach is relevant to any business where there is catastrophe exposure. Since every catastrophe has its own individual patterns of development of incurred claims and paid claims, it is necessary to deal with each one separately. The author favours representing the losses advised up to development time t by a double Gauss curve (described in his 1986 paper) with one term relating to short-tail losses and the other to long-tail losses. He draws attention to many practical features that need to be taken into account.

3.8

Lowe, J A *A practical guide to measuring reserve variability*
1994
GI Conv, 157

Type: Spec
Tech level: Bey
Pages: 40

This paper describes three possible approaches to the measurement of the variability of reserve estimates: bootstrapping, operational time and the distribution-free approach of T Mack. The author illustrates by means of a numerical example how bootstrapping can be applied to a development triangle in order to produce a variety of pseudo-data triangles and hence a corresponding variety of reserve estimates. The operational time approach of T Wright is based on the concept that whatever the average time to settlement of a group of liability claims may be, the longer a claim takes to be settled the larger it is likely to be. The method therefore uses a model of the settlement cost as a function of the relative proportion by number of the claims settled. The paper concludes with a brief description of the approach set out in full in Thomas Mack's paper published in the proceedings of the 1994 CAS Spring Forum and in Volume 2 of the *Claims Reserving Manual*.

3.9

Mack, T
1994
CAS Spring Forum, 101

Measuring the variability of chain ladder reserve estimates

Type: Spec
Tech level: Stan
Pages: 82

This paper, which also appears in Volume 2 of the *Claims Reserving Manual*, shows how the variability of chain ladder reserve estimates may be quantified without assuming any specific distribution function for the claims amounts. The author develops a formula giving an estimate of the standard deviation of the outstanding claims reserve and uses it to show how a confidence interval for the outstanding claims reserve and for the ultimate claims amount can be constructed. The paper itself, with its very clear exposition, occupies 37 pages, followed by 31 pages of mathematical appendices and 14 pages of diagrams.

3.10

Maher, G P M
1995
BAJ 1, 689

Loss reserves in the London Market

Type: Core
Tech level: Stan
Pages: 55 + 17

This paper, which places the emphasis on practice rather than theory, addresses the process of estimating the loss reserves required by an insurance company or Lloyd's syndicate writing business in the London Market. The author stresses the importance of having discussions with staff in the underwriting, claims handling and reinsurance departments with a view to understanding the business, and focuses on the arrangements needed for collection and verification of data rather than on the statistical techniques that might be applied.

3.11

Blanchard III, R S &
Marchen, E P
1995
JAP 3, 243

Sensitivity testing of property/casualty cash flows

Type: Core
Tech level: Stan
Pages: 25

The authors describe in general terms the property/casualty cash flow testing that had been developed over ten years for one US insurance company. They address the approaches taken for major categories of invested assets to reflect the prepayment/call risk and the default risk. They also discuss run-off of a non-invested asset that was significant for the company in question because of the type of business written, namely accrued retrospective premiums. Cash flows for loss reserves and other liabilities are only briefly touched on. Finally, the authors give some examples of presentation, to non-actuarial audiences, of nominal net cash flows, present value and internal rate of return.

3.12

Spore, L B
1998
CAS Summer Forum,
373

*Techniques for the conversion of loss
development factors*

Type: Spec
Tech level: Stan
Pages: 16

This fairly elementary paper describes the mathematical relationship between accident year and policy year development factors (depending on the assumption of when policies are written throughout the year). It thereby offers a method of estimating one set of factors from the other, which may be useful when data are available in only one of the two forms. The influence of changing exposures on accident year development is also discussed.

3.13

Tu, S T
1998
CAS Summer Forum,
389

*The application of cumulative distribution
functions in the stochastic chain ladder model*

Type: Spec
Tech level: Bey
Pages: 25

The author introduces an iterative method based on a stochastic model which introduces an innovation into the traditional chain ladder method by making explicit use of a cumulative distribution function to represent the payment pattern for each accident year. It incorporates a mathematical rationale for non-stochastic variations in the age-to-age factors, and provides an estimate of the variance of the ultimate loss in the form of the sum of the process and parameter errors. The so-called governing equation which is used to represent the loss factors includes a scaling function (which is shown to be necessary for an assumption of a normal distribution for the errors) and a proportionality function. The model is claimed to work well on historic paid losses for long-tailed lines of business, if a transformed lognormal distribution is used for the cumulative distribution function.

3.14

Czernuszewicz, A J et
al
1998
GI Conv, 119

Reserving and pricing for large claims

Type: Intro
Tech level: Non
Pages: 46

The paper is concerned mainly with large individual claims, but with occasional references to large aggregates of claims arising from a single event such as a natural catastrophe. The authors point out that the definition of "large" is arbitrary and the choice will depend on the purpose in hand. The process of making case estimates of potentially large individual claims is illustrated by reference to a motor insurance claim involving bodily injury. The paper discusses the making of implicit or explicit allowance for large claims when calculating IBNR reserves, and goes on to refer briefly to the estimation of reinsurance recoveries. There follows a discussion of top-slicing and other ways of seeking to reduce the distorting effect of individual large claims when analysing the claims experience for the purpose of pricing. At the end there is a reading list on large claims and catastrophes.

3.15

Dew, E D & Hedges, B W
1997
CAS Summer Forum, 1, 39

Reserving for excess layers: a guide to practical reserving applications

Type: Intro
Tech level: Stan
Pages: 57

The paper is in three sections. The first gives a clear exposition of commonly used techniques, classified under five headings, for reserving for excess layers and provides practical spreadsheet examples. Section II presents a simulation procedure that uses computing power to develop a range of potential costs for the layer of coverage. Section III applies the methods from the first two sections to a common set of data and retrospectively tests the performance of each method.

3.16

Blum, K A & Otto, D J
1998
CAS Fall Forum, 55

Best estimate loss reserving: an actuarial perspective

Type: Intro
Tech level: Non
Pages: 47

The authors advocate the adoption of agreed clear and consistent terminology to communicate the results of actuarial analyses, with particular reference to that used for actuarial opinions on loss reserves. They point out the dangers inherent in the use of a single figure to serve different purposes, and go on to focus on the interpretation of the term *best estimate* which appears in various regulations and guidelines as well as in many actuarial papers, along with other terms such as *adequacy*, *conservative*, *reasonable provision*, *most likely circumstances* and *fair and reasonable estimate*. They suggest the use of the terms *best estimate expected value of unpaid losses* and *best estimate loss reserve* and propose a definition of each of them. The first appendix illustrates the advantages of the mean over both the median and the mode, and the second summarises the regulations and guidelines in the form of statutory accounting principles in the USA, generally accepted accounting principles, guidelines of the Securities and Exchange Commission and the code and regulations of the Inland Revenue Service.

3.17

Lommerle, J A & McCarter, M G
1998
CAS Fall Forum, 211

Is the "best estimate" best? Issues in recording a liability for unpaid claims, unpaid losses and loss adjustment expenses

Type: Intro
Tech level: Non
Pages: 17

These authors, like Blum and Otto, are concerned about the need for clarification of the concept of *best estimate*. They suggest that there will be scope for confusion between the term *reasonable provision* used in the Statement of Actuarial Opinion and the term *management's best estimate* used in Statement of Statutory Accounting Principles No. 55.

