GRIP

General Insurance Premium
Rating **I**ssues Working **P**arty

Duncan Anderson (Chairman)
Clive Bolton
Gary Callan
Martin Cross
Sheree Howard
Grant Mitchell
Karl Murphy
James Rakow
Peter Stirling (Secretary)
Gabriel Welsh

12 January 2007

GRIP - General Insurance Premium Rating Issues Working Party

Acknowledgments

The authors would like to express their sincere gratitude to the following who assisted with various aspects of this paper:

Clive Allison
Anju Bell
David Bennett
Dan Bishop
Martin Cairns
Chris Carlson
Alex Foord
Will Forster
Paul Hewett
Neil Hilary
Don Johnstone
Tom Jowett
Dermot Marron
David O'Connor
Estelle Pearson
John Pedrick
David Sanders
Dawn Wakefield
Ryan Warren
Jeremy Waite
Tom Wright

The authors would also like to thank ActEd for providing a copy of their examination educational materials.

1 Introduction

Introduction and terms of reference

1.1 Following widespread positive feedback on the achievements of the General Insurance Reserving Issues Taskforce "GRIT", the General Insurance Board of the Faculty and Institute of Actuaries established GRIP in 2005 to review actuarial involvement in premium rating issues, pricing being one of the key areas in which actuaries work.

1.2 The initial terms of reference as suggested by the General Insurance Board ("GI Board") were refined following discussion within GRIP and wider consultation with the Faculty and Institute of Actuaries ("the Profession") at GIRO in October 2005. The final terms of reference agreed with the GI Board are set out in Appendix A but can be summarised as follows:

- To review the areas in which UK actuaries are currently involved within the overall premium rating process, and to identify any areas where actuaries might be able to improve their contribution and/or add further value.
- To summarise, in broad terms, current methods used by actuaries in GI premium rating, to identify areas where types of methods and approaches could potentially be improved or used more appropriately, and to suggest potential areas for further research.
- To consider whether and how improvements could be made to the way GI pricing actuaries communicate with others.
- To consider whether existing professional guidance should be modified/clarified to make its application to premium rating clearer and to consider whether there is a need for more detailed best practice guidance from the Profession setting minimum standards for a direct business pricing assignment.
- To consider whether there are any implications for professional guidance or communication resulting from commercial pressures within organisations.
- To consider trends in the area of Treating Customers Fairly and to consider what the Profession might need to consider in preparation for issues arising in this area.
- To consider whether the content of the exam syllabus is adequate to prepare actuaries to work in the pricing area.
- To consider whether more should be done to provide CPD in this area, and if so what.

1.3 Although it was initially proposed that GRIP should not consider London Market reinsurance pricing, feedback from the Profession clearly suggested that there was a desire that this area also be covered. Thus it was agreed that GRIP should consider "issues of relevance to Faculty and Institute members involved in pricing direct insurance (individual and account level products) and reinsurance".

Stakeholder consultation

1.4 We felt it was important to understand at the outset how actuaries were perceived in the underwriting and pricing arena. We therefore undertook a series of interviews with senior non-actuarial "stakeholders" in the insurance industry, analogous to those undertaken by GRIT in 2004.

1.5 Such individuals included CEOs, CFOs, Directors and senior underwriters. Some 17 interviews were undertaken around September 2005. The same following questions were posed to each interviewee:

- What do you see as the main strengths of actuaries involved in GI rating?
- What are GI pricing actuaries' greatest skills, and to which parts of the rating process do they most effectively contribute?
- Are there areas in which actuaries could improve?
- Do you see the role of actuaries developing in the future, and if so how?
- Are there additional skills that actuaries will need?
- Are there any other comments you would like to make?

1.6 Each interview was confidential and thus we cannot report individual responses. Instead we note the following four very clear themes that emerged from these interviews.

- Firstly, the feedback was generally positive. There was a clear indication that where actuaries are used in the pricing process, our stakeholders value what we do. One memorable quote was "It's hard to imagine pricing now without actuarial input". The positive feedback tended to relate to actuaries' ability to perform complex technical analysis, rather than to wider contributions to the business.
- One clear theme arising, however, was that actuaries would benefit from improved communication skills. Of the 17 stakeholders interviewed, 14 raised this as an issue. Some interviewees referred to the inability of some actuaries to explain complicated issues clearly, in a way non-actuaries can easily understand. Many, however, alluded to wider communication issues relating more to management skills and the ability to persuade and get others to "buy in" to concepts and results.

- Another clear theme arising was that many felt that actuaries were unhelpfully detached from some working detail, and that an improved understanding of products and markets would be helpful.
- Related to this, but as a distinct issue, many felt that companies could do better if actuaries were more closely integrated with other parts of the business, working at the "coal face". Several made comments about actuaries needing to "come off the fence" on issues, and not "walk away" when a technical analysis has been delivered.

1.7 Some stakeholders also questioned what value actuaries added over other professionals with a numerical background, such as statisticians and those with a Financial Mathematics background.

1.8 Overall GRIP was left with a feeling that notwithstanding some positive feedback, perhaps actuaries are not currently fulfilling a potentially valuable bridge between theory and practice.

GRIP workstreams

1.9 Given the stakeholder feedback and the finalised terms of reference, GRIP established different workstreams to consider different areas. Each workstream was chaired by a GRIP member, and many included other volunteers from across the industry.

1.10 The following workstreams were established:

- "Role workstream" - to review the role of the actuary in pricing
- "Methods workstream" - to consider issues relating to methods in use and areas for research (this workstream itself was formed of a personal lines group and a London Market group)
- "Communications workstream" - to consider issues relating to communication, in particular in light of the stakeholder feedback
- "Education/CPD workstream" - to review the relevance of the current syllabus, CPD, and other education issues
- "Guidance" - to review the need for amendments/additions to formal professional guidance.

1.11 Other issues were discussed directly within GRIP. One such issue was the topic of Treating Customers Fairly.

1.12 Although individual GRIP members coordinated activities within each workstream, the issues and conclusions emerging were discussed by all members of GRIP, and the conclusions represent the collective view of the group.

Consultation with the Profession

1.13 GRIP has consulted with members of the Faculty and Institute in discussions at GIRO in October 2005, at the Current Issues in General Insurance seminar ("CIGI") in May 2006, and at plenary and workshop sessions at GIRO in September 2006. A consultation draft of this report was also released in September 2006 for feedback during September and October 2006.

1.14 In addition, GRIP has discussed many of the issues in this paper with relevant members of the Casualty Actuarial Society (CAS) and the Institute of Actuaries of Australia (IAA). Although GRIP's terms of reference focus on issues of relevance to members of the UK Profession, and although there are a number of regulatory differences (especially in the USA) which make some comparisons less relevant, it is interesting to note that both CAS and IAA members felt that there were a number of strong parallels between some of the issues discussed by GRIP and some of the issues which the CAS and IAA currently face, particularly with regard to the role of the actuary in pricing.

Content of this paper

1.15 A description of the work undertaken by each workstream and the conclusions and recommendations are set out in the following sections:

- Section 2 - The role of the actuary in pricing
- Section 3 - Methods
- Section 4 - Communication
- Section 5 - Education
- Section 6 - CPD
- Section 7 - Guidance
- Section 8 - Treating Customers Fairly.

1.16 A summary of all GRIP's recommendations is set out in Section 9.

Notes

1.17 GRIP was established by and reports to the General Insurance Board, and under its terms of reference it is not the intention that this report constitutes a formal report as defined in the Profession's Guidance Note GN12 as adopted by the Board for Actuarial Standards with effect from 12 June 2006.

1.18 GRIP's recommendations are addressed to the General Insurance Board. All other material included in this paper is provided for information and discussion purposes only and does not constitute professional advice. No reliance should therefore be placed on such material.

2 The role of the actuary in pricing

Introduction

2.1 The role of the actuary in the pricing of general insurance business has received limited study in the past. This may have much to do with the fact that pricing has not been seen as the primary area in which actuaries operate, as demonstrated by the relatively limited attention devoted to this key area within the current actuarial training programme.

2.2 Nevertheless, the past 20 years have seen a substantial development in the engagement of actuaries in pricing especially in markets where there are no regulatory requirements for their involvement. The growing awareness of risk as a factor in all industries, not solely insurance, has given greater impetus to these developments, yet little is understood about the actuarial role in pricing and to date little initial training time is devoted to this area of activity.

2.3 We started this workstream with the intention of confirming the actuary's role in the calculation of risk cost and exploring how the Profession is expanding from this area. We were confident that the work we have done to introduce scientific, statistically based techniques over the last 15 years would have cemented our central position in this area.

2.4 What we actually found was rather surprising and defined the direction of this workstream.

- Of the major personal lines insurers represented on GRIP (almost half of the UK motor market) only a small proportion of the pricing teams were active members of the actuarial profession at that time, although there was some evidence that this may be changing.
- There was relatively limited representation of active members of the actuarial profession in the management layers of their underwriting/pricing functions.
- There even appeared to have been examples of pricing actuaries removing actuarial references from their business cards as they felt it acted as an obstacle with key stakeholders both outside and within larger organisations.

2.5 Far from being at the centre of pricing, actuaries appeared to be being marginalised from areas that had once been a stronghold. Although these observations were not true for all areas of business (areas such as the London Market and reinsurance for example) this appears to be the trend for the more statistically based areas in particular in personal lines.

2.6 Although actuaries appear to have played a vital role in developing the principles and running the large scale statistically based pricing functions initially, once the activity had become well defined and industry consolidation provided scale the focus in the large personal lines insurers seems to have been on industrialising the processes, separating them into sub-tasks that could be re-engineered for efficiency.

2.7 For example:

- The pricing process has been broken down in to the component tasks which are carried out by functional specialists eg modelling by statisticians, data management by IT specialists, workflow by operational mangers.
- The emphasis has arguably changed from a research environment to one where, perhaps, 20-30 rating changes are scheduled each month.
- Traditional actuarial skills are still appreciated particularly in improving the performance of the models etc. However actuaries are becoming more likely to be advisors to the management rather than managers themselves.

Approach of this workstream

2.8 As a workstream of GRIP, with additional members from around the industry, we sought to understand better the developments which led to past and potential future changes in the role of pricing actuaries by identifying various models of pricing which we have either experienced ourselves or have come to see as operating in other markets.

2.9 For each role we sought to clarify the characteristics of the model and the existing roles undertaken by the actuary. We then moved on to establish the types of general insurance which typically relate to these models to show the frequency with which an actuary may be expected to be engaged in each model, considering both the country and type of insurance dimensions.

2.10 Finally we have attempted to look to the future and understand the likely developments of the actuarial role in each model and with it the training and communication implications for the Profession.

Models of operation

2.11 Based on the work undertaken by the workstream we identified five models of operation, which we classified as:

- **Tariff** - where the regulator has significant influence over the rates.
- **Qualitative** - where the "correct" price cannot be determined purely by numerical analysis and subjective factors play a significant role.
- **Cost Plus** - where the price is set based on a statistically driven analysis, based on the expected cost of claims, appropriately loaded for expenses, profit etc.
- **Distribution** - where the price allows for non-cost elements such as the customer's propensity to shop and effectively relates to markets where the pricing strategy is being managed across multiple distribution channels.
- **Industrial** - currently the domain of only the very large personal lines insurers who are operating multiple brands across multiple channels, and potentially across multiple countries, where the focus is on operational efficiency and economies of scale.

Tariff

2.12 In this model, which could, for example, represent the UK motor market in the early 1960s or the Chinese and Indian motor markets recently, rates are typically the responsibility of the regulator, through either rate filing or rate setting.

2.13 This model can, however, also be seen in the traditionally more competitive and deregulated markets for products/classes of business where the rates are set by convention or competition. A good example of this would be the motor breakdown insurance market in the UK where, until relatively recently, the rates were set relatively simplistically, based on market convention as opposed to being based on the true risk characteristics and hence expected risk cost.

2.14 In this model, a key role for the actuary is within the regulator to review and agree the rates. The actuary can also act as a bridge between the regulator and the industry, negotiating on behalf of the industry, drawing on both their strategic level understanding and their ability to understand the lower level detail. Given the key objective of this model is to ensure that no customer groups are discriminated against, the key qualities for which the actuary is renowned - professionalism and objectivity - are seen as strengths in this model.

Qualitative Underwriting

2.15 This model is characterised by the situation where an accurate price cannot be estimated accurately by the use of numerical data, requiring a blend of both numerical/quantitative and qualitative information - a mixture of art and science. Examples of this approach exist where the numerical data is incomplete (owing to long distribution chains), imperfect (owing to the failure of recording systems or categorisation), sparse (eg only a few claims are available for analysis), or where risk perception is a key factor in determining price, as may be seen within the Lloyd's market.

2.16 This model would have characterised the UK motor market in the 1970s, mainly as a result of incomplete data or lack of computing power to manipulate effectively what data was available.