3.18

Patel, C C &
Raws III, A
1998

*Statistical modeling techniques for reserve
ranges: a simulation approach*

Type: Intro
Tech level: Stan
Pages: 27

CAS Fall Forum, 229

The authors suggest techniques for combining actuarial judgement and statistical simulation to generate a range of technical reserves. They illustrate their approach by using four families of continuous distributions (uniform, triangular, normal and lognormal) and give results of applying them to three companies with diverse portfolios.

3.19

Gluck, S M
1997
PCAS 84, 482

*Balancing development and trend in loss reserve
analysis*

Type: Core
Tech level: Stan
Pages: 51

The process of loss reserving, using the traditional form of loss development triangle, can be regarded as the projection of the loss development for each year of origin, allowing for trends in the relationship between amounts for different years of origin. The author sets out to present methods that simultaneously reflect development and trend in a unified approach, reasonably reflecting the relative accuracy of the two types of projection. The methods covered are Bornhuetter-Ferguson, Cape Cod and two generalisations of Cape Cod, called the decay factor approach and the adaptive variance approach. The paper itself discusses the intuitive reasonableness of the methods and gives clear numerical examples, while the mathematical features are consigned to appendices.

3.20

Struzzieri, P J
& Hussian, P R
1998

*Using best practices to determine a best reserve
estimate*

Type: Core
Tech level: Stan
Pages: 61

CAS Fall Forum, 353

The authors propose a set of “best practices” for actuaries to follow if they are to arrive at what may justifiably be termed a “best estimate” of reserves for losses and loss adjustment expenses. Much of the discussion relates to the practices to be followed in respect of the methods described in the paper by Gluck (reference 3.19). An appendix refers to best practices when the data are inconsistent and may need to be adjusted to remove distortions.

3.21

Taylor, G C
2000
Kluwer

Loss reserving: an actuarial perspective

Type: Core
Tech level: Stan
Pages: 397

This textbook covers the main concepts and techniques that have been applied in loss reserving. It consists of five chapters on deterministic models and seven on stochastic models:

Deterministic Models

- 1 *Basic concepts*
- 2 *Claim counts*
- 3 *Claim amounts – simple models*
- 4 *Claim amounts – other deterministic models*
- 5 *Combination of deterministic estimates of liability*

Stochastic Models

- 6 *Stochastic techniques*
- 7 *Stochastic chain ladder*
- 8 *Stochastic models with a GLM basis*
- 9 *Credibility models*
- 10 *Kalman filter*
- 11 *Bootstrap*
- 12 *Final estimates of liability*

The opening chapter introduces the reader to the basic concepts and also to the author's notation, which is summarised in Appendix A. The methods are illustrated by numerical examples, most of which are based on a single set of data, given in Appendix B.

The first five chapters are straightforward and should be well within the capacity of all actuaries. The mathematical level of the later chapters is more demanding, and while trying to absorb the technical details the reader will need to keep in mind the limitations that apply to the manipulation of any data derived from the results of human decisions and activity.

The book as a whole provides a comprehensive guide to available techniques, from which the actuary can select those that seem appropriate having regard to the range and quality of the data and to responses to enquiries as to factors that may have led to unusual features in the data.

3.22

Archer-Lock, P R
et al
1999
GI Conv, Vol 1, 387

Reserving for unknown liabilities

Type: Intro
Tech level: Non
Pages: 55

The authors give examples of unknown liabilities that have emerged in the past and divide them into categories for later discussion. After reviewing the causes and the processes by which the claims emerge, they discuss the philosophy underlying the reserving for such claims and the ways in which this will depend on the purpose for which the reserves are required: Companies Act accounts, statutory returns, tax returns, internal management accounts or mergers and acquisitions. They then outline the available methodologies for reserving for unknown liabilities. They end with a discussion of the extent to which insurers may attempt to exercise some control over the future emergence of unknown liabilities. The paper as a whole provides a check-list of points that actuaries engaged in the reserving process may need to consider in respect of unknown liabilities.

3.23

Mack, T
2000
AB 30, 333

Credible claims reserves: the Benktander Method

Type: Core
Tech level: Stan
Pages: 15

The author describes and analyses a claims reserving method first suggested by Gunnar Benktander in 1976 and independently arrived at subsequently by other actuaries. The method can be regarded as a credibility mixture of the Bornhuetter-Ferguson and chain ladder methods, in which the credibility factors have an intuitive appeal as a means of giving increasing weight to the chain ladder estimates, and correspondingly decreasing weight to the Bornhuetter-Ferguson estimates, as we go from one development year to the next. The author points out that estimates given by the Benktander method will have a smaller variance than those given by either the Bornhuetter-Ferguson or the chain ladder method, and advises actuaries to include the Benktander method in their standard reserving methods.

3.24

Conger, R F &
Grove, R L
2001
CAS Fall Forum, 1

The value of interacting with the claim department

Type: Intro
Tech level: Non
Pages: 42

The paper describes and illustrates important benefits, to both parties, of regular interaction between casualty actuaries and claim department personnel. Examples are given of circumstances in which qualitative and quantitative input from the claim department can be critical in helping the actuary to understand, interpret and sometimes anticipate changes that affect the data and actuarial projections. The authors go on to illustrate how the actuary may be able to help the claim department and the management of the company by identifying features that indicate that some action may be required.

4 FINANCIAL CONTROL

4.1

Daykin, C D & Hey, G B
1990
JIA 117, 173

Managing uncertainty in a general insurance company

Type: Spec
Tech level: Stan
Pages: 87 + 18

This substantial but readable paper was developed from several earlier papers that stemmed from the formation in 1982 of the Solvency Working Party of the General Insurance Study Group. It describes in considerable detail a computer simulation model for general insurance business. The discussion on the paper is also extensive and at times critical. Both the paper and the discussion provide useful reading for anyone wishing to model the business of a general insurer.

4.2

Ryan, J P & Larnar, K P W
1990
JIA 117, 5

The valuation of general insurance companies

Type: Intro
Tech level: Non
Pages: 55 + 18

The authors propose a theoretical framework for the valuation of a general insurance company, based on an appraised value equal to the sum of the present values of future earnings at what is deemed to be an appropriate risk discount rate. The paper includes numerical examples and suggestions as to how appraised values might be used. The discussion covers several points of interest regarding the principles underlying the appraised value approach and the practical difficulties in its application and presentation.

4.3

Hodes, D M et al
1996
CAS Spring Forum, 3

The financial modeling of property/casualty insurance companies

Type: Intro
Tech level: Non
Pages: 86

This paper describes a financial model developed for and used by a large US multi-line insurer. The model uses a cash-flow approach on the lines of that developed by the British solvency working party. Emphasis is placed on the practical application of the model and the authors provide numerical examples of input to and output from the model for the types of underwriting, financial operations and time periods that it caters for. The paper will form useful background reading for anyone developing a model of general insurance business.

4.4

Lowe, S P & Stanard, J N
1996
CAS Spring Forum, 89

An integrated dynamic financial analysis and decision support system for a property catastrophe reinsurer

Type: Intro
Tech level: Non
Pages: 30

This paper describes a dynamic financial analysis (DFA) model used by a property catastrophe reinsurer based in Bermuda. The authors begin by classifying and discussing the risks that are faced by an insurance enterprise and need to be considered when designing a DFA model. They conclude by giving some numerical examples of the output produced by the model.

4.5

Christofides S et al 1996 GI Conv, 55	<i>GISMO - General Insurance Stochastic Model Office</i>	Type: Intro Tech level: Stan Pages: 44
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This very readable paper describes a stochastic cash flow model designed as a management tool to indicate the variability in key accounting figures under different scenarios. The authors discuss the nature of risk and uncertainty, the concept of exposure and the relationship of these to management objectives. They go on to describe the structure of the model and set out the simplifying assumptions that were made, and end by reviewing the types of management decision for which the model may be helpful.

4.6

D'Arcy, P et al 1998 CAS Summer Forum, 53	<i>Using the public access DFA model: a case study</i>	Type: Spec Tech level: Bey Pages: 66
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The paper describes the application to an actual insurance company of a publicly available dynamic financial analysis (DFA) model for general insurance. The broad approach, with some characteristics of the model, is set out in some 20 pages, while an appendix gives the report to management (with appropriate caveats regarding the use of DFA models) in eight pages of text and 37 pages of exhibits.

4.7

Patrik, G S et al 1999 CAS Spring Forum, 243	<i>The use of risk adjusted capital to support business decision-making</i>	Type: Core Tech level: Stan Pages: 92
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The paper starts with a discussion of how to define and then to measure the capital a company has (its risk bearing capital) and the capital it needs (referred to as its risk adjusted capital). The latter is intended to reflect the types of business that the company transacts and its management objectives, and the authors stress the importance of using models that are simple enough to be readily understood. The risks are discussed under the three main headings of underwriting, investment and credit risks, with particular reference under the first of these to the modelling of catastrophes, both natural and man-made. There follows a discussion of the desirable properties of methods of allocating the risk adjusted capital to sub-portfolios, and of the ways in which the results may be used in making business decisions.

4.8

Cumberworth, M P et al 1999 BAJ 6, 259	<i>Corporate decisions in general insurance beyond the frontier</i>	Type: Intro Tech level: Non Pages: 19 + 19
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The authors discuss the possible advantages of using a stochastic simulation model, by what is known as dynamic financial analysis (DFA) or asset/liability modelling, as an aid to making financial decisions. The arguments are illustrated by reference to a hypothetical example concerned with the

assessment of the benefits that may stem from diversification into different classes of general insurance business. The authors discuss the relationship between risk and the cost of capital, and suggest that DFA may help in answering such questions as how much capital is needed to run the business, how much reinsurance should be bought, what dividends should be paid, and how the answers may change if the mix of business is changed. Both in the paper and in the discussion there are references to the practical limitations and to the often conflicting aims of shareholders, managers and customers.

4.9

Emma, C C et al 2000 CAS Winter Forum, 317	<i>Dynamic financial models of property-casualty insurers</i>	Type: Intro Tech level: Non Pages: 31
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This short paper by the Dynamic Financial Analysis Committee of the Casualty Actuarial Society provides guidance on broad issues that confront actuaries when designing, building or selecting a dynamic financial model of property-casualty risks. After an introduction which mentions early references to dynamic financial analysis (DFA) in an industrial context in the 1960s, the paper focuses on the application of DFA to insurance, under the following headings:

- Uses, users and resources
- Types of models and the considerations for choosing between them
- Risks facing a property-casualty insurer, classified as asset risks, obligation risks, interest rate risks and mismanagement risks
- Risks inherent in the modelling process
- Measuring results, including consideration of the various possible forms of output

An appendix to the paper gives a short but useful checklist of considerations.

4.10

Mango, D F & Mulvey, J M 2000 CAS Summer Forum, 55	<i>Capital adequacy and allocation using dynamic financial analysis</i>	Type: Intro Tech level: Non Pages: 21
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This clear and concise paper is based on the authors' experiences in using dynamic financial analysis to review overall capital adequacy and capital allocation between operating divisions within an insurance company.

The authors discuss the relative merits of four measures of risk: probability of ruin, variance or standard deviation of surplus, expected policyholder deficit and "expected default loss rate on surplus", the last of these being a measure proposed by Mango in an earlier paper. This review is followed by comments on selecting an appropriate standard for the chosen risk measure (e.g. the basis for assessing capital adequacy, the time horizon and the acceptable level of probability). A table illustrates how the capital requirements depend on these decisions. There follows an explanation of how the use of the variance as the risk measure, combined with an allocation scheme based on the Shapley value (named after an early leader in game theory) leads to manageable calculations and results that have desirable characteristics.

The authors stress the importance of the process of communicating the results and the potential value of comments from people who may be unfamiliar with DFA techniques but have extensive knowledge and experience of the business.

4.11

Wiesner, E R
& Emma, C C
2000
CAS Summer Forum,
79

*A dynamic financial analysis application linked to
corporate strategy*

Type: Intro
Tech level: Non
Pages: 26

This short paper describes a strategic review carried out for a workers' compensation insurer using dynamic financial analysis (DFA). The paper describes how those carrying out the review worked closely with senior executives to identify:

- the strategic goals (those chosen in this case being long-term return on equity, stability in returns, and longevity of the company);
- the corresponding business measures;
- the available strategic options (those chosen being business as usual, geographical expansion or diversification across lines of business); and
- the scenarios against which the different strategies should be tested (in this case, the expected level and a pessimistic level).

Great stress is placed on the use of DFA as a tool and not a goal in its own right, as well as the challenge in managing the large quantities of data that such models generate. The value of "extreme" simulation results is also highlighted and some useful specimen outputs are included in appendices. The paper encourages practitioners to work closely with business users to achieve an effective communication of the results and consequences of DFA exercises.

4.12

Ryan, J P et al
2002
BAJ 7, 519

Financial condition assessment

Type: Intro
Tech level: Non
Pages: 66 + 19

This paper sets out a framework and approach for assessing the capital adequacy of a non-life insurer. It is set against the background of recent guidance on the disclosure of risks (primarily in the interests of shareholders) by listed companies in general and the rules proposed by the Financial Services Authority (primarily in the interests of policyholders) relating to the prudential management of UK regulated insurance companies.

The authors consider the contribution that actuaries could make towards a Financial Condition Assessment (FCA) of a non-life insurance company, which they visualise would require a multi-disciplinary team because of the wide range of risks that would need to be considered.

A structure for the investigation is proposed, working through a process of risk identification, individual risk assessment and then combining these results to arrive at a combined view of the overall risks faced by the insurer. The "risk co-ordinator" is identified as a key function to which

actuaries would be ideally suited.

The paper follows the structure of the investigation process and finishes with a discussion of professional issues arising from the FCA proposals.

There are 30 pages of appendices that include:

- a discussion of the legal framework, together with reference to systems operating in other countries
- a classification of types of risk, with an indication of those susceptible to assessment by actuaries
- a summary of techniques for determining aggregate capital requirements
- an example FCA, followed by an indication of the extent of the work required to prepare an FCA in different circumstances
- suggested positions for the risk co-ordination role within a stand-alone or group company structure.

5 ASSET/LIABILITY MODELLING

5.1

Correnti, S & Sweeney, J C 1994 AFIR 4, 907	<i>Asset-liability management and asset allocation for property and casualty companies - the final frontier</i>	Type: Intro Tech level: Non Pages: 12
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This short paper provides an overview of the asset-liability modelling process which was adopted by one US insurance company and referred to as the Asset-Liability Management Efficient Frontier (ALMEF). The paper describes briefly the five-step process: balance sheet evaluation (considering the “ongoing nature” of the business), capital market evaluation (using a stochastic economic simulation model), surplus optimisation (non-linear), sensitivity testing (of key asset, liability and capital market factors) and performance measurement. For the balance sheet evaluation the assumed rate of renewal is critical in determining the duration of the liabilities. The purpose of the ALMEF model is to improve investment decision making by developing a prospective investment policy based on not only the liability profile for the existing balance sheet but also how the balance sheet will look going forward.