2.17 The role of the actuary in this model today is typically one working alongside underwriters, but not usually in distinct roles. Instead, they exist in a continuum with the actuaries typically at the numeric end and the underwriters more focused on the risk perception.

2.18 In this environment, especially where the objectives are business driven, individuals with actuarial skills are sought, with the additional skills of adaptability, empathy, negotiation and intuition, with the ability to use the data as a guide as opposed to it providing the "answer" as well as being comfortable with ambiguity. It is only when governance issues emerge that professional actuaries are specifically sought.

Cost Plus

2.19 This model is characterised by the existence of suitable cost data (both expenses and claims) appropriate for either complex or simplistic statistical modelling to determine the cost element of price. It is most appropriate for "steady state" or minimally competitive markets, not being sold through multiple distribution channels. As such, new entrants can easily change the competitive position of the market, with recent examples encompassing UK motor breakdown insurance, SME commercial insurance in the UK, and some continental European motor business.

2.20 In this role, it is essential that the actuary not only has core infrastructure and statistical skills, but is a practitioner with a wide range of business skills and an ability to interpret results appropriately. This model commonly employs more statisticians with actuaries providing the higher level technical skills along with an ability to manage people; the appropriate reputation to give the work credibility; and the commercial understanding and foresight required to enable the bigger picture to be understood.

Distribution

2.21 In this model, there is a distinction between cost and price. Whereas the processes for determining the claims and expense elements are similar to the "Cost Plus" model, this model additionally considers the sensitivity of different customers to price changes, with the motivation being to identify opportunities to charge different prices to different customers or through different distribution channels in order to optimise performance. As such, deals, discounts and special offers along with the provision of add-on products and customer incentives are vital elements of this model. Indeed, it is quite likely that the examples provided within the Cost Plus section above could rapidly move through the Cost Plus stage and into this element of the chain of development, leveraging off the experience gained from the personal lines commoditised markets.

2.22 The skills needed by the actuary in this model are similar to those for the Cost Plus model (a combination of statistical knowledge, business awareness and common sense), but in addition there is a need for communication and negotiation skills, since there will be additional stakeholders in the pricing process, such as marketing and corporate partners. The technical and negotiation parts of the role could be done by different people but it is arguably more efficient and effective if one individual covers both elements, especially when dealing with external parties.

2.23 For the actuary to function successfully in this role, in addition to the skills noted above, team leading skills and general business financial knowledge, it is also important that they have an understanding of the whole company process, (call centres, claims handling processes, costs including ABC models etc), so that they can conceive the value chain at the heart of the business.

Industrial

2.24 This is a relatively new model and is currently the domain of only large personal lines companies operating within the commoditised markets, with multiple products, brands and distribution channels. This model is process orientated and operation driven with the goals of achieving operational efficiency and effectiveness, as well as economies of scale. This model is mainly about the management of the process to ensure consistency and process efficiency across the large number of customers and volume of data.

2.25 The role of the actuary in these circumstances is primarily concentrated upon management, between the need for continual innovation/research and the maintenance of these systems, as well as liaison with other key stakeholders on business ideas. As such, the actuary managing this type of model will need to have an understanding of complex systems and their management, along with a professional advocate status within an organisation to enable efficient and effective communication between the various stakeholders.

Overall skills matrix

2.26 Appendix B provides a more detailed overview of the skills we believe are required by actuaries operating in each of the models described above.

Examples of the different models

2.27 Although the above models of pricing (and the associated roles of actuaries within them) have been identified as being in operation, they do not all apply to every class of insurance or market. Some have geographical boundaries, particularly the tariff model, where rules are imposed by culture or government regulation. However, in other markets, the models do exist in relation to the class of insurance and on occasions (for example with the Industrial model) it is the nature of the operation which determines the model and hence the potential role of the actuary.

2.28 The table below sets out our understanding of the most likely model to operate in relation to the major classes of business in markets where controls are limited. Of course, there is no definitive link in any case and some models will merge and change over time as the nature of the business varies, such as described for the Cost Plus model. Nevertheless, an understanding of the models and the likelihood of actuaries being engaged within each gives us a starting point in understanding the educational and developmental needs of the Profession as we seek to operate in this complex environment.

Examples of the different models

Class of Business	Category	Tariff	Qualitative Underwriting	Cost Plus	Distribution	Industrial
UK Personal Motor	1960s	←	→			
	1970s		←	→		
	1980s			←	→	
	1990s			←	→	
	Now				←	→
Indian Motor Market - Now		←	→			
UK Domestic Household					←	→
Pet				←	→	
Travel				←	→	
Creditor					←	→
Motor Vehicle Breakdown					←	→
Home Response		←	→			
Commercial Motor	Small Vans				←	→
	Small Fleet			←	→	
	Large Fleet		←	→		
Commercial Property	SME			←	→	
	Other			←	→	
Pecuniary Loss	SME			←	→	
	Other			←	→	
General Liability	SME			←	→	
	Other			←	→	
Professional Indemnity	SME		←	→		
	Other		←	→		
D&O			←	→		
Marine			←	→		
Aviation			←	→		
Medical Malpractice				←	→	
Facultative Reinsurance				←	→	
Treaty Reinsurance				←	→	
Commercial Crime				←	→	
Bankers Blanket Bond				←	→	

Developing roles and training

2.29 As with the existing roles, the future development and training needs will vary between the models.

Tariff

2.30 The individual actuary, if not the Profession, will be asked to identify how to break the mould, such as identifying classes/territories where competitive advantage could be gained by refining the rating; highlighting new rating factors; identifying cross subsidies so they can be removed, as well as influencing the regulators often across international boundaries. A detailed understanding of the various markets and the customs in each will be essential for the actuaries engaged in this model.

2.31 In addition, actuaries may be involved in areas other than pure risk related analyses, but which make use of their core statistical and business skills. For example, actuaries may be asked to analyse the impact of alternative marketing strategies on both the types and nature of business attracted, including marketing efficiency, to facilitate the insurer's identification of optimal marketing strategies to either improve marketing efficiency and/or to capitalise on known cross subsidies within the rates, where these are also known to exist in competitor rating structures.

Qualitative Underwriting

2.32 The key future challenge will be the increasing dominance of governance as a driving factor and therefore the potential requirement for the actuary to be solely engaged in the numeric end of the spectrum of activity in this model.

2.33 As a result, actuaries will need to develop the management skills as well as end-to-end business knowledge to allow them to occupy management/executive roles where they can provide the maximum business advantage. This could, however, have a potential negative impact on the Profession, as the skills rather than the professional qualification become seen as the key to advance. Therefore, a perceived key need for the Profession is to ensure that it extends its training and development to embrace these executive skills where required, as it could be argued that currently the Profession is too concerned with governance issues and not sufficiently focused on the role of an actuary as a business manager in a competitive environment.

Cost Plus

2.34 Based on our review of the actuarial educational material (see Section 5), it is clear that the Profession perceives this as the actuary's predominant role in general insurance pricing. However, the general view is that the UK education system is weaker on applied statistics relative to comparable overseas actuarial professional bodies. As a result, both statistical and business knowledge requires strengthening through "on the job" training. Despite this, the view is that having actuaries in these types of role provides credibility from the regulatory perspective, driven by the perceived ability of the actuary to play both the professional and commercial roles. The actuary is also well placed to "push the boundaries" given their professional mindset and understanding of the non-cost factors.

Distribution

2.35 As generally actuaries working in this area have progressed into it via working in a Cost Plus environment, it is arguable that many actuaries working in a Distribution focused environment are already well equipped for the role, although the additional key skills of general wider business knowledge including key business financials, negotiation and team management must again be gained through "on the job" training. As more companies and products migrate into this pricing model, actuaries will increasingly need these skills.

2.36 Actuaries working in this area are likely to hold positions which leverage their skills and knowledge such as technical or business development directors, as opposed to chief executive officers.

2.37 It is also arguable that actuaries who have worked within this model are better placed to use their skills in the wider business environment, such as banking or other distribution focused industries, than actuaries who have only worked in the Cost Plus environment.

Industrial

2.38 As a newly emerging model, actuaries who are currently working in this area have the advantage of experience gained through working in the other pricing environments through which they will have gained a detailed understanding of the issues as well as the general business environment.

2.39 However, as these roles become more commonplace, the training currently received by actuaries, either through the Profession or "on the job" within the other pricing environments, does not provide the breadth of operating experience which is required for this role. As such, there is potentially scope for competition for senior roles in this environment from other industries, with the actuary being a sub-manager as opposed to the main manager.

2.40 Therefore, to ensure that actuaries are best placed to assume these types of role in the future, it will be essential for the training to focus on an understanding of the total business operation and an appreciation of the relative importance of technical information, in addition to those skills and training needs highlighted above.

Governance vs business advice

2.41 Whilst reviewing the roles of actuaries in the various models we observed that, potentially, those members of the Profession who wish to engage actively with the business often migrate to more pricing based roles through a process of self selection, having invariably started in the more governance focused reserving and capital based roles.

2.42 Indeed, for actuaries engaged in pricing in all of the operational models considered above, we identified areas of potential conflict between our governance related role, as highlighted in our Professional Conduct Standards and Guidance Notes, and the need to operate in a commercial environment. This was more particularly the case for actuaries operating within insurance organisations. (This is discussed further in Section 7.)

2.43 As such, we feel there is a need for the Profession to debate openly and agree how to balance the need for strong governance roles with the desire for actuaries to hold management positions in value adding pricing/underwriting functions within commercial entities.

Conclusions and recommendations

2.44 GRIP believes that there are a number of issues arising from our discussions of the role of the pricing actuary.

- Different stages of the pricing process require a different mix and emphasis of skills. However, the skills are broader than any examination system and may be inherent to a greater or lesser extent in individuals. As such, the individuals having these abilities may find that the pricing area offers them a more enjoyable and productive actuarial career path. Further, consideration of the choice and variety of actuarial careers may enhance the appeal of the Profession.
- Owing to the nature of the skills required, however, actuarial qualification is no longer seen as a prerequisite to a career in general insurance pricing management. It is desirable but not necessarily looked for above other qualities.
- Actuaries are most influential when using their broader financial understanding to introduce new techniques and setting the strategic agenda (which was the case from the introduction of mainframes in the 1970s to the embedded application of GLMs in the early/mid 1990s).

- Since then influence has lessened to a degree in personal lines, with shifts in techniques no longer solely coming from the Profession in the last ten years or so. Whilst we recognise that actuaries have contributed significantly to the development of the "Distribution" model over this period, there has also been significant input from non-actuaries into this area.
- The success of actuaries appears to be around setting up and embedding processes rather than running them in the longer term.
- A further consideration for the UK-based Profession is the potential ease with which some of these well sorted and documented processes could be off-shored.
- GN12 gives further momentum to actuaries becoming advisors to the pricing management rather than management themselves.

2.45 In terms of looking to the future we would recommend the following:

- The Profession should introduce basic general insurance pricing training into the actuarial education syllabus and offer further formal training as part of its CPD programme (this is discussed in more detail in Section 5).
- The General Insurance Board should debate the desired role that the Profession should play in the evolution of this aspect of the insurance industry, for example whether new techniques should be the subject of GIRO papers or will they be developed within organisations and controlled by intellectual property concerns.
- The Profession should debate and agree how to balance the need for strong governance roles with the desire for actuaries to hold management positions in value adding underwriting/pricing functions.

3 Methods

3.1 The terms of engagement of the methods workstream are:

- to summarise, in broad terms, current methods used by actuaries in GI premium rating
- to identify areas where types of methods and approaches could potentially be improved (eg expense modelling / capital aspects of uncertainty), and to identify areas where existing methods could be used more appropriately
- to suggest potential areas for further research.

3.2 The majority of work in this area concerns the first of these objectives. It is not within GRIP's terms of reference to write a definitive "Premium Rating Manual". Instead we have sought to outline methods commonly in use at the moment by Faculty and Institute members. In each case we have not described the methods in detail but instead have provided extensive references. Our aim was to create material such that given this paper and access to all the references, (and a sufficient amount of time!), an actuary could put together a comprehensive "Premium Rating Manual".

3.3 The main focus of the methods described is around deriving technical prices. Although we touch on some aspects of "demand" modelling, we have not discussed utility pricing and price optimisation within the personal lines market in any detail. GRIP felt that this is a developing and commercially sensitive area, and that practitioners (whether members of GRIP or not) would not be willing to share in any detail methods being developed in this area. This is not to say, however, that research into this area may not serve the Profession well in terms of delivering real value for money to stakeholders.

3.4 At an early stage, it became obvious that there was a requirement to split the workstream further. Although there is an element of commonality between the pricing of different classes of business, the main elements in use are very different between different classes of business, and can broadly be split between the personal lines market, London Market, and the commercial market. The characteristics of the personal lines market compared to the London Market include having more data available, at a more granular level, but with more straightforward contracts and coverages. Commercial lines can be considered to be somewhere between the two.