5.2

Smith, A D 1995 GI Conv, 311	<i>Stochastic asset models</i>	Type: Spec Tech level: Bey Pages: 77
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The paper was prepared as the basis for a workshop presentation at the convention, at which the author’s objective was to provide working examples of the main approaches to stochastic asset modelling. The paper is in two sections, the first outlining the philosophies underlying the various models and the second setting out criteria for judging which of the models may be the best for a particular application. Technical specifications of the models are set out in appendices.

number of rating classes, presumably with the aim of avoiding sharp differentiation between adjacent areas.

6.5

Zehnwirth, B 1994 CAS Winter Forum, 615	<i>Ratemaking: from Bailey and Simon (1960) to generalised linear regression models</i>	Type: Spec Tech level: Bey Pages: 45
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The author reviews the concept of regression modelling for the purpose of ratemaking, starting with very simple examples and proceeding to the stage of generalised linear models, setting out the generalisations or extensions that have been made of the Normal based linear regression models.

6.6

Lemaire, J 1998 NAAJ, 2, 1, 26	<i>Bonus-malus systems: the European and Asian approach to merit-rating</i>	Type: Intro Tech level: None Pages: 13 + 9
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The paper describes the characteristics of bonus-malus systems and gives some indication of the diversity of the systems in use around the world. It deals largely with countries in which there is, or has been, a single bonus-malus system operated throughout the insurance market, sometimes in conjunction with a *a priori* rating based on only a few rating factors. It does not give any examples derived from the United Kingdom with its long experience of virtually complete freedom in rating and the resultant diversity of both a *a priori* and bonus-malus (no-claim discount) systems. Using examples of systems in five countries, the author explores the effects of bonus-malus systems on the variability of the premiums, and goes on to consider the strategy to be adopted by a policyholder in deciding whether or not to claim. The paper is followed by two contributions by other authors, under the heading *Discussions*, on particular features of bonus-malus systems.

6.7

Francis, L 2001 CAS Winter Forum, 253	<i>Neural networks demystified</i>	Type: Intro Tech level: Stan Pages: 67
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This introductory paper begins with a clear definition and description of neural networks. Stress is placed on the importance of obtaining large data sets, not least to support testing after training the network, and detailed information is provided on the “threshold” or “activation” functions that lie at the core of a neural network. Good use is made of illustrative examples, based on synthesised data that can be checked against the inferred model fits, comparing results with those derived using more traditional techniques.

Neural networks are presented as universal function approximators. Superior performance is claimed in fitting non-linear data (or where there are no transformations that might reduce such data to a linear form), in reducing the dimensionality of data where correlated variables are involved, in dealing with interactions and where data are messy. The later sections of the paper provide comments and illustrations on techniques that can be used to interpret and visualise the implicit model within a neural network, countering the widely held impression that neural networks are a “black box” because the available software typically does not supply the user with information about the nature of the relationship between predictor and target variables.

7 PREMIUM RATING: COMMERCIAL LINES

7.1

Sanders, D E A et al *UK environmental pollution* Type: Intro
1993 Tech level: Non
GI Conv, 581 Pages: 26

The paper charts the history of insurance cover for environmental pollution and the way in which companies and their insurers have become increasingly at risk of incurring substantial claims for pollution-related liabilities. After insurers had responded by introducing exclusion clauses there evolved in the 1990s new types of policy designed to cover environmental liabilities only, so that they might be used to complement general public liability policies containing pollution exclusions. These Environmental Impairment Liability (EIL) insurance policies are described, with particular reference to the exclusions that they themselves contain. The authors go on to discuss some legal issues and also the potential effect of pollution on property values.

7.2

Sanders, D E A et al *Disease and employer's liability insurance* Type: Intro
1994 Tech level: Non
GI Conv, 323 Pages: 45

The paper illustrates, by reference to three examples, namely upper limb disorders, deafness and stress, how the pattern of claims for industrial diseases can be influenced by prevailing fashions. It then goes on to discuss briefly how these features need to be allowed for in reserving, pricing and accounting, and the desirability of ensuring that employers operate effective systems of risk management.

7.3

Sanders, D E A *Liability insurance and pollution* Type: Intro
1995 Tech level: Non
TICA 4, 59 Pages: 30

In this paper, which follows on from the papers presented at the general insurance conventions in 1993 and 1994, the author gives a comprehensive review of pollution cover available in the UK and the often conflicting interests of the various parties. He describes environmental impairment liability insurance and its limitations, and also the development of environmental remediation insurance.

7.4

Michaelides, N et al *Premium rating of commercial risks* Type: Intro
1997 Tech level: Non
GI Conv, 397 Pages: 97

This paper provides an introductory survey of the problems of pricing commercial risks. It proposes a broad classification of risks according to size (small, medium, large) and type of cover (liability, property, motor) and goes on to discuss the extent to which the premiums should be affected by the past claims experience of the particular risk - with regard to both the relatively small (or attritional) claims and the (suitably defined) large claims - and hence the blending of book and experience rating. Appendices set out specific features of commercial motor, commercial property and liability

insurance, and provide details on the recording of claims experience, data sets that may be useful, and captive insurers.

7.5

Weltmann, L N
& Muhonen, D
2001

Extended warranty ratemaking

Type: Core
Tech level: Stan
Pages: 29

CAS Winter Forum, 187

The paper describes various types of extended warranty contract that have evolved in the USA, ranging from vehicle service contracts where there will usually be a fair volume of historical data available but adjustments may be needed to allow for changes that have occurred, to new kinds of warranty where there will be no relevant historical data. The authors give numerical examples to illustrate methods that may be used, and draw attention to possible pitfalls including those associated with moral hazards and conflicts of interest.

8 PREMIUM RATING: COVER FOR CATASTROPHES

8.1

Christofides, S et al
1992
GI Conv, 5

Storm rating in the nineties

Type: Intro
Tech level: Stan
Pages: 85

This paper, prepared in the aftermath of the severe storms affecting the UK in 1987 and 1990, outlines the causes of storms and considers the evidence for increases in their frequency and severity. Data on UK storm losses from 1920 to 1970 are used to construct a model using a Poisson distribution for frequency and a composite distribution with a Pareto tail for severity. There follows a discussion on the use of such a model for rating and reinsurance.

8.2

Gogol, D F
1994
PCAS 81, 1

An actuarial approach to property catastrophe insurance ratemaking

Type: Core
Tech level: Stan
Pages: 35

This paper, which was awarded the 1994 Dorweiler Prize (for original research and the solution of an advanced insurance problem), describes a model for rating catastrophe covers for insurers in any region of the continental United States.

Smooth surfaces are fitted to the data by region (using four parameters: the area of the region; the distance from the coast; the latitude; and the longitude of the midpoint of each region), and experience rating is applied in an attempt to give appropriate weight to regional departures from the smoothed results. Severity distributions and frequencies are estimated for each region and a method of applying them in pricing catastrophe covers is discussed. The author also presents a method for using the experience of an insurer to produce an experience modification.

8.3

Hays, D H &
Farris, W S
1994

*Pricing the catastrophe exposure in property
insurance ratemaking*

Type: Core
Tech level: Stan
Pages: 44

CAS Winter Forum, 485

This paper, which updates and expands upon a paper presented by the authors in 1990, describes how provision may be made for catastrophes, at the statewide level and to some extent by areas within a state, when setting premiums for homeowners' insurance in the USA. It is explained how the catastrophe losses of an individual state are capped prior to calculating the state's catastrophe provision, so that the losses that exceed the cap can be spread over either a group of states or the country as a whole. There is a short section on catastrophe provision for lines of business other than homeowners'.

8.4

Kozlowski, R T &
Mathewson, S B
1995
JAP 3, 211

Measuring and managing catastrophe risk

Type: Intro
Tech level: Stan
Pages: 31

The authors provide a highly readable, basic discussion of catastrophe modelling, starting with a brief history of the insuring of catastrophes, moving on to a description of consequential exposure data and the insufficiency of many companies' collections of such data, and then to catastrophe modelling itself. Three 'modules' of catastrophe simulation modelling are identified: the science module (eg meteorology), the engineering module (eg building structure) and the insurance module (eg coverage limitations). Control of concentration of catastrophe exposures is discussed, and reinsurance implications are touched upon including the limitations of market share analyses.

8.5

Hartington, A W et al
1997
GI Conv, 209

Catastrophe modelling

Type: Intro
Tech level: Non
Pages: 90

In the short introduction to the paper, the authors review the trend in catastrophes in recent decades and discuss the factors that may have influenced the developments in both total losses and insured losses. In the following section they review the scientific issues (atmospheric, geophysical and extraterrestrial) associated with natural sudden-onset catastrophes and discuss steps that might be taken to mitigate losses. In the third and final section they consider the insurance issues, with a discussion of modelling and its advantages and disadvantages, a description of practical aspects of underwriting catastrophe exposures and an outline of some simple methods used in rating.

8.6

Rootzén, H &
Tajvidi, N
1997
SAJ 1, 70

Extreme value statistics and wind storm losses

Type: Spec
Tech level: Bey
Pages: 25

The authors review the current state of the statistical theory of extreme values and give an example of how it may be applied in large claims insurance, using data relating to wind storm losses. They use a peaks over thresholds model in which the losses that are larger than a chosen excess level occur as a Poisson process and the amounts by which the losses exceed the excess level follow a generalised Pareto distribution. They discuss the estimation of the parameters and quantiles in the model, and also the choice between the Pareto and lognormal distributions. They go on to consider the possible allowance for trends associated with climatic changes, and the feasibility of improving the precision of the risk estimates by using meteorological information.

9 SPECIFIC CLASSES OF BUSINESS

9.1

Orros, G C &
Webber, J M
1988
JIA 115, 169

Medical expenses insurance - an actuarial review

Type: Intro
Tech level: Stan
Pages: 85 + 16

In this paper, the first on medical expenses insurance to be presented at a sessional meeting of the Institute, the authors begin by giving the historical background to the evolution of this business in the UK. Medical expenses insurance, which is technically classified as a form of general insurance business although it has some characteristics of long term business, is intended to provide indemnity cover for the recovery of costs incurred in the private treatment of acute medical conditions. The features of the four main purchase categories, or plans (individual purchase, affinity group, voluntary group and company paid), are described. The authors go on to discuss risk characteristics, the effect of selection, and the usual actuarial topics of reserving and pricing, including experience rating.

9.2

Akers, P J et al
1992
GI Conv, 139

Mortgage indemnity guarantee

Type: Intro
Tech level: Stan
Pages: 88

The 88 pages are roughly equally divided between paper and appendices. The insurance companies that transacted large volumes of mortgage indemnity guarantee business had incurred huge losses in the early 1990s as a consequence of an unprecedented combination of adverse economic conditions, and the paper was written against this background. The authors describe their attempts to develop models that might help in making realistic estimates of technical reserves and in premium rating.

9.3

Taylor, G C
1993
AB 23, 287

The incidence of risk under credit insurance

Type: Intro
Tech level: Stan
Pages: 13

The form of credit insurance discussed provides coverage against sickness or accident, and/or unemployment, for insureds who are subject to obligations to repay credit advances by means of periodic instalments. The author discusses the modelling of the incidence of risk over the term of such policies, to enable the earning of the (usually single) premium to be appropriately spread.

9.4

Taylor, G C
1994
AB 24, 97

*Modelling mortgage insurance claims experience:
a case study*

Type: Intro
Tech level: Stan
Pages: 33

The author describes the development of a model, based on experience in Australia in the 1980s, of claims experience on mortgage indemnity guarantee insurance. The factors used include a home affordability index, a housing price index and the loan to valuation ratio. It is not obvious how successful a model on those lines would have been in predicting the scale of the claims experienced in the UK in the early 1990s.

9.5

Malde, S et al
1994
GI Conv, 467

Marine insurance

Type: Intro
Tech level: Non
Pages: 64

This paper provides background information on the London marine insurance market and goes on to describe the four main classes of business, namely Hull, Cargo & Specie, Liability and Energy. Attention is drawn to aspects in which an actuarial approach may be particularly helpful - not only reserving but also rating, the monitoring of exposures, the collection and management of relevant data, the devising of reinsurance programmes, the design of management reporting systems and the modelling of different scenarios.

9.6

Bolton, C G et al
1995
GI Conv, 43

Household insurance

Type: Intro
Tech level: Non
Pages: 31

The paper dealt with two types of claim: flood and subsidence, and looked at the extent to which the premiums being charged for household buildings insurance appeared to have been adjusted to reflect the latest information about the geographical variation in each of those risks. Comparisons were made between two studies that had recently been made of the risks of coastal flooding, one by Halcrow and the other by Greig Fester, and attention was drawn to the limitations of each of the two approaches. An attempt was made to estimate the relationship between movements in sales and purchases of houses and subsequent reporting of claims for subsidence.

9.7

Lyons, G E et al
1995
GI Conv, 237

Aviation

Type: Intro
Tech level: Non
Pages: 10

This short paper provided a basis for a workshop session at the Convention. It gives an outline of the aviation insurance market and the market associations, and indicates the types of risk that are covered.

9.8

Lyons, G E
1996
GI Conv, 385

Aviation underwriting

Type: Intro
Tech level: Non
Pages: 30

This paper, like that of the previous year, was prepared as background for a workshop presentation. It identifies the classes of aviation business, includes a description of how the business is written, briefly indicates the type of information that will be available to the underwriter, sets out the rating factors used for hull and liability, and indicates the approach adopted for the rating of excess of loss reinsurance treaties. The paper also includes miscellaneous topics such as space risks and commercial satellite insurance.

9.9

Charles, J M et al
1996
GI Conv, 99

The future of the motor insurance market

Type: Intro
Tech level: Non
Pages:42

This paper focuses on the private motor insurance market in the UK and discusses the prospects for each of the main distribution channels, the future of direct marketing in particular, trends in profitability and in the factors affecting claim costs, developments in underwriting, and the potential for using new techniques to refine the process of relative pricing.