3.5 The different market characteristics have led to very different pricing methods being employed. There is a certain amount of overlap between the different markets, so there is a certain amount of repetition, and also certain methods can be used between the different markets (for example, marine insurers are beginning to use GLM methods for rating ships in the same way that motor insurers having being using GLMs for many years).

3.6 This section has the following sub-sections:

- the underwriting cycle
- overall pricing and capital charges
- personal lines market pricing methods
- London Market pricing methods
- commercial lines pricing methods
- recommended areas of further research.

3.7 All references to papers quoted are detailed in Appendix J.

The underwriting cycle

3.8 The cyclical nature of premium rate movements is a very real market challenge, perhaps the most challenging aspect of managing a portfolio of risks for many lines of business. There are many causes of underwriting cycles, including

- a delay in the understanding of the emergence of higher claims costs, which leads to under-pricing of current risks
- inflows and outflows of capacity to the market, often as a result of large scale catastrophes
- deliberate under-pricing (or the use of expense advantage) by key players in an attempt to drive out competitors
- an attempt to grow volume in order to cover high fixed expenses
- pricing strategy being determined by chasing market prices (upwards or downwards) rather than being based on sound technical prices, with no player willing to be the first to break.

3.9 Different markets are impacted to a greater or lesser extent by these factors, and certain markets tend to exhibit more or deeper cyclical trends than others.

3.10 Market cycles are a feature of the insurance market, but arguably can be softened if prices are based on a model with a sound technical cost base, and if there is a clear communication of the technical price to the pricing decision makers, so that departures from the technical price are clearly recognised and understood by all. Actuaries can have a key role to play in both of these areas.

3.11 Alternatively, if a rate-monitoring program is implemented, this will provide an early warning sign of the softening of rates. For the London Market, as critical to performance is changes in Terms and Conditions. This is discussed in detail in the GRIT document from the perspective of reserving, but much of this equally applies to pricing.

Overall pricing and capital charges

3.12 The main differences between the different markets relate to the estimation of the expected claims cost. However, once the expected claims cost has been estimated, similar methods are required for deriving a technical price.

3.13 A technical price can be considered to consist of:

- expected claims costs
- expense loadings, including reinsurance costs
- a discount factor because of delays in payments
- a capital charge to reflect the cost of capital.

3.14 Deriving the expected claims cost is often the major part of the work in deriving the technical price, and is the main subject focus of the methods described in Appendices D and E.

3.15 Expense loadings are also discussed within Appendices D and E, although are often applied using simple loadings and perhaps should be calculated in a more actuarial manner.

3.16 The discount factor is reasonably straightforward in that it simply involves applying a discount rate to an expected payment pattern. Expenses can similarly be discounted.

3.17 The fourth element of the technical price, namely the capital charge, has been subject to a reasonable amount of research recently. Two things need to be considered: the amount of capital allocated to a line of business, and the method by which the loading is applied.

3.18 Details of possible capital allocation and loading methods are set out in Appendix C.

Personal lines market pricing methods

3.19 A comprehensive summary of the main methods currently used for pricing personal lines insurance can be found in Appendix D. Topics covered include:

- generalised linear models
- other relativity methods
- classification techniques
- expense modelling
- technical base rates
- rate implementation
- lifetime customer value models
- classes with additional characteristics
- issues more relevant to non-UK actuaries.

London Market pricing methods

3.20 A comprehensive summary of the main methods currently used for pricing London Market business can be found in Appendix E, and is aimed at providing quite a practical view of the challenges faced by pricing actuaries in this market. Topics covered include:

- overview of experience rating and exposure rating
- estimating the loss cost
- pricing excess of loss
- stochastic and other methods
- exposure measures
- data issues
- attachment of cover
- contract structure
- other factors
- catastrophe models in pricing.

Commercial lines pricing methods

3.21 Personal lines and the London Market represent the two extremes of pricing work. Personal lines business has standard policies and coverage with a lot of data. Sometimes claims experience is allowed for within rating factors (eg a no claims discount scale). London Market business has variable and complex coverage (often unique to each policy) with little grouped data so is more often priced using actual claims experience for the policy (or group of policies) being priced.

3.22 Commercial lines business, by which we mean direct insurance sold to businesses via the company market, uses techniques used in both of the above markets, but in the main uses a blend of the two approaches.

3.23 Insurance sold to very small businesses and the SME market is often priced in a similar way to personal lines business, the only difference being the level of granularity of the rates (ie there are usually fewer rating factors). Over time we can expect more and more commercial lines business to be rated using personal lines techniques, in the same way that such techniques have spread throughout personal lines business.

3.24 Insurance sold to large corporate customers is often bespoke in terms of coverage, both extent and depth. As such it will be priced in a similar way to London Market business, with actuaries being asked to opine on various parts of the policy structure. Techniques used will be the same as in the London Market (not least because such business can be placed in either the conventional company market or the London Market, so it can be evaluated in a similar fashion).

3.25 However the bulk of commercial lines business is reasonably standard (in terms of ground-up coverage and steady limits) and lies somewhere between the two. It is expected that the end price will be a blend of the exposure (rated) price and the experience price; the key to pricing in this market is how the actuary and underwriter blend the two. Pricing in the commercial lines market is a partnership between the actuary and the underwriter, and it is critical that a sound working relationship is established between these two essential parties. Actuaries can help ensure that not too much reliance is placed on good claims experience and not too little on poor experience, and can use methods with a sound credibility basis that allows exposure and experience rates to be blended using mathematical credibility. The techniques used are very similar to those detailed in the CAS core reading, but essentially the bigger the risk and/or the more claims data available the greater the credibility. The use of such techniques is mathematically the same as assigning a return period to all large claims; this can help explain the techniques to the underwriting community.

3.26 If a sound blending basis can be put forward by the actuary and agreed by the underwriter it is possible to rate a large proportion of commercial lines business automatically, leaving just the larger cases requiring individual attention from both the underwriter and the actuary.

3.27 A comprehensive discussion of the methods used to price commercial business can be found in *Michaelides et al*.

Recommended areas of further research

3.28 Part of GRIP's terms of reference is to recommend areas for potential future research, either to augment current thoughts or to develop new lines of thought. GRIP's recommendations for further research are as follows.

Integration with ICAs

3.29 As part of the FSA's new solvency regime, most insurers have developed stochastic models as part of their ICAs submissions. It is the FSA's preference (and indeed good business practice), for these models to be integrated within the business. Part of this integration involves having consistent assumptions within the stochastic model and any pricing models (or at least assumptions within the capital model that are prudent compared to pricing models). These assumptions will include things like:

- loadings for catastrophe claims
- investment return assumptions
- frequency and inflation trends
- IBNR adjustments to historic data
- expected loss ratios
- business plans
- reinsurance recoveries
- capital loadings
- views of market cycles.

3.30 Many insurers have just completed the first iteration of building capital models, and an important next phase is to complete this integration.

Expense allocation

3.31 In personal lines insurance, a great deal of work is often undertaken on modelling risk premiums, with new rating factors explored and complicated interactions modelled, yet when it comes to loading for expenses, these are often implemented either at quite a simplistic level (perhaps even as a simple percentage of premium) or as a result of Activity Based Costing models often developed for other purposes. In particular, the interaction between fixed cost and variable cost is often not fully understood or recognised within pricing models, and we believe that there is scope for further research on the topic.

Variable capital loading

3.32 Capital allocation and loading methods are discussed in detail in Appendix C. All of these methods, however, derive an overall capital loading that does not differentiate risk by segment (or which makes a loading in proportion to the expected cost of claims). For example, within a motor portfolio, a higher capital loading might be appropriate for segments that generate more large claims or have higher levels of inherent variability. There has been little research to date as to how this link may be best achieved.

Catastrophe models

3.33 Outputs from catastrophe models are widely used by actuaries for pricing, particularly within the London and commercial markets. This usually involves taking output from proprietary catastrophe models. We believe that all aspects of these catastrophe models are not necessarily completely understood by actuaries, however, and we believe that there can be a lot more actuarial involvement in their development and use by insurers.

Pricing for latent claims

3.34 Latent claims are a concern for many reserving actuaries, but not much thought has gone into how potential future latent claims may be loaded into current prices.

Implementation

3.35 One of the key areas of feedback from stakeholders was that they felt that actuaries should not "walk away" when a technical analysis has been delivered. Some research on the best ways of delivering and communicating something that stakeholders can use and implement would be invaluable to the Profession and to stakeholders. Along a similar theme, actuaries potentially could have a very valuable input into the design of implementation and delivery systems in order to implement the best pricing solutions.

Market prices of insurance liabilities

3.36 John Hele, the Chief Insurance Risk Officer of ING, gave a talk at Staple Inn on 13 January 2006 entitled "What Do Actuaries Need to do to become Serious Broad Financial Services Risk Managers?". In his talk, he compared the approach of insurers to valuing liabilities compared to other financial services providers, and concludes that insurers are very poor at doing it. Particularly given potential future accounting changes, there is a huge amount of research required for deriving market prices of insurance liabilities. Further details of this discussion are available at www.actuaries.org.uk/Display_Page.cgi?url=/finance_invest/networking20060213.html

Game theory pricing

3.37 Although we have viewed discussing deriving market prices from technical prices as being largely out of our scope, we feel that there is scope for using game theory for explaining market movements in prices.

Effect of climate change

3.38 There has been much research undertaken by scientists in terms of the effect of climate change on weather patterns; we believe that it would be very useful to research into how this climate change might translate into insurance losses.

Market information

3.39 In the US, ISO (Insurance Services Office) provides a considerable amount of benchmark information on US lines of business. There is a feeling that similar data for the UK market would be of enormous benefit for pricing actuaries.

Using pricing models within reserving

3.40 The outputs of pricing models can be fed into the reserving process. For example, pricing models can be used as a prior input into a Bornhuetter-Ferguson calculation. Also, outputs from personal lines GLM models can be used within claims departments for assessing initial individual case estimates based on the factors and circumstances of the claim.

Demand and elasticity modelling

3.41 Although some work has been done on modelling elasticities and demand, there is still much work to be done in the area and in particular on which are the best techniques to use given the typical data availability.

Price optimisation

3.42 Price optimisation is currently an area of significant interest within the personal lines market, and is an area where actuaries are being challenged by offerings from non-actuaries. Further actuarial research on this topic may help put actuaries back to the forefront in the debate.

Conclusions and recommendations

3.43 Although we have not sought to write a comprehensive "Premium Rating Manual", we feel that such a document would be invaluable to the Profession and would feed very naturally into the education syllabus and CPD. Appendices C, D and E may form an extended "Table of Contents" for such a manual.

3.44 Our recommended approach to writing such a manual is in the form of a "Wiki". A Wiki is an online document which can be edited by anyone with the appropriate password. Individuals are free to write what they like on a topic, and over-write other contributions. Further details on Wikis can be found on the Toolkit Working Party page (http://toolkit.pbwiki.com). The best-known Wiki is wikipedia.com, and this may form a good template for how it may work. Most contributions are made by registered users, so that it is known who has made what changes. There is a board of reviewers that periodically reviews the content, as well as making recommendations to contributors as to what areas may require attention and maintenance. Such a board of reviewers could be formed by a new Faculty & Institute group, perhaps commissioned by the General Insurance Board. Such a group could manage the creation and maintenance of the Wiki, and also agree on issues such as

- whether only members of the Faculty, Institute and other specified professional bodies should be given access to contribute to the Wiki, or whether a wider access should be granted
- the degree to which the group should act as an active editor - for example establishing the balance between acting as "gatekeeper", filtering contributions prior to posting, as opposed to acting as periodic reviewer of material that has been posted previously
- what procedure should be adopted for resolving disputes in the event of contributors disagreeing on content.

3.45 The advantage of having a manual in the form of a Wiki is that contributors can come from around the actuarial world, and we would hope that very valuable contributions could come from members of bodies such as the CAS and the IAA, as well as from ASTIN members.

3.46 We have also suggested a range of research topics which we feel would benefit the Profession and the industry.

4 Communication

4.1 When we polled our stakeholders we received much feedback relating to communication issues. The comments received included observations such as:

- Actuaries need to be able to present results to management and other non-actuaries such that they understand - they should use plain English and not assume that their audience has the same depth of understanding of the range of issues that actuaries generally have.
- Actuaries should improve their influencing skills and become better at getting "buy-in" of others in the process, eg underwriters, marketers etc.
- Numerical analyses should be translated into recommendations.
- People from other disciplines, eg the marketing department, have a higher profile within organisations because they can often develop internal networks and relationships more effectively than actuaries.
- Actuaries could improve their listening skills and be more open to views of people such as claims managers.