9.10

Winter, R D et al
1997
GI Conv, 337

UK household business

Type: Intro
Tech level: Non
Pages: 60

The paper reviews features of the household insurance market in 1997, a time of strong competition based largely on pricing and methods of distribution rather than on product differentiation, although there were signs of a trend towards wider policy coverage. It describes the trend towards finer risk classification, based primarily on the use of first the postcode district and then the postcode sector, in an attempt to cater for variations in the risk of theft, subsidence and flood. Insurers were increasingly experimenting in the use of externally available geophysical and geodemographic systems of risk assessment, to construct models of the levels of risk associated with the various postcodes. An appendix to the paper gives a detailed description of the system of postcodes and draws attention to practical implications of using postcodes for rating household insurance business.

9.11

Winter, R D,
Jones, S M &
Williams, N P
1998

UK household business

Type: Intro
Tech level: Non
Pages: 64

GI Conv Vol 1, 287

This sequel to the 1997 paper reviews the experience of the intervening 12 months and sets out in an appendix the updated results of a survey of proprietary geophysical and geodemographic risk assessment systems. The paper includes a discussion of the extent to which, as a consequence of more sophisticated systems of risk assessment and premium rating, increasing numbers of people will find that they can no longer obtain insurance cover at a price they can afford. The authors suggest that this does not constitute a significant problem for buildings insurance but does in the case of contents insurance in some areas, where some ingenuity is called for in designing a profitable product at an affordable price.

9.12

Ellis, P A et al
1999

Bodily injury claims

Type: Intro
Tech level: Non
Pages:97

GI Conv Vol 1, 75

The paper provides an introduction to the subject of bodily injury claims. After 20 pages setting out the legal principles that apply in England and Wales, the authors review current legal developments, including those relating to the Ogden tables, structured settlements, the Woolf reforms, the Compensation Recovery Scheme, hospital charges, the mechanisms for funding legal action, recommendations for reforms relating to general damages, and changes in the attitude of society towards the justification for making various kinds of claim. They go on to discuss pricing and reserving for bodily injury claims by both insurers and reinsurers. The paper ends with summaries of some legal cases.

9.13

Charles, J M et al
2000
GI Conv, Vol 1, 149

Structured settlements

Type: Intro
Tech level: Non
Pages: 48

This paper was prepared by a working party to follow up, in relation to structured settlements, the paper presented by Ellis et al at the GI convention in 1999. It reviews the advantages of structured settlements over lump sum awards for the larger claims for personal injury, and supports the suggestion that courts in the UK should be given the power to impose structured settlements in appropriate circumstances. Notes are provided on the practices adopted in the USA, New South Wales and some European countries. The appendices include extracts from the judgement of the House of Lords in 1998 in the case of Wells versus Wells and two similar cases, and the response submitted in 2000 by the Faculty and Institute of Actuaries to the Lord Chancellor's Department's consultation paper on damages.

9.14

Gibbs, J R,
Williams, N P et al
2000
GI Conv, Vol 1, 353

Employers' liability insurance

Type: Intro
Tech level: Non
Pages: 59

This paper updates the one presented by Michaelides et al at the GI convention in 1990. It covers the legal and contractual framework to employers' liability insurance in the UK, provides an overview of the UK market, discusses the main types of claim and the methods used for reserving for injury and disease claims, and reviews some current and potential issues relating to the employers' liability market. An appendix gives claims run-off patterns for sixteen UK insurance companies.

9.15

Harding, R J et al
2000
GI Conv, Vol 1, 415

The aviation and space insurance market

Type: Intro
Tech level: Non
Pages: 52

This paper gives a clear description of the aviation and space insurance market and the types of insurance cover that it provides. The aviation market is reviewed under five sections: airline insurance (hull and liability), airline insurance (hull war), product liability, general aviation, and miscellaneous covers, followed by a section on current issues in the aviation market at the time the paper was written. After a section on space insurance the authors discuss a number of features of the aviation and space market and give information on premium income and loss ratios in the 1990s. Readers will be able to judge for themselves the potential magnitude of the effects of the events of 11 September 2001 on the aviation insurance market.

10 REINSURANCE AND ALTERNATIVE RISK TRANSFER

10.1

Carter, R L
1995
RPG

Reinsurance (3rd ed)

Type: Intro
Tech level: Non
Pages: 790

This textbook, not designed for an actuarial readership, ranges widely over the practical features of reinsurance and may form a useful reference source for actuaries who have had only limited direct experience of reinsurance business.

10.2

Craighead, D H
1993
JIA 120, 311

Financial reinsurance

Type: Intro
Tech level: Stan
Pages: 56 + 14

The paper, which was largely derived from a document that had been prepared by a working party for a discussion meeting held by the Institute of Actuaries in February 1993, is followed by an abstract of the discussion at that meeting. It seeks to define and explain financial reinsurance and provides criteria for assessing the degree of risk transfer and its associated limitations. The author sets out criteria for estimation of technical reserves from the points of view of both insurers and

reinsurers, and goes on to discuss accounting and regulatory implications. Contracts in use at the time (time and distance, loss portfolio transfers and spread loss) are described and an example is given of stochastic modelling of a spread loss contract.

10.3

Sanders, D E A
1995
CAS Forum, 157

*When the wind blows: an introduction to
catastrophe excess of loss reinsurance*

Type: Intro
Tech level: Non
Pages: 72

The author begins with a brief outline of the system of placing catastrophe excess of loss reinsurance business and continues with a description of the retrocession market and the London Market Excess of Loss (LMX) spiral. He then outlines the three approaches to rating of catastrophe covers (simulation, burning cost, and exposure rating), reserving for catastrophes (with development graphs of the four biggest catastrophes of 1989) and his views on the future of the catastrophe reinsurance market. Graphs comprise some two-thirds of the paper.

10.4

Hooker, N D et al
1996
GI Conv, 339

Outward reinsurance

Type: Intro
Tech level: Non
Pages: 24

This paper was prepared by a working party whose aim was to review the issues relating to outward reinsurance that would be relevant to providing an actuarial opinion on the technical provisions of a general insurer. After identifying the key issues, the authors proceed to give a catalogue of traps for the unwary, under the headings of accounting, information, interpretation, claims handling, method and classification.

10.5

Coutts, S M &
Thomas, T R H
1997
BAJ 3, 583

*Modelling the impact of reinsurance on financial
strength*

Type: Intro
Tech level: Stan
Pages: 54 + 17

The paper builds upon the work described in several earlier papers on the stochastic modelling of assets and liabilities. The authors describe the structure of their cash flow model and indicate the various assumptions that need to be made by users of the model. They go on to illustrate, by means of a deliberately over-simplified example, how the model can be used to test the effects of alternative forms of reinsurance programme. The paper and the discussion together convey an idea of the range of considerations that arise in the use of this type of modelling.

appeal to different types of investor. The paper concludes with details of three specific examples - the first being a scheme that was proposed but not proceeded with and the other two being arrangements that were actually adopted.

10.10

Meyers, G G
& Kollar, J J
1998

On the cost of financing catastrophe insurance

Type: Core
Tech level: Stan
Pages: 29

CAS Summer Forum,
119

The authors outline a method of analysing the cost of financing insurance cover for catastrophes by a combination of insurer capital, reinsurance and catastrophe options. They used a proprietary model of hurricanes and applied it to a sample of 50 insurers that report their personal lines exposure to the Insurance Services Office. They then set up illustrative catastrophe options and calculated, using the model, the probabilities that each option would be exercised. They found that the use of catastrophe options and reinsurance could each reduce significantly the cost of financing insurance and that the role of catastrophe options was greatest for those insurers whose catastrophe losses were closely correlated with the index on which the options were based. They end by suggesting some ways in which the use of catastrophe options might be developed.

10.11

Augustine, L V
1998

Catastrophe risk mitigation: a survey of methods

Type: Core
Tech level: Stan
Pages: 19

CAS Summer Forum,
323

The author surveys the ways that have become available for insurers to mitigate their catastrophe risks: traditional methods, using per occurrence catastrophe excess of loss treaties, quota share reinsurance, or aggregate excess of loss treaties; a blend of traditional and non-traditional methods, using the Catastrophe Risk Exchange (CATEX) operated by the New York Insurance Department; and non-traditional methods, using catastrophe options, contingent surplus notes, "Act of God" bonds, catastrophe equity put options and various forms of securitisation.

10.12

Cox, S H et al
1999

*Actuarial and economic aspects of securitization
of risk*

Type: Intro
Tech level: Stan
Pages: 39

CAS May Meeting, 19

This paper explains securitisation of risk, with an emphasis on risks that are usually considered insurable risks, by describing its essential components and its economic rationale, and using examples and descriptions of actual transactions. The authors discuss the securitisation of both assets and liabilities and give examples of each type.

After introducing the concept of complete and incomplete markets the authors consider the securitisation of catastrophe risk by reference to specific examples relating to hurricanes, windstorms and earthquakes. They then describe five examples of asset securitisation: stripping coupons, mutual funds, mortgage-backed securities, life insurance policyholder loans and life insurance premium loadings. After a mathematical section on the demand for insurance-based

securities, reasons are suggested for there to be a continuing supply. An appendix indicates some of the issues involved in the pricing of insurance risk securitisations.

10.13

Corvett, R W *Insurance securitization: the development of a* Type: Intro
1999 *new asset class* Tech level: Non
CAS May Meeting, 133 Pages: 41

The paper provides an introduction to the process of insurance securitisation and its products. Insurance securitisation is considered both as a subset of financial securitisation and as one of many financial tools available for insurers to use in risk management. The author defines insurance securitisation and describes the process by which securitisation – both insurance and non-insurance – has evolved. He then discusses the factors that have led to the development and expansion of insurance securitisation and describes various securitised products, with particular attention to several catastrophe bonds that had been offered. The paper concludes with a discussion of the potential future development of insurance securitisation. There is a useful summary of successful securitisations and a glossary of terms.

10.14

Meyers, G G & *Catastrophe risk securitization: insurer and* Type: Intro
Kollar, J J *investor perspectives* Tech level: Non
1999 Pages: 50
CAS May Meeting, 223

The paper begins by indicating how the growth in losses due to catastrophes caused insurers to look for new ways of financing their catastrophe risk, by turning to the capital markets. The authors review different forms of catastrophe risk securitisation, in the form of contingent surplus notes, catastrophe bonds, catastrophe equity puts and exchange-traded catastrophe options, and list the advantages and disadvantages of each. They indicate how securitisation may be used to complement the traditional approaches to the financing of catastrophe risk, namely the raising of capital and the use of reinsurance. They focus on one form of securitisation – options on a catastrophe index – to show how insurers can seek to combine them with capital and reinsurance to finance catastrophe risk for the least cost. They construct an illustrative example based on the estimated hurricane exposure of fifty insurers and on illustrative catastrophe options, and go on to show how three selected insurers of different types can reduce the cost of financing insurance through the proper use of reinsurance and catastrophe options.

10.15

Chandaria, S, *Reinsurance pricing* Type: Intro
Mackie, F J et al Tech level: Stan
1999 Pages: 50
GI Conv, Vol 1, 207

This paper sets out clearly a procedure for pricing standard non-proportional reinsurance treaties. The methods described represented typical practice in the London Market during the late 1990s and seem likely to remain so. All are capable of practical use needing only standard data and software. The paper includes several sections describing common pitfalls and offers suggestions for avoiding them. Among these are those associated with aggregate features such as annual aggregate deductibles, annual aggregate limits and reinstatement premiums, and the danger of using the

wrong aggregate claims distribution. A useful feature of the paper is an appendix describing, without the customary rather formidable mathematics, the Panjer recursion algorithm for calculating an aggregate claims distribution.

10.16

Walker, S R et al *ART and insurance derivatives*
1999
GI Conv, Vol 1, 287

Type: Intro
Tech level: Non
Pages: 100

This paper follows on from those presented by Bulmer et al in 1997 and by Sayers, Fulcher et al in 1998, both of which it is advisable to have previously read. The authors point out that such developments as securitisation and alternative risk transfer (ART) are examples of a growing convergence between the insurance and banking industries. They provide definitions and examples, and go on to illustrate the convergence process under four main headings: risk securitisation, convergence products, capital market insurance and insurance derivatives. They examine the market from the perspectives of both buyers and sellers and explain the various products on offer, giving real life examples. Details of specific securitisations are given in appendices.

11 LLOYD'S AND THE LONDON MARKET

11.1

London Market *An actuarial view of Lloyd's and the London*
Actuaries Group *Reinsurance Market*
1989
IA

Type: Intro
Tech level: Stan
Pages: 130

The original purpose of this monograph was to provide a course of study for examination candidates who would be studying general insurance at the specialist level. In the event, the material included went well beyond that required for the examinations, but it was nevertheless published since it could clearly be of value to actuaries whose work requires them to become familiar with the practices of Lloyd's and the London Market. There are seven chapters as follows:

- 1 *The structure and scope of the London Market*
- 2 *Accounting*
- 3 *The regulatory environment*
- 4 *Reinsurance*
- 5 *Premium rating*
- 6 *Claims and estimating reserves*
- 7 *Miscellaneous points*

11.2

Sanders, D E A et al *Pricing in the London Market*
1995
GI Conv, 103

Type: Intro
Tech level: Stan
Pages: 109

The bulk of this wide-ranging paper is in two sections, the first being on pricing techniques used in practice and the second being on strategic pricing. In the first of these there are eight sub-headings:

- 1 *Risk excess of loss treaties (experience rating, curve fitting, exposure rating)*
- 2 *Catastrophe excess of loss treaties (aggregate-based methods, loss-based methods, simulation/modelling-type methods, burning cost rates, exposure rates)*
- 3 *Proportional treaties*
- 4 *Use of simulation methods*
- 5 *Stop-loss treaties*
- 6 *Credibility theory*
- 7 *Distribution calculus*
- 8 *Generalised linear interactive models*

The second section describes the links between underwriting targets, pricing and reserving. It covers such topics as the relationship between risk and reward, allocation of capital, profit testing and management of the underwriting cycle. The paper ends with a discussion of the role of actuaries in pricing.

11.3

Sanders, D E A et al *Pricing in the London Market, Part 2*
1996
GI Conv, 141

Type: Intro
Tech level: Stan
Pages: 34

This paper is largely devoted to aspects of the pricing of property reinsurance, namely experience rating, exposure rating and the specific topics of reinstatements and annual aggregate limits, aggregate annual deductibles and no-claim bonuses.