4.2 Clearly this is a common theme, replicating what GRIT found when it polled its stakeholders, so it is an area that requires positive action. Pricing actuaries operate in an environment where many of the people with whom they work do not have the same level of technical and mathematical expertise. Add to this the fact that the language used is often unique to each market place, with no common definition of terms used, and it can be seen that the area of communications is fraught with difficulty and some very interesting challenges.

People

4.3 The people with whom a pricing actuary will deal are many and varied, from their own team and reserving actuaries operating in a similar technical framework, to underwriters, sales teams, management, Executive Officers and external bodies such as Regulatory authorities, the press and policyholders. All have differing views on what an actuary does, and all have their own outlook on what they are trying to achieve within the insurance market. Ultimately they must all receive the same understanding of what the actuary has been trying to achieve so that no ambiguity remains - this is a challenge to the best of communicators, let alone the actuarial profession.

4.4 Section 2 discusses five models of operation (Tariff, Qualitative Underwriting, Cost Plus, Distribution and Industrial) which describe different types of pricing work in which an actuary can be involved. Each model involves quite different types of work and gives rise to quite different communication styles and needs which will be required if the actuary is to be effective.

4.5 In particular, the people involved in each role will be quite different and communication style must be adapted to reflect both who is communicating and what is being communicated, not just to whom communications are being aimed. For example, there is quite a difference in the communication issues faced by the following three roles:

- *Analyst* - typically a student or newly qualified actuary, carrying out detailed analysis (eg GLM) using a high level of technical detail and large volumes of output
- *Portfolio Management* - typically senior students through to actuaries with several years of experience who are involved in the higher level running of an insurance portfolio (a business segment or line of business, say), responsible for pricing and other business decisions
- *Senior Management* - qualified and usually senior actuaries who are in strategic decision-making positions, including directors, who have responsibility for the profitability and performance of the business but who often have limited day-to-day involvement in detailed technical issues.

With whom do we communicate?

4.6 There will be many people with whom the pricing actuary will come in contact, each having their own brand of skills and means of understanding insurance from their own perspective. For example we have identified the following broad groups of people (or bodies):

- Other *internal actuaries*
  - Actuaries in senior positions within the organisation - they can be expected to have a good grasp of the technical aspects of the pricing actuary's work, depending on their prior work experience. Communication should be possible at all levels, and as they will be used to communicating with less technical senior management it might be possible to use them to assist with communicating pricing matters to them.
  - Reserving and Financial Actuaries ie those persons responsible for establishing claims provisions for the business, often involved in other aspects of finance such as planning and monitoring. Whilst they will be familiar with much terminology and general actuarial techniques they may not have the same level of familiarity on technical pricing matters. Communicating these may require starting from first principles but should be able to take place on a similar professional level. In this case the two parties should be equally interested in what the other is doing so regular two-way communication (talking **and** listening) is essential, particularly around issues of reserving the latest year and current pricing assumptions.

- Other members of the pricing team - the type of communication will depend on one's position within the team. Upward communication should be straightforward, but downward communication must have regard to the level of expertise and skillset of the recipient, this can be thought of in similar terms to the training methods employed when teaching less experienced people.

- *External actuaries* - these will usually be consultants, either called on to assist with pricing work or projects, or opining on reports under the auspices of GN12. As such they can be expected to be conversant with most actuarial pricing methods and terminology and so communication should be straightforward.

- *Underwriters* at all levels. Usually they will have ultimate price setting responsibility. Whilst they have an excellent understanding of the business they will be less conversant with actuarial and mathematical matters - some are strong mathematically (some may even be actuaries), others are not, and this must be established before attempting to communicate. Careful explanation and appropriate techniques must be employed to ensure the points are understood without confusion or misinterpretation.

- *Sales people* - often non-technical people whose understanding of insurance, and in particular matters pertaining to pricing, is often variable. They will be looking for information that makes their job easier which will require the actuary to convey the meaning of sound technical pricing. Different types of people are:

  - Internal, responsible for maximising sales. They are looking for areas that make sales more productive.

  - External (eg brokers) ie those people/bodies who are expected to purchase insurance or act as agents. Actuaries will usually be called upon to explain why prices are going up (no-one complains when they are on the way down), such people can be assumed to have a good understanding of the business but be fairly non-technical.

  - Marketers (internal or external) - those who look to find and expand the available markets, more at a portfolio level of involvement. Historically they are non-technical but increasingly we are finding mathematical techniques being of increasing importance in this area, so as technical competency is improving, it is possible that one may come across an actuary operating in this field.

- *Chief Executive Officer and Board*, very busy people more used to sound bites than detailed technical explanations.

- *Finance Departments* and people responsible for performance reporting, monitoring, planning, regulatory requirements etc. Such people have a sound business knowledge, invariably numerically strong, but it cannot be assumed they understand all mathematical concepts and this must be explored carefully when attempting to communicate.
- *The public* (individuals or corporate bodies) who usually see the insurance industry in a poor light and will be quite mistrustful of any communication. Historically the actuary has had little involvement, the two main contact points being:
  - as purchasers/policyholders (or with the potential to be)
  - as claimants (successful or otherwise).
- *The Press*, ranging from knowledgeable trade press to sensationalist tabloids. It is important to prepare carefully when communicating with them and only the most experienced actuaries should attempt to communicate 'off the cuff', particularly in recorded interviews.
- *Shareholders* or other *Stakeholders* in the business. They will have no interest in technical detail and so communication must be clear and easy to follow, typically visual methods are employed to best effect.
- *Regulatory Organisations* (eg FSA). If an actuary is involved there will usually be one on both sides of the table, so communication between the two parties should be straightforward. If no other actuary is present then it should be assumed that industry knowledge is excellent but technical matters may need careful explanation.
- *IT departments* and those responsible for providing data, hardware and software requirements, and help desks. They are not interested in technical detail and these will require careful step by step explanation, backed up by visual aids such as flow charts and diagrams. It can be important not to assume without confirmation that they understand what the actuary is trying to achieve.
- *Operational departments* and teams who run the people and facilities side of businesses, ensuring the business functions. They are technically weak and will require careful communication depending on the subject matter.

4.7 It can be seen that many different types of communication will be required depending on the situation and the level of understanding of the other party. The actuary will need to be aware how the different parties respond to the medium being used and must be prepared to amend or add other methods if the message is not being received and understood. Listening and observing reactions are critical to successful communication. The communication method used must be fit for purpose, but must reflect the differing requirements and skills/experience of the people involved, the subject matter and the level of understanding required.

Types of communication

4.8 Many perceive that actuaries occupy a world of numerical analysis and are often most happy when surrounded by as many numbers as possible. This perception is perhaps rather inaccurate, but it is almost certainly true that actuaries, unlike many others involved in insurance, are very comfortable communicating data and technical matters. Few others can relate to data in the same way, so the actuary will almost certainly have to translate the very technical nature of their roles into the non-technical. The type of actuary who gets drawn into general insurance usually is aware of this, and may even be expecting to devote a large amount of their time to doing it. But this does not necessarily mean that they do it well.

4.9 There are many types of communication, including:

- *Oral* - the use of the spoken word where issues can be checked in real-time, includes one-way oratories or discussions involving two or more people. This is very useful in face to face meetings (naturally) where reaction to statements can be assessed and appropriate action taken. When not in such situations (eg telephone) greater caution must be taken to prevent misunderstanding.
- *Written* - the use of reports, formal or otherwise, involving words and small tables, graphs or pictures. This facilitates large amounts of explanatory material, but lack of immediate feedback means that such reports must be constructed carefully. Quality and not quantity must be the watchword; too much information and it will not be read, too little could confuse. Careful use of management summaries and appendices will help it to be readable.
- *Graphical* - the use of charts or pictures, including tables of data. Owing to the depth of analysis carried out in personal lines this is usually the best way of conveying the results. In more general terms this is an excellent communication medium for non-technical people.
- *Visual* - the use of presentation techniques, including verbal and non-verbal backup. Again, particularly when combined with graphical output this is often the best medium for communicating with a non-technical audience.
- *Listening* - attentively hearing and understanding what is being communicated to the actuary so that the request or information is understood and modifications can be made before misunderstandings (in either direction) occur.

4.10 These may be used in isolation or together to improve overall communication.

Conclusions and recommendations

4.11 GRIP feels that there are two types of issues relating to communication:

- issues around the communication skills of actuaries in general, and
- specific and almost factual issues around the communication of pricing matters (not all of which will be "actuarial").

4.12 GRIP did discuss whether the first point was a matter for the Profession to address, or whether it was more for individuals and employers to develop these general skills. Given that the ability to communicate in general terms is tested to a certain extent within the examination structure by subject CA3 (formerly 201), GRIP feels that it is appropriate that the Profession seeks to address this more general issue.

4.13 Although the issue of communication skills in general applies to a much wider field of activity than general insurance pricing alone, and is therefore somewhat outside GRIP's terms of reference, we discuss some general aspects of communication in more detail in our discussion of CPD in Section 6. This discussion includes the recommendations that

- the Profession considers working with a third party educational partner to develop an educational product specific to actuaries, and also that
- the Profession considers extending the existing professionalism course to cover communication and other wider non-technical skills that should be expected of a newly qualified actuary.

4.14 In Section 7 we also discuss some general communication issues arising under the recently revised professional guidance.

4.15 More generally GRIP believes that improvements could be made in this area simply by actuaries endeavouring to be more aware of the requirements of their audience.

4.16 For issues relating to general insurance pricing, we would hope that the above discussion of the wide range of types of communication which can take place is a helpful framework in which to interpret any broader skills education or training initiatives which the Profession implements in the future. In addition, we believe that there are some specific issues which we feel merit particular attention:

- GRIT recommended that attention be paid in particular to issues around communicating uncertainty. We have similar concerns but are also aware of a number of other areas requiring attention. We set out in Appendix F some of the more common topics (or "pitfalls") which we have found to cause problems with communication. If sufficient interest exists, a catalogue of such pitfalls and tools to tackle such issues (including example wording, forms of graphs, "storylines" of concepts to stress etc) could be developed by the Profession perhaps as an appendix to a future Premium Rating Manual discussed in Section 3.
- GRIP also feels that it would be helpful if a more common way of defining the terminology within pricing could be established. We therefore recommend that a comprehensive glossary of pricing terms be compiled and published on the Profession's website. We believe that such a glossary would be helpful to those writing premium rating reports under the recently revised version of GN12. We set out in Appendix G some possible example sources of material to assist with the compilation of such a glossary.

5 Education

Introduction

5.1 GRIP's terms of reference regarding education are "to consider whether the content of the exam syllabus is adequate to prepare actuaries to work in the pricing area".

5.2 The motivations for our recommendations come from the Roles, Methods and Communication sections of this paper together with a comparison with the relevant CAS syllabuses. We feel the CAS comparison is particularly relevant at a time when overseas candidates are viewing the CAS qualification as an alternative to seeking Fellowship of the Faculty or Institute.

5.3 Reviewing the requirements of the examination system is linked with Continuing Professional Development requirements which are discussed in Section 6.

Current developments in the educational domain of the actuarial profession

5.4 In order to understand how best the existing Faculty and Institute education material could be improved with regard to pricing, during 2006 GRIP sought to understand the then current developments regarding how the education process may change in the future.

Different forms of assessment

5.5 The examinations of the Actuarial Profession have traditionally been three-hour tests in scrutinised examination halls without access to textbooks or other personal notes. Changes have been gradual over the years but are now, we understand, rapidly accelerating with the advent of the 2005 Strategy. Two of the newest examinations, CT9 (Business Awareness) and CA2 (Modelling), are run as two-day assessments involving interactive lecturing, problem solving, computer-based assignments and working in teams. The follow-up tests for CT9 are on-demand and via the website. Students can use textbooks or any other material that they bring with them for their modelling assignment in CA2.

5.6 A third exam to change is ST6 (Finance and Investment - Derivatives). For the 2007 exams, textbooks will become the major source of learning material, largely replacing the familiar core reading. As yet however, permission has not been granted for access to this material during the actual exam process.

5.7 Finally the Profession may approve a particular piece of dedicated research as a route to success at ST (specialist technical) or SA (specialist applications) level. Here the Profession would expect to be approached with the concept prior to the work beginning and for the work to be undertaken purely for the exemption process (ie not on the back of a pre-existing doctorate thesis). There would need to be supervision and interview to ensure that the final submission was indeed the student's own work and is equivalent in quality to the examination it replaces.

Recognition of exams from other actuarial bodies eg SOA, CAS

5.8 We understand that the Profession feels that, with the growing internationalisation of the actuarial profession and the ever closer cooperation of kindred bodies, it is reasonable to consider recognising learned assessments of other actuarial institutions. The UK Profession regularly monitors exam standards across the globe and is prepared to accredit passes in other regimes against its own syllabuses where appropriate.

5.9 Thus, we understand, students preferring to take CAS exams may do so and get exemptions from the equivalent papers in the UK framework. Students are always advised to inform the Profession of their intention and to gain confirmation of likely credits to be gained from success in their intended subject.

Greater involvement of universities for provision of parts of the syllabus

5.10 Another feature of the Morris Review is the encouragement of wider university participation in the provision of actuarial education for prospective Faculty and Institute qualifiers. Many universities currently offer courses which may entitle students to exemptions. Heriot Watt and Cass (City) are two of the better known UK faculties offering such courses. Typically exemptions are available up to the level of ST examinations.

5.11 We understand that it is not the Profession's intention that in future assessment would become the exclusive monopoly of universities. This could present problems in transition and may also conflict with an employer's wishes that students benefit from simultaneous experience and study.

Logs of work-based skills

5.12 Students are required to maintain logs of the key aspects of on-the-job experience which have been learned during the mastering of actuarial tasks in the office. These have to be submitted to the Profession and may generate comment if the work progression is not deemed appropriate for a student in a particular sector, given his/her experience and likely length of time to qualification.

Proposal for second specialist technical paper in general insurance

5.13 Many practitioners are unhappy about a seemingly widening gulf between the rapidly expanding needs of new qualifiers in general insurance and the topics taught by the current GI syllabus. One potential solution is to produce greater depth to the techniques which form the course and we understand that the introduction of a second ST subject is currently being considered by the Profession. We understand that a split between pricing and reinsurance in one paper and reserving and capital modelling in the other is the current proposal.

5.14 Such a change would bring about transition problems. It might also be argued that in digging deeper into currently taught techniques, it will make the GI qualification harder to get than life or pensions - this at a time when the pass rates for SA3 are about half of SA2 (life) and SA4 (pensions). The proposal has yet to be put before the Education Committee and ECPD Board but at the time of writing it has the outline approval of the GI Board.

Issues arising from the Role workstream

5.15 The Role workstream identified that separate areas of actuarial involvement require different skill sets depending upon the development stage of their sector. For example, in the Tariff model the actuary needs to have influencing skills in dealing with the regulator.

5.16 For all actuaries there is a fundamental requirement to have the key core technical actuarial skills. Beyond that as pricing actuaries we need to be able to demonstrate the softer skills, in particular team management, persuasion, negotiation, innovation and even political skills. These are discussed in more detail in Appendix B.

5.17 GRIT identified the need of reserving actuaries to understand better the underlying business. Clearly this is also a requirement of the pricing actuary and the Roles section highlights the importance of understanding not only the technical aspects of the underlying contracts but also the wider business and the markets our employers and/or clients operate.

Issues arising from the Communications workstream

5.18 The Communications workstream concluded that, as with the wider Profession as a whole, pricing actuaries could benefit from improved communication and influencing skills. Communication issues are of particular importance to pricing actuaries given the perhaps unusually diverse range of people with whom communication takes place. Whilst some issues around communication are of a general nature and overlap with issues of relevance to the whole Profession, there are some specific and almost factual issues around the communication of pricing matters which could be addressed at least in part in the examination syllabus or CPD material.

5.19 The current communication examination is arguably not sufficiently focussed on the areas that are important to the Profession or our stakeholders, with perhaps undue attention to items more suited to the GCSE English Language syllabus rather than the ability to communicate complicated technical ideas to people with different skills and knowledge.

Issues arising from the Methods workstream

5.20 Generalised linear modelling is a fundamental tool in personal lines pricing. There is a significant discrepancy between the skills required from a practicing actuary and the detail in the examination syllabus.

5.21 After analysing loss potential and then expense apportionment the next key step is understanding profit maximisation. Demand modelling, price elasticity and optimisation techniques are relevant skills for newly qualified personal lines pricing actuaries. Even where such sophisticated analysis is not possible an understanding of the underwriting cycle is desirable. Currently little or no education material is provided on these subjects.

5.22 Current actuarial skills are ideally suited to catastrophe modelling, and we believe that this is an area that could have been contributed to by actuaries in the same way that the introduction of GLM into personal lines pricing was in the 1990s. Actuaries should make further progress in this area and a proper grounding as part of the education syllabus would help in this regard.

5.23 A useful educational and CPD resource for actuaries moving into the pricing area would be a premium rating manual. Section 3 and Appendices C, D and E could form the potential structure of such a manual.

Issues arising from the stakeholder feedback

5.24 In addition to highlighting communication issues, the stakeholder feedback suggested that the contribution of actuaries could be improved if they had a greater understanding of insurance products and markets. Insurance products are covered to some extent in the current syllabus, however the feedback implies that a greater understanding would be helpful.

5.25 The Chartered Insurance Institute's (CII) education material covers products in great depth and we feel that the Profession, with the help and permission of the CII, could extract the CII examination material relating to insurance products to create additional education and CPD material. We feel that while a small amount of detail could be added to the examination syllabus (perhaps as an additional chapter in ST3) the bulk of such material might be more appropriate as background reading for SA3 or as a CPD reference document.

Issues arising from the consultation process

5.26 In many cases it would be beneficial for actuaries to contribute more (and at an earlier stage) in the design of IT systems so that the data they will eventually require is more readily available. Historically such contributions have been made without the benefit of specific professional training. In the future we feel that effective data design should be covered, at least to a limited degree, in the examination syllabus.

5.27 Although the rating factors of various lines of business are currently included in the Profession's examination syllabus, we received feedback that this area should be covered in greater detail, in particular with regards to understanding why different rating factors are predictive of experience.

Syllabus comparison with CAS

Introduction

5.28 GRIP has undertaken a summary comparison of the treatment of general insurance pricing material in the Faculty and Institute examinations with that in the CAS examinations. There are significant differences not only between the topics covered but also between the style and depth of material used in the two education systems. These reflect both the space available in the overall examination systems and the extent to which general insurance pricing is regulated by the country or state. In this section both the style and content of examination material are compared.

5.29 The syllabuses for CAS examinations 5 "Introduction to Property and Casualty Insurance and Ratemaking", 6 "Reserving, Insurance Accounting Principles, Reinsurance and Enterprise Risk Management" and 9 "Advanced Ratemaking, Rate of Return, and Individual Risk Rating Plans" can be found from the following link: https://www.casact.org/admissions/syllabus/2006/. Most of the readings for these can be directly downloaded from the website.

5.30 The syllabuses for the Faculty and Institute examinations CT6 "Statistical Methods", ST3 "General Insurance Specialist Technical" and SA3 "General Insurance Specialist Applications" can be downloaded from the profession's website at http://www.actuaries.org.uk/Display_Page.cgi?url=/students/syllabuses2007.html. The Core Reading is not available on the internet but can be purchased from the Institute or Faculty of Actuaries or from Acted.

5.31 We also reviewed the relevant Institute of Actuaries of Australia examinations which we felt confirmed that our recommendations from the CAS analysis were appropriate. The syllabuses for the Institute of Actuaries of Australia can be found at the following addresses: (Part I subjects, General Insurance A, General Insurance B respectively)

- http://www.actuaries.asn.au/NR/rdonlyres/4A181E68-5FD9-4BBF-B211-2DC23E0AA1EC/488/part1syllabus2006.pdf
- http://www.actuaries.asn.au/education/courses/C3A
- http://www.actuaries.asn.au/education/courses/C3B

Qualitative differences in examination material

5.32 The CAS system has nine examination papers all of which are relevant to general insurance although three of these papers are common with the Society of Actuaries (SOA). Of the nine CAS examinations two are solely on ratemaking: examination 5 and examination 9. Reinsurance pricing is covered in examination 6. In contrast the Faculty and Institute system has 14 examinations, three of which, CT6, ST3, SA3, are directly relevant to general insurance, each of these having only a small part directly relevant to pricing. Given the difference in emphasis on general insurance between the two examination systems it is not surprising that the CAS examinations are able to cover pricing in much greater depth.

5.33 The Faculty and Institute syllabus consists of a list of objectives which are covered in more detail in the Core Reading. The Core Reading gives a concise description of all the material that could be examined in the examinations. This material is fleshed out to some extent by study material available from Acted. The CAS syllabus also has a list of objectives and for each of these a list of reading is given. The reading consists of a mixture of book chapters, journal articles, specially written study notes and Actuarial Standards of Practise (ASOP). To give a feel for the difference between the material compare the length of unit 9 "Rating Methodology" of ST3, which covers the majority of rating material in this examination in 9 pages, with the 77 page chapter 3 "Ratemaking" from "Foundations of Casualty Actuarial Science" which is just one of 33 readings for CAS examination 5.

5.34 The style of material is also quite different in the two examination systems. The UK material tends to cover concepts at high level giving students a pointer to which factors are important in rating without going into much detail for specific situations or classes of business. In contrast to this the CAS material goes into great detail on both methods and principles and many of the readings relate to one particular class of business.

5.35 There are advantages and disadvantages with both styles. The brief UK style has the advantage of directing a student's attention to the key aspects of each topic and allowing them to spend time on these. Ideally, this would give the student a set of principles to apply in any situation. In reality there can be a huge gap between the material covered in the examinations and the knowledge necessary for day to day pricing work. With the US style, students need to condense a large body of disparate material, select and take on board the key factors. Use of journal articles in the CAS syllabus will familiarise students with use of the literature and allow new material to be added in easily. However, there will inevitably be duplication of material between various articles and some may go into unnecessary detail. Also, much of the CAS material will not have been written specifically for use in an examination syllabus.

5.36 Another major difference between the syllabuses comes from the need for the CAS to prepare its students for filing rates and information with state bodies and also to be able to make use of the information available from rating bodies such as the Insurance Services Office (ISO) and the National Council on Compensation Insurance (NCCI). This material could be considered to be irrelevant as country specific, however, the ratemaking concepts are useful to understand and a better knowledge of rating bodies and data available from them would be invaluable to actuaries of London Market insurers and reinsurers who write large volumes of US business.

Comparison of topics covered

5.37 Given the differences in depth, style and emphasis of study material described above it is hard to make a direct comparison between the content of the CAS and Faculty and Institute examination syllabuses. We have focused on topics covered by the CAS examinations but which are largely missing from the Faculty and Institute syllabuses.

General rating principles

5.38 Both syllabuses cover the basic principles of rating such as exposure, trends, loss development, types of policy and business, data, profits, expenses, contingency loads, credibility, regulatory and economic environments. However, most of this is covered in far greater depth in the CAS examinations. The CAS examination 5 covers the specialised lines of business, Medical Malpractice, and Professional Liability. Professional Liability is mentioned briefly in Unit 2 of both SA3 and ST3. Further details of this product and of medical malpractice would be very helpful for London Market students. Another key topic covered by the CAS examination 5 but missing from the Faculty and Institute syllabus is rating Claims Made Cover. CAS examination 9 includes Risk Loading and its link to variability. Risk loading is widely used in the London Market but is not included in the Faculty and Institute syllabus.

Classification ratemaking

5.39 This is the rating of grouped risks, ie personal lines. Both the US and UK syllabuses cover the selection of rating factors and grouping of data. However, this is dealt with in greater depth in the CAS examinations. A key topic missing from the Faculty and Institute examinations is generalised linear models. Some theory is covered in CT6 Unit 9 of the Faculty and Institute examinations, however, no link is made from this to the practical use of GLMs in personal lines pricing. Pricing with GLMs is not covered in ST3 or SA3. In contrast to this GLMs are now covered in some detail in the CAS examination 9. See for example the study note "A Practitioner's Guide to Generalized Linear Models" by *Anderson et al*.

Individual risk rating

5.40 This is rating individual large risks ie commercial lines or some of the sorts of risks that would be seen in the London Market. The CAS examinations cover this topic in both examinations 5 and 9. Key areas covered are: experience rating, exposure rating, schedule rating, prospective and retrospective loss sensitive rating, large deductibles and excess layers and credibility. Much of this material is very US specific referring to NCCI and ISO rate filing. However, more general references, such as the CAS study note "Individual Risk Rating" by M.W. Tiller, are also given. Although individual risk rating is mentioned in a paragraph of Unit 9 of ST3, there does not seem to be a clear distinction between classification rating and individual risk rating in the Faculty and Institute syllabus. Unit 8 of SA3 briefly covers prospective and retrospective rating.

Excess and deductible rating

5.41 CAS examination 9 covers the use of frequency and severity distributions to determine expected losses by layer of insurance. Methods of estimating frequency and severity distributions from losses are also covered. These are key topics missing from the Faculty and Institute examinations. Unit 2 of CT6 gives a derivation for loss distributions in excess of loss reinsurance but this is never expanded upon to show how the theory could be used in practice to price excess layer business.

Increased Limit Factors (ILFs)

5.42 These are covered in detail as part of CAS examination 9. Although they will be introduced into the UK syllabus this will only be at a very basic level which is not sufficient for a subject so useful and important as ILFs.