11.4

NAIC Review Team *Lloyd's: a review by US state insurance regulators*
1998
NAIC

Type: Intro
Tech level: Non
Pages: 80

This is the report of a review team formed by a NAIC Surplus Lines Task Force to investigate the structure and workings of Lloyd's and to recommend the funding levels to be required for Lloyd's US Situs Trust Funds - Surplus Lines. Part 1 (56 pages) gives a clear description of the structure of Lloyd's, its business processes and its financial reporting and regulatory systems up to 1998, and outlines the developments which led to the formation of the reinsurance company Equitas in 1996. It also sets out the structure of Equitas and the principles on which it was founded. Part 2 (11 pages) describes the on-site work undertaken by the review team and sets out conclusions and recommendations. Six appendices occupy the remaining 13 pages.

11.5

Hindley, D J et al
2000
BAJ 6, 651

The Lloyd's reinsurance to close process

Type: Intro
Tech level: Non
Pages: 48 + 22

The authors provide a clear description of the reinsurance to close (RITC) process applied to Lloyd's syndicates and give in an appendix some relevant extracts from various Lloyd's documents that refer to RITC. They then go on to consider the forms of opinion on RITC that might be provided by actuaries if they are asked, or were to be required, to provide such opinions. They describe the concept of what they term the 'actuarial RITC' which corresponds closely, in the context of Lloyd's, to the apparent requirements of the international proposals for fair value accounting. There follows a discussion of the alternative courses of providing an opinion on the actuarial RITC and providing an opinion on the RITC reserves themselves, the latter being essentially a 'two-sided' opinion on the reasonableness of the RITC reserves, having regard to the need for equity between the members on the closing year and those on the accepting year. The paper ends with a discussion of related issues concerning other actuarial roles in general insurance.

11.6

Sheaf, S H et al
2000
GI Conv, Vol 1, 243

Reinsurance to close

Type: Intro
Tech level: Non
Pages: 69

This paper follows on from that presented by Hindley et al at a sessional meeting of the Institute in March 2000. The authors discuss the implications of the suggestion made in that paper that actuaries might sign opinions on reinsurance to close (RITC) premiums. Since such premiums need to be set at a level which is equitable both to the members on the closing year and to the members on the accepting year, the opinions would need to be two-sided, as distinct from the one-sided opinions provided by actuaries as to the adequacy of reserves for the purpose of solvency. After considering the implications of two-sided opinions from the points of view of the various stakeholders – policyholders, Names, shareholders of managing agencies, the Corporation of Lloyd's and the Inland Revenue, the authors give the results of a reserving exercise they had carried out, duly acknowledging its limitations, and go on to discuss several methods that have been suggested for measuring the variability in reserves. They end with a consideration of the derivation of risk loads and their relationship to the question of discounting.

12 THE INTERNATIONAL SCENE

12.1

Clark P K et al
1993
GI Conv, 289

US legal system - implications for UK insurers

Type: Intro
Tech level: Non
Pages: 13

This short paper was prepared as background material for a workshop session at the Convention. It describes the structure of state and federal courts, the choice of jurisdiction and venue, the appeal procedure and the rules relating to discovery, and discusses class actions, punitive damages and contingency fees.

12.2

Clark, P K et al
1994
GI Conv, 531

US medical malpractice insurance

Type: Intro
Tech level: Stan
Pages: 56

This paper is in five parts: (i) a description of the market in US medical malpractice insurance, (ii) terminology and definitions, (iii) rating and reserving, (iv) reinsurance programmes and (v) a hypothetical example of the kind of actuarial submission that an actuary working in the London Market might expect to receive from a cedant.

13 DISTRIBUTIONS

13.1

Hogg, R V & Klugman, S A 1984
Loss distributions
Wiley

Type: Spec
Tech level: Stan
Pages: 235

This textbook is devoted to the problem of fitting probability distribution models to data representing the size of losses of the kind associated with claims against various types of insurance policies. It consists of five chapters and an appendix, as follows:

Chapter 1	Introduction
Chapter 2	Models for random variables
Chapter 3	Statistical inference
Chapter 4	Modelling loss distributions
Chapter 5	Applications of distributional models
Appendix	Characteristics, values and estimators for selected distributions

The short introductory chapter introduces the relevant insurance terminology and includes useful warnings about the care needed in handling raw data and the types of adjustment that may be necessary before attempting to fit distributions to the data. The next two chapters cover the standard statistical textbook material that is relevant to the fitting of loss distributions. Chapter 4 illustrates the process of fitting, using data relating to hurricane losses, fire and theft losses under homeowners' policies, and losses in group long-term disability insurance, automobile bodily injury insurance and hospital malpractice insurance. The distributions used are selected from the eight whose details are set out in the Appendix, namely the Burr, Pareto, Generalised Pareto, Transformed Gamma, Gamma, Log-gamma, Lognormal and Weibull. The final chapter illustrates the uses of distributional models for such purposes as estimating the effects of inflation, evaluating deductibles, limits and layers, estimating the losses falling within different percentiles, and comparing the effects of using different distributions.

Although this book may be regarded as superseded by that by Klugman, Panjer & Wilmot (Reference 1.5), it is retained here because, being much shorter, it may be more convenient to refer to.

13.2

Wang, S
1998
NAAJ, 2, 2, 88

An actuarial index of the right-tail risk

Type: Spec
Tech level: Bey
Pages: 14

It is widely acknowledged that the standard deviation is not a good measure of the risk associated with the markedly skew distributions found in many types of insurance, where a significant proportion of the total risk stems from large-loss events that occur with low frequency. The author defines a quantity termed the right-tail risk, together with its associated right-tail index, and calculates the index for several of the continuous and discrete probability distributions that are commonly used in insurance applications, all having the same mean and coefficient of variation. The ranking of the distributions by the right-tail index corresponds sensibly with their relative tail thickness.

13.3

Mata, A J
2000
GI Conv, Vol 2, 151

Parameter uncertainty for extreme value distributions

Type: Spec
Tech level: Stan
Pages: 23

The pricing of high layers of excess of loss reinsurance is subject to great uncertainty for several quite obvious reasons, including the scarcity of observations from past experience and the variability of the kinds of event that can give rise to very large claims. The author describes research undertaken with the objective of answering the question "How uncertain are the premiums given for high layers based on the observed data?" After an introduction referring to available texts on extreme value theory, the author summarises the main results of that theory when dealing with large losses above high thresholds. The research described later in the paper, using Danish fire data that had been used in earlier published work, includes estimation of the effect of parameter uncertainty for both frequency and loss distributions, and also the effect of model uncertainty. Simulations are carried out using the bootstrap method, the stages of which are clearly set out. Although the paper may be regarded as somewhat specialised for actuaries with limited experience of work in general insurance, it provides a readable introduction to a topic that is becoming increasingly a focus of actuarial research.

13.4

Papush, D et al
2001
CAS Winter Forum, 175

Approximations of the aggregate loss distribution

Type: Core
Tech level: Stan
Pages: 12

The authors briefly review, with references to the relevant papers, various probability distributions that have been used to represent aggregate loss distributions, all of which were calculated using methods based on the assumption that separate distributions of loss frequency and loss severity would be available. Then, using available data on frequency and severity of losses for major lines of business, they select parameters for distributions to represent seven different scenarios, the severity distributions being Pareto in six cases and lognormal in the seventh, and the frequency distributions being negative binomial throughout. They then carry out repeated simulations to obtain a sample of aggregate losses to which selected distributions (normal, lognormal and gamma) can be fitted. They conclude that taking the seven scenarios as a whole, of the three distributions the gamma gives the best fit for aggregate losses and they recommend its use as a reasonable approximation when there is no separate frequency and severity information available.

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