Reinsurance rating

5.43 Both the CAS and Faculty and Institute examinations cover reinsurance products and the sharing of risk between insurer and reinsurer. All aspects of reinsurance are covered in CAS examination 6 and the CAS study note "Basics of Reinsurance Pricing" by D.R. Clark gives a very full description of reinsurance pricing methods including Burning Cost Rating, Experience Rating, Exposure Rating, and use of ILFs. Reinsurance pricing is not covered explicitly in any of the Faculty and Institute examinations.

Catastrophe modelling

5.44 Pricing for catastrophic events using computer models is covered in CAS examination 9 although only one reading is given and this focuses on homeowners business. Catastrophe models are not included in the Faculty and Institute syllabus.

Discussion

5.45 At present it would be fair to say that, given equivalent work experience, an actuary who has just passed the CAS examinations will have far greater knowledge of general insurance theory, and in particular pricing, than one who has just qualified with the Faculty or Institute. This lack of knowledge may be compensated for by personal study and relevant work experience (especially considering that the feedback suggested that a good working knowledge of products and markets is very much valued by our stakeholders). However, there is anecdotal evidence, particularly in the London Market, that some companies now prefer to recruit general insurance actuaries with the CAS qualification.

5.46 A particular problem with the lack of coverage of pricing in the Faculty and Institute examinations is that not all newly qualified UK general insurance actuaries will have the necessary background to work in pricing. In contrast to this the CAS examinations provide a solid background from which to begin pricing work.

5.47 A quick solution to this problem would be for all trainee general insurance actuaries to sit the CAS examinations. However owing to the lack of support for this in the UK and the US specific nature of some of the material this could be an impractical option. Also UK specific topics and classes of business are not covered in the CAS examinations. Furthermore, it is unlikely to be in the long term interest of the Profession to encourage participation in another body's examination syllabus in preference to our own.

5.48 Additionally, there are some potential benefits to the Faculty and Institute style of study material. Covering topics at a high level can enable students to stay open minded and learn to think through many possibilities. Having a Core Reading rather than a disparate set of texts can allow the most important aspects of topics to be expressed in a concise way that is easy for students to learn. Avoiding too much detail can be beneficial so long as there is enough to allow the theory from the examinations to be used in practice in the workplace.

5.49 Another option would be to incorporate some material on pricing from the CAS syllabuses into the Faculty and Institute syllabuses. This would not be straightforward as each of the CAS examinations 5 and 9 probably covers more material than any one of the Faculty and Institute examinations. However, if more space were given over to general insurance in the Faculty and Institute examinations it could be possible to condense some of the most important parts of the CAS readings on pricing and include these in our examinations.

5.50 Insurance is a global business since risk is spread internationally. Unlike for life and pensions there is little need for an examination to deal solely with UK practice. In fact there is not a great deal of difference between the topics currently covered in ST3 and SA3. As well as learning about UK specific topics it would be useful for general insurance students to learn about some US specific topics since many UK insurers and reinsurers write significant volumes of US business. For example, basic information about US rating bodies and the use of ISO and NCCI data could be helpful, as could a summary understanding of some of the issues arising from differences in personal lines products in Continental Europe (eg Bonus-Malus systems and inter-insurer agreements). However this sort of information could equally be drawn together into some kind of note that could be used for CPD.

Recommendations

5.51 Considering the issues raised in the previous sections GRIP recommends that the ST and SA examination syllabuses be enhanced to cover the following topics which GRIP considers to be missing or inadequately dealt with in the current syllabuses:

- pricing basics
- policy terminology, including Claims Made vs Occurrence cover
- insurance products (based on CII material)
- data design
- understanding rating factors
- exposure measures
- exposure rating
- experience rating
- trends (exponential and linear)
- profit, expense, risk and catastrophe loading
- generalised linear models
- demand modelling, price elasticity and optimisation techniques
- individual risk rating
- excess and deductible rating
- reinsurance rating
- catastrophe modelling
- medical malpractice and professional liability business
- use of ISO and NCCI information.

5.52 It may be necessary to create a new examination to deal solely with general insurance pricing. Such an additional examination may fit in well with potential changes to the education system currently being discussed.

5.53 As an example of the level of detail we envisage we set out a suggested draft syllabus item for generalised linear models in Appendix H.

5.54 GRIP further recommends that:

- The Profession considers using the CAS and IAA syllabuses as part of the basis for enhancing the ST and SA examinations, incorporating key material for each of these topics into the Core Reading. This task would require significant resources as the relevant CAS and IAA reading will need to be read and condensed.
- A comparison of examination questions as well as syllabus topics should be undertaken as these may reveal further noteworthy differences.
- Certain overseas specific topics of relevance to UK actuaries could be included in the examination syllabus or be made available as CPD.
- The CT examinations, in particular CT6, be reviewed to ensure that the necessary mathematics has been covered to allow students to tackle pricing topics suggested above in sufficient detail.
- Some of the more "factual" aspects of how to communicate pricing matters effectively (for example some of the issues set out in Appendix F) should be covered in the examination syllabus while reducing the prominence of punctuation, grammar and spelling.
- At the same time, the Profession should seek to ensure that any changes to the examination syllabus do not detract from the goal of developing well rounded technical professionals who are able to think for themselves.

5.55 Our discussions also highlighted a number of other softer skills which should be developed, for example relating to communication and management (examples are discussed in Appendix B). We feel that these skills requirements are better addressed via CPD, which is discussed in Section 6.

6 CPD

Introduction

6.1 GRIP's terms of reference regarding Continuing Professional Development (CPD) are "to consider whether more should be done to provide CPD in this area, and if so, what".

Current CPD options

6.2 The Profession requires actuaries to demonstrate that they develop and maintain the skills required to perform their professional role. In this section we discuss the current options and make recommendations for the future provision of CPD relevant to UK general insurance pricing actuaries.

6.3 Currently the main CPD options are GIRO and the Current Issues in General Insurance seminar. They cover a broad audience and do not have room for enough specialist pricing talks to provide all the CPD for a pricing actuary. For GIRO the timing, length and cost of the event makes it hard for some people to attend.

6.4 There are regional actuarial groups but outside London there is not a great deal of discussion directly relevant to general insurance actuaries. There is the London Market Actuaries Group (LMAG), however like GIRO this group covers a wide range of general insurance topics and does not provide focused pricing CPD.

6.5 The overseas options can still be very relevant for UK actuaries, particularly those involved in international business.

6.6 The CAS Seminar on Ratemaking is a very well run 1½ day event, and for London Market pricing actuaries their Reinsurance Seminar is also highly relevant. In the last three years the CAS has also held annual special interest seminars on predictive modelling. The presentations are designed around training and providing information and are graded by the level of knowledge assumed from the audience. The CAS also runs other conferences which have relevant CPD material.

6.7 Other international options are the statistically technical ASTIN (Actuarial Studies In Non-life insurance) conferences and the International Congress of Actuaries which meets broadly every 4 years.

6.8 There is a new organisation called the Lighthill Risk Network that has recently organised technical events. In September 2006 they held a half day pricing seminar.

Pricing conference

6.9 In our discussions by far the most popular suggestion was a short conference on the lines of the CAS Seminar on Ratemaking, hereafter referred to as the "Pricing Conference".

6.10 The target audience of this conference would be qualified actuaries currently spending a meaningful percentage of their working time on GI pricing, ranging from newly qualified actuaries to experienced professionals, from personal lines to London Market.

6.11 Students would not be excluded but the intention would be for them to continue their professional development through the education and examination systems, our recommendations for improvements in this area are in the education section.

6.12 In order to cater for this range of experience and to help people to select appropriate breakout sessions or workshops, the conference should use "level of experience" indicators, eg Basic, Intermediate, Expert.

6.13 Initially we recommend a one day course, in an easy to get to location, probably London. Until the event is established the size problems which currently GIRO faces are unlikely to be a limitation.

6.14 In the longer term we would like to move towards a two day event, with part attendance being "officially" possible and charged for on a one day or two day basis. This allows those who have trouble leaving the office for a couple of days the option of obtaining relevant CPD and keeping the costs down. Some thought will be required into the design of the program to make the one day attendance useful, perhaps targeting personal lines one day and commercial/London Market the next day.

6.15 Regarding timing we would recommend avoiding quarter end reserving periods for those who are involved in this activity, pricing renewal seasons, summer holidays, GIRO and the Current Issues seminar. Given the work both before and after quarter end reserving this leaves February and November as potentially the best times of the year.

6.16 We would like the format of the conference to be a relatively short plenary session at the start of each day with the rest of time being workshops, leaving time between workshops to discuss and think about the concepts presented.

6.17 The workstream discussed extensively the type of material to be presented. Ideally we would like to have practical examples and discussion of methods which can be easily translated back to the office.

6.18 Examples of the sort of topics we envisage are:

- summaries of implementations of "famous papers" with discussions around practical problems of using the methods from these papers
- use of external datasets, eg for floods
- provision of relevant data, eg providing a forum for collecting and distributing market data
- introduction to personal lines, commercial lines, London Market, and reinsurance
- statistical approaches applicable in personal lines, eg geographical spatial analysis methods
- issues relating to other practice areas eg how pricing actuaries can use ICA models.

6.19 The introduction of a Pricing Conference is GRIP's key recommendation regarding CPD. It will ease the strain of numbers on GIRO, provide pricing actuaries with alternative CPD options, particularly if they are unable to leave the office at the end of September / start of October.

6.20 The main issue may be persuading individuals to devote the time required to present at the conference.

6.21 Even after the introduction of a Pricing Conference we still feel it would be desirable to have a few more pricing workshops at GIRO.

6.22 In the short term, prior to a Pricing Conference being arranged, one option is to encourage members of the Profession to attend CAS events. These are well run and relevant to a pricing actuaries even if they have no or little US exposure in their day to day work.

Other CPD options

6.23 Outside of a pricing conference we did discuss other methods of delivering relevant CPD to pricing actuaries.

Premium rating manual

6.24 As noted in Section 6, a useful CPD resource for actuaries moving into the pricing area would be a premium rating manual.

Post qualification examination

6.25 The idea of a post qualification examination was not thought helpful by members of the workstream and other actuaries canvassed. The real provision of CPD is through the educational material itself rather than the sitting of an examination, relying on the qualified professional to have the motivation to learn directly relevant information.

Institute website

6.26 The Faculty and Institute website contents and search facilities could be significantly improved to contain research information in an easily accessible way. The research section of the CAS website was widely cited as best practice.

6.27 The core reading is a useful resource in areas a practising actuary may not have experience. The profession's website could be used to store the core reading, preferably on a page open to the public.

Discussion groups

6.28 Those members of GRIP participating in the methods workstream found it very useful to discuss methods and common problems. Small informal groups to discuss pricing issues can be a helpful support, allowing actuaries to ask "stupid" questions without fear of ridicule in a larger group. Care should be taken to avoid discussing individual cases or covering areas that might break competition law.

6.29 GRIT recommended a buddy system for reserving actuaries where an actuary, which may be external to one's own company, acts as a "buddy". Given the commercial sensitivities involved this would be difficult to implement in a pricing context.

Advisory notes

6.30 In the US the Actuarial Standards Board issues Actuarial Standard of Practice notes which set out generally accepted actuarial practices. Similar advisory notes could be produced for use in the UK environment. This is discussed further in Section 7.

Non-technical skills

6.31 During the stakeholder interview process at the start of GRIP, participants cited many skills that effective pricing actuaries should have. Many of these are discussed in Section 2 and Appendix B. CPD should also include these "non-core" actuarial skills such as:

- people management
- communication
- negotiation.

6.32 The Institute or Faculty may not be the most appropriate provider of the softer skills and business understanding training, however, their involvement with an educational partner could tailor an educational product specific to pricing actuaries. Indeed over recent years the CAS has included as part of its general meetings and seminars optional workshops run by specialist third party providers which cover a range of communication skills. The UK Profession might wish to consider this approach in the future.

6.33 Also of potential interest is the fact that The Institute of Actuaries of Australia recently introduced a mandatory six day residential course (with assessment) covering a range of non-technical skills. This "Commercial Actuarial Practice" course has the overall objectives of providing the skills and knowledge to be able:

- to apply actuarial skills across a range of traditional practice areas and in unfamiliar (ie non-traditional) areas by contextualising actuarial solutions or approaches in the wider commercial environment of the business as a whole
- to apply ethical concepts, corporate governance requirements and actuarial professional standards when contextualising actuarial solutions or approaches
- to communicate successfully the actuarial solutions or approaches to a range of audiences.

6.34 Further details of this course can be found on the Institute of Actuaries of Australia website at www.actuaries.asn.au/education/courses/C10

6.35 One option may be to extend the current UK professionalism course from two days to three to five days, covering not just professionalism but also communication and the other wider non-technical skills that should be expected of a newly qualified actuary, along the lines of the approach adopted by the Institute of Actuaries of Australia.

Knowledge of products and markets

6.36 The Role workstream identified that even the above standard softer skills were not sufficient in the more developed models of operation and that an actuary requires a complete end-to-end understanding of all the business processes of an insurance company.

6.37 The stakeholder feedback also suggested that actuaries could be more effective if they possessed an increased understanding of products, markets, and practical issues around the functioning of an insurance company (for example claims processes, underwriting procedures, operations, the dynamics of different distribution channels).

6.38 In reality much of this practical knowledge comes from relevant work experience, and indeed it could be argued that the nature of most actuarial careers (and indeed the examinations themselves) result in actuaries bypassing work experience that would provide the grounding in these matters that other career paths provide.

6.39 Some of these "market knowledge" issues can and perhaps should be touched on explicitly in future examination syllabuses and CPD initiatives. In particular, as discussed in Section 5, we believe it would be helpful if CII examination material relating to insurance products could be used to enhance the syllabus and also to prepare a CPD reference document. Perhaps the most effective course of action in this area, however, is to ensure that all CPD material is designed with this issue in mind, and that CPD is given a "practical edge".

Recommendations

6.40 In summary, in relation to CPD, GRIP recommends that:

- The Profession organises an annual one day pricing conference from 2008.
- A future group within the Profession creates a premium rating manual freely available on the Institute website, ideally in the form of a Wiki as described in Section 3.
- The Profession materially enhances its website to include an effective research search facility. The website should also include core reading from the examinations system.
- The Profession explores the idea of approaching a third party training company to design a training package around softer skills relating to communication and management.
- The Profession ensures that all CPD initiatives are designed bearing in mind the stakeholder feedback which called for a greater understanding of products and insurance markets. CII education material may help with this in areas relating to insurance products.

7 Guidance

Introduction

7.1 The landscape of professional guidance for actuaries has changed significantly during 2006. On 1 April 2006 the Financial Reporting Council (FRC) took on responsibility for overseeing the regulatory activity of the Profession and established the Board for Actuarial Standards (BAS) which will, in future, set technical standards for actuarial work.

7.2 This change in the regulation of the work of actuaries was one of the central recommendations of the Morris review and was endorsed by both Government and the Profession.

7.3 2006 also saw two significant developments in the guidance notes applicable to members of the Profession working in the field of general insurance. GN50: General Insurance Principles and Practice was introduced on 1 April 2006 and adopted by BAS on 19 May 2006. GN12: General Insurance Business: Actuarial Reports was substantially amended and the new version has been effective from 1 June 2006. GN12 was adopted by BAS on the same day.

Standards and guidance for UK pricing actuaries

7.4 There are currently no standards/guidance notes whose application is specifically stated as being only for general insurance pricing. However, there are now three standards and guidance notes with which actuaries involved in pricing work need to comply. These are the Professional Conduct Standards (PCS), GN50 and GN12. Quotes in this section are from these documents.

PCS

7.5 PCS gives guidance on professional conduct to which all members of the Profession must conform in both "the spirit and the letter". PCS is *always on* ("All members must comply at all times with the PCS") and applies "even if a member is also subject to the standards of another professional actuarial body".

7.6 PCS is general in nature but makes specific reference to situations where the advice relates to an insurance company or a Lloyd's syndicate:

"3.5 Advice should normally include sufficient information and discussion about each relevant factor and about the results of the member's investigations to enable the intended recipient of the advice to judge both the appropriateness of the recommendations and the implications of accepting them, including, where the advice relates to an insurance company, a Lloyd's syndicate, a friendly society or a retirement benefit arrangement, the implications for the policyholders of the insurance company or syndicate, the members of the friendly society or the beneficiaries of the retirement benefit arrangement, as the case may be."

7.7 GRIP's consideration of some of the current issues regarding the implications of the pricing actuary's advice on policyholders is given in Section 8: Treating Customers Fairly.

7.8 Given that many UK pricing actuaries are involved in work outside the UK we highlight that PCS sets out the standards that are applicable when a member is providing advice in, or carrying out work in, a jurisdiction outside the UK.

GN50

7.9 The stated purpose of GN50 is to give guidance on the professional behaviour expected of members in the field of general insurance. For such members GN50 is *always on.* We note that, as GN50 has "natural relevance to actuarial modelling of risk beyond traditional insurance applications", pricing actuaries currently working or intending to work in wider fields will also need to consider the implications of GN50. In particular GN50 states that "a member must be able to justify any non-compliance with a general insurance guidance note that would appear to have natural relevance".

7.10 Members of GRIP reviewed the exposure draft of GN50 and did not identify any major concerns regarding the implications of this new guidance note for pricing actuaries. However, from 1 April 2006, all such actuaries will need to consider the impact of GN50 on their work and company procedures (eg GN50 gives guidance regarding data imperfections, communicating uncertainty and documentation).

GN12

7.11 The stated purpose of GN12 is "to give guidance on the circumstances in which a member should normally prepare a formal report in the field of general insurance, and to describe the basic elements that should normally be included in such a report". Unlike PCS and GN50, GN12 is not *always on* in so far as it only applies to a member preparing a formal report. GN12 requires the member to exercise professional judgement when deciding whether work requires a formal report and gives principles that the member should follow when making this judgement.

7.12 Members of GRIP reviewed the GN12 exposure draft EXD62. GRIP appreciated the need for a clearer stance on guidance in the changing general environment but considered that there were significant problems with the exposure draft from a pricing perspective. In particular, our view was that:

- the definition of a formal report was too wide
- there was a reserving bias
- some requirements would be onerous in a pricing context.

7.13 Regarding this last point, in the initial stakeholder feedback on the role of actuaries in pricing, senior stakeholders said that they would like to see actuaries getting closer to the business. If guidance was too onerous this could be a step in the opposite direction.

7.14 GRIP's full response to the consultation on EXD62 given at the consultation meeting in Staple Inn on 18 January 2006 is set out in Appendix I.

7.15 Following the consultation period, the changes made for the version of GN12 approved under due process substantially addressed our immediate concerns. However, there are a number of areas where we suggest that *Information and Assistance Notes* (IANs) be provided to give further help to members, for example:

- We feel it would be helpful to clarify how GN12 applies to pricing actuaries working in companies. A particular example is the Industrial model described in Section 2. In this model the role of the actuary can be primarily concentrated upon management and maintenance of complex systems and there may be only a relatively small fraction of the pricing team that are actuaries.

- GN50 asks members to be mindful of the intended audience when presenting the findings of the work carried out. This audience may not be an actuarial audience. GN12 states that a formal report should normally contain detail sufficient for another suitably experienced member to form an opinion of the original member's key judgements and assess the reasonableness of the results. This can lead to conflicting guidance on what the most effective communication of the findings would be.

- It may not always be clear how much detail is sufficient for a member to comply with paragraph 3.3 of GN12 (which states that "The report *should normally* contain detail sufficient for another suitably experienced member to form an opinion on the original member's key judgements and assess the reasonableness of the results"). GN12 currently leaves this to the professional judgement of the actuary writing the report, which may not be the same as the professional judgement of an actuary assessing the reasonableness of the results. As an example consider a personal lines claims analysis using GLMs. It might be possible that a dataset analysed contains six different claim types and sixty potential explanatory variables. Claims frequency and average claim amounts might be modelled separately, and the models iterated to include only those factors which a member considers to be statistically significant (perhaps, for the sake of argument, thirty in each model). To demonstrate the appropriateness of the member's model selection, in addition to various statistical diagnostics it could easily be argued that the report should include graphs showing the statistical effect of each factor included in the model and also each factor excluded from the model. In total this would amount to over

700 graphs. In addition, it could easily be argued that all interaction factors investigated should be included in the report, whether deemed significant or not. This could take the overall number of graphs in the report to over 1,000. It would be helpful for the Profession to have a common interpretation of what GN12 requires in this case.

Other professional bodies

Casualty Actuarial Society

7.16 The Actuarial Standards Board promulgates Actuarial Standards of Practice (ASOPs) for use by actuaries when providing professional services in the United States. There are 10 ASOPs which are applicable for product development, rate making or pricing.

ASOP	Purpose	Comments
No. 9.	To define the documentation and disclosure required of an actuary in property and casualty insurance	This ASOP has an appendix containing the CAS Statement of Principles Regarding Property and Casualty Insurance Ratemaking. This Statement of Principles is discussed in 7.17 to 7.21 below. This ASOP covers many of the same issues as GN12.
No. 12	To provide guidance to actuaries when performing professional services with respect to designing, reviewing, or changing risk classification systems.	This ASOP covers all practice areas. There is no direct equivalent for the UK Profession, but some of the issues are addressed by PCS and GN50.
No. 13	To provide a basis for assessing procedures appropriate for estimating future expected values by analyzing historical data and other relevant information.	This ASOP is applicable to all property and casualty lines of insurance. There is no equivalent for the UK Profession.
No. 23	To give guidance on selecting the data that underlie the actuarial work product; relying on data supplied by others; reviewing data; using data; making appropriate disclosure with regard to data quality.	This ASOP covers all practice areas. There is no direct equivalent for the UK Profession, but many of the issues are addressed by the Data sections of GN12 and GN50.

No. 25	To provide guidance in the selection of a credibility procedure and the assignment of credibility values to sets of data.	This ASOP is applicable to accident and health; group term life; property /casualty coverage. There is no direct equivalent for the UK Profession, but many of the issues are addressed by the Analysis of Emerging Experience section of GN12.
No. 29	To provide guidance in estimating expense provisions in ratemaking	This ASOP is applicable to all property /casualty coverages. There is no equivalent for the UK Profession
No. 30	To provide guidance in estimating the cost of capital and evaluating underwriting profit and contingency provisions.	This ASOP is applicable to all property /casualty coverages. There is no equivalent for the UK Profession
No. 38	To provide guidance to the actuary in using models that incorporate specialized knowledge outside the actuary's own area of expertise.	This ASOP is applicable to all property /casualty coverages. Examples of such models are catastrophe and credit scoring models. There is currently no equivalent for the UK Profession. Reliance on experts is included in GN50.
No. 39	To provide guidance on the treatment of catastrophe losses in ratemaking	This ASOP is applicable to all property /casualty coverages. There is no equivalent for the UK Profession
No. 41	To provide guidance with respect to written, electronic, or oral communications.	The title of this ASOP is "Actuarial Communications" and applies to all actuaries. There is no direct equivalent for the UK Profession, but many of the issues are addressed by PCS, GN50 and GN12.

7.17 The CAS Statement of Principles regarding Property and Casualty Insurance Ratemaking aims to provide the foundation for the development of actuarial procedures and standards of practice. The Statement does not address specific issues such as utility pricing, which is not surprising as it was adopted in May 1988, but states that it is important that proper actuarial procedures be employed to derive rates that promote equity and availability for insurance consumers.

7.18 The four principles set out in the Statement are:

- Principle 1: Rate is an estimate of the expected value of future costs
- Principle 2: A rate provides for all costs associated with the transfer of risk
- Principle 3: A rate provides for the costs associated with an individual risk transfer
- Principle 4: A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future cots associated with an individual risk transfer.

7.19 As well as the above four principles the Statement contains a useful list of definitions and a set of 'considerations' that are common to many methodologies (eg choice of exposure units, organisation of data). In the final sentence of its conclusion the Statement echoes the views obtained in our stakeholder interviews with the words "By interacting with professionals from various fields including underwriting, marketing, law, claims and finance, the actuary has a key role in the ratemaking process".

7.20 The Statement of Principles regarding Property and Casualty Insurance Ratemaking can be found at www.casact.org/standards/princip/sppcrate.pdf

7.21 Ratemaking in the United States is heavily regulated compared with the UK. Many of the ASOPs indicate that the reason they were produced was because of the increasing complexity of aspects of rate making and greater public scrutiny of actuaries. The above table shows that, whilst we have fewer documents in the UK that are applicable to pricing, many of the issues in the ASOPs are addressed by the UKs Profession's guidance notes. Many of the ASOPs are closer in style and content to what the UK Profession would call an advisory note.

The Institute of Actuaries of Australia

Pricing specific guidance

7.22 In contrast to the US, Australia only has one guidance note with specific application to pricing/rating. This is in relation to premium rate filings under the New South Wales Motor Accidents Scheme. Insurers are required by law to submit their rates to the regulatory body, the Motor Accidents Authority (MAA). These submissions are to be accompanied by a report from an actuary in which the actuary gives an opinion as to whether the insurer's proposed premium will fully fund the liability.

7.23 If there were such a reserved pricing role for actuaries in the UK then we would expect the BAS to consider issuing a guidance note.

General guidance

7.24 The IAA Code of Professional Conduct ("Australian Code") applies to all members (including student members) and is the Australian equivalent to the UK Profession's PCS. It can be found at www.actuaries.asn.au/ActuarialPractice/ProfessionalStandards

7.25 The Australian Code differentiates between Actuarial Advice and a Professional Service. Actuarial Advice can only provided by an Actuary (being a qualified member) and is a subset of Professional Services. The two terms are defined as follows:

- **"Professional Service"** means a service provided by a Member in a professional capacity, including Actuarial Advice provided by an Actuary. A Professional Service includes such a service provided on a pro bono basis**.**
- **"Actuarial Advice"** is any conclusion, result, opinion or recommendation provided by an Actuary as a result of performing a Professional Service:
  - **a.** in a Statutory Role; or
  - **b.** within the scope of the Professional Standards; or
  - **c.** for his or her Principal concerning a matter and in circumstances where the Principal reasonably believes that the conclusion, result, opinion or recommendation is being given in accordance with professional requirements governing impartiality, expertise as an Actuary and formal reporting.

7.26 There is also an option for an Actuary to clarify with a client that certain advice is a Professional Service rather than being Actuarial Advice.

7.27 The Code has some sections covering all Professional Services including the potential for misuse of Professional Services, the appropriate use of publicity and confidentiality. Sections 5 and 6 of the Code specifically cover Actuarial Advice and Actuarial Reports. The section on Actuarial Reports covers many of the issues covered by GN50 and GN12, but notably makes no reference to any specific area of practice (eg life or general insurance). Other specific requirements for Actuarial Advice include issues of impartiality, replacing an Actuary, Third parties and Professional Indemnity Insurance.

7.28 We understand that the intention of the IAA is to have Professional Standards (which will include lots of "musts") that cover only work provided in a Statutory role or where there is a strong public interest argument.

7.29 The Australian Code appears to define "two hats" that an actuary might wear by reference to whether or not the "service" being given falls under the three-part definition of Actuarial Advice given above. In the context of general insurance the Australian Code therefore defines Actuarial Advice, which would require formal reporting, in a relatively "narrow" sense as there are only two Professional Standards (covering Advice on General Insurance Technical Liabilities and Financial Condition Reports for General Insurance) and two Guidance Notes (Premium Rate Certification for the NSW Motor Accidents Scheme and Evaluation of General Insurance Technical Liabilities) specifically for general insurance.

7.30 The UK Profession's general insurance guidance notes define their application in very broad terms (specifically including wider fields which have risk characteristics similar to general insurance) and then, in the case of GN12, leave it to the actuary's professional judgement, albeit with some guidance, to determine whether a formal reporting hat is on. This is in contrast with the approach in Australia where part c) of the Australian Code definition of "Actuarial Advice" directs the actuary to clarify with their "Principal" (client) whether or not a formal reporting hat is being worn.

7.31 It is difficult to map the Australian Code to the UK Profession's PCS and guidance note structure. Much of what is covered in GN50 and GN12 is covered in the Australian Code but we again note that this Code is not specific to general insurance.

The Institute of Chartered Accountants

7.32 Although there are no direct analogies with pricing work within the field of accountancy, it is of interest to note the way in which The Institute of Chartered Accountants approaches the "two-hat" issue from a different perspective.

7.33 In the Institute's Code of Ethics a distinction is made between a Professional accountant in business and a professional accountant in public practice. The relevant definitions in the Code are given below.

- **Professional Accountant**: A member or where appropriate, member firm.
- **Professional accountant in business**: A professional accountant employed or engaged in an executive or non-executive capacity in such areas as commerce, industry, service, the public sector, education, the not for profit sector, regulatory bodies or professional bodies, or a professional accountant contracted by such entities. A professional accountant in business may be a salaried employee, a partner, director (whether executive or non-executive), an owner manager, a volunteer, or another working for one or more employing organisation. The legal form of the relationship with the employing organisation, if any, has no bearing on the ethical responsibilities incumbent on the professional accountant in business.

- **Professional accountant in public practice:** A professional accountant, irrespective of functional classification (eg audit, tax or consulting) in a firm that provides professional services. This term is also used to refer to a firm of professional accountants in public practice.
- **Professional services:** Services requiring accountancy or related skills performed by a professional accountant including accounting, auditing, taxation, management consulting and financial management services.

7.34 Within the Code of Ethics there are then separate parts for these two types of professional accountants which illustrate how the conceptual framework of the Code of Ethics is to be applied in specific situations. In part, this is done through Case Studies. This is in contrast to the UK Actuarial Profession's PCS, GN50 and GN12 which make no such distinction.

Royal Statistical Society (RSS)

7.35 The RSS has a Code of Conduct which states that all professional statisticians should:

- work within the public interest
- uphold a duty of care to both their employer and their clients
- uphold a duty of care toward the profession and its standards
- maintain and build upon their professional competence.

7.36 The RSS has not issued any other standards or guidance notes of the equivalent nature of those issued by the UK Actuarial Profession. It has a CPD policy in which it states that CPD means the development of the "whole person" - statistical and non-statistical, technical and personal.

Conclusions and recommendations

7.37 In initial stakeholder feedback on the role of actuaries in pricing senior stakeholders said they would like to see actuaries getting closer to the business and adding value. If guidance is too onerous this will be a step in the opposite direction. The UK Actuarial Profession has guidelines covering many, in some cases more, of the same pricing issues that other professional bodies have considered in their guidance notes. For these reasons GRIP believes that further formal professional guidance relating to premium rating is not currently required, and that improvements to the standards and value of actuarial work in the pricing area would instead best be facilitated through enhanced education and CPD initiatives.

7.38 GRIP further believes that the Australian system of classing actuarial activity into two different categories, each having different associated guidance, has a number of significant attractions to pricing actuaries. Of particular attraction is the clarity and simplicity of determining when different elements of guidance apply, given that pricing actuaries have no statutory or reserved roles and sometimes work as closely with other parts of the business "at the coal face". Notwithstanding the fact that this has wider implications than pricing or indeed general insurance, GRIP recommends that the Profession debates with the BAS the merit of adopting this type of approach in the UK. In addition, there may be a strong case for making a distinction in the Profession's Guidance Notes (particularly GN50 and GN12) between actuaries in public practice and those in business, in a similar manner to that adopted by the Institute of Chartered Accountants.

7.39 In the shorter term, GRIP recommends that *Information and Assistance Notes* (IANs) should be issued to give further help to pricing actuaries on the interpretation of GN50 and GN12. Examples are provided above in 7.15.

7.40 There is a wide variation in the number and scope of pricing guidance notes issued by actuarial and other professional bodies. Many of the US ASOPs which are applicable to pricing include appendices setting out generally accepted actuarial practices. An area for further consideration by the GI Board is the development of similar technical advisory notes for the UK Profession, and indeed some elements of a future Premium Rating Manual discussed in Section 3 could perhaps provide a basis for such notes.

8 Treating Customers Fairly

8.1 It is not the intention within this paper to consider issues arising from the FSA's principle of "Treating Customers Fairly" ("TCF") in depth, especially as a 2006 GIRO Working Party has considered these issues in some detail.

8.2 GRIP recognises that TCF is currently a key issue for many insurers. However, what the principle means is generally being left for individual firms to determine for themselves. At present, it appears unlikely that the FSA will impose strict rules in relation to this area in respect of general insurance.

8.3 GRIP considers that there are a number of pricing-related issues that could be considered to fall within the scope of the TCF principle:

- the extent to which premium rates attempt to reflect the expected risk cost at a very granular level, and whether this goes against the concept of pooling of risk
- the practice of charging premiums not directly related to the risk cost, to reflect other customer characteristics such as the propensity to seek alternative quotes
- the apparent granting of discounts (particularly No Claims Discounts) if these are not a true reflection of the discount provided
- the perceived poor value-for-money of certain products such as creditor insurance.

8.4 Each of these issues is discussed in more detail in the sections that follow.

Pooling of risk or granularity of pricing

8.5 The original concept of insurance was one of pooling risk. A group of risk-owners would each contribute to a central pot, which would pay out to any one of them in the event of a loss. Risk differentiation was limited and similar premiums were charged for broad groups of policyholders.

8.6 For some general insurance products, this practice persists. For example, premium rates charged for creditor insurance typically vary little between ages or by occupation. Premium rates for extended warranty insurance are often similar for different manufacturers, despite widely differing claims experience.

8.7 For other products, such as personal motor insurance, risk premiums are calculated at an increasingly granular level and aim to measure precisely the expected claims cost for an individual policyholder. There might appear to be very little pooling of risk in this example.

8.8 It is not clear which of these practices would be considered more "fair" - to treat all customers equally by charging the same premium, or to treat them all as individuals and seek to equalise contribution to the insurer's expenses and profit.

8.9 In fact, it could be argued that pooling of risk continues to apply even for products that are priced at a very granular level. In that case, it is the element of random variation that is pooled, whilst the systematic variation is explicitly allowed for.

8.10 The FSA stated in July 2005 that "TCF does not indicate that we intend to become an economic regulator. It is not our role to determine firms' pricing policies." The products that are priced at the most granular level, such as personal motor, are also usually those where the market is most competitive. A common argument is that the market is effectively self-regulating - the interests of the customer in finding an acceptable premium are helped by the number of companies competing for that business, and any distortions in the market will soon be removed by competitive forces.

8.11 It is GRIP's view that this issue does not fall within the remit of TCF. The issue of what degree of pooling of risk or granularity of pricing is appropriate is one for individual companies to determine and, as the FSA indicates, it is not the role of the regulator to determine pricing policy.

Utility pricing

8.12 The practice of varying premiums depending on non-risk factors, such as the customer's propensity to shop around for alternative quotes, described here as "utility pricing", is becoming increasingly common in the most competitive general insurance markets such as personal motor.

8.13 A particular example is the practice followed by some insurers of charging different premiums for renewing customers than for otherwise identical new business in an attempt to reflect the differing loyalty of existing customers.

8.14 This practice could be considered "unfair" in that two apparently identical customers could be charged widely different premiums for the same cover.

8.15 However, in addition to stating that "TCF does not indicate that we intend to become an economic regulator. It is not our role to determine firms' pricing policies." the FSA has also said that "TCF does not mean customers are no longer expected to take decisions or to take responsibility for them".

8.16 It is GRIP's view that this issue does not fall within the remit of TCF. Pricing policy in this area is for individual firms and it is not the role of the regulator to intervene. Customers are offered an insurance contract at a particular price and are at liberty to seek alternative quotes if they wish.

8.17 At present, there is no indication that the FSA will attempt to regulate practice in this area. However, it is an area of possible future development and GRIP recommends that actuaries maintain an awareness of developments in this area.

Premium discounts

8.18 Marketing material for personal insurance products commonly refers to premium discounts for customers meeting certain criteria. For example, a discount could be offered to customers in the first year of their policy, or to customers who additionally hold another product with the same insurer. A very common example is a No Claims Discount (NCD) whereby a customer with a history of claim-free insurance may be offered a discount. In some instances, it may be possible for a policyholder to protect an earned level of NCD so that it applies in future years even if a (fault) claim is made under the policy.

8.19 Discounts, however, often refer to an undeclared or as yet undefined rating structure, and therefore discounts may not be as simple as they might appear. For instance, a customer might protect a No Claims Discount and therefore be invited to renew at the same notional level of discount, despite having made a (fault) claim in the intervening period. On occasion, however, a premium loading might be added to allow for the past claim. This may not have been what the customer was expecting when they chose to protect their discount.

8.20 Similarly, an insurer's marketing material might offer a discount in the first year of a policy. The underlying premium rates, however, might also vary by policy duration, so that the difference between the first and second years' premiums is not as high as might be expected.

8.21 Under the principle of TCF, a customer is entitled to expect communications that are clear and not misleading. Insurers are expected to honour promises that lead to legitimate customer expectations. GRIP considers that there may be potential issues if marketing material advertising implied future premium discounts creates customer expectations that are not borne out in reality.

8.22 This issue is not purely a pricing one. However, GRIP recommends that pricing actuaries, together with colleagues responsible for marketing literature, should consider the extent to which the reality of pricing is aligned with the marketing material, and whether any misalignment is adequately and clearly disclosed to the customer.

Creditor insurance

8.23 Creditor insurance has attracted particular attention recently. The FSA has been undertaking a piece of thematic work on the sale of payment protection insurance (PPI), the first results of which were published in November 2005. In September 2005, Citizens Advice submitted a super-complaint to the Office of Fair Trading (OFT) about PPI. The OFT responded to this complaint in December 2005, and launched a more in-depth study of PPI marketing in April 2006. In doing so, the OFT noted that it would continue to work closely with the FSA.

8.24 In its thematic work, the FSA expressed concern about a number of aspects of payment protection insurance including the suitability of products for the customers, the complexity of policy conditions, exclusions and eligibility criteria, and the low level of disclosure of product and price. In particular, the FSA noted that the level of premium charged was sometimes not being taken into account in determining the suitability of an insurance product for a customer.

8.25 The clear suggestion is that price is a factor in determining whether a product is suitable for a customer and therefore there is a point at which pricing falls within the remit of the FSA. This might be expected to apply particularly for products where the premium appears high relative to the possible benefits, for instance in cases where market loss ratios have historically been low.

8.26 The FSA indicated that it would prefer the market to find its own solution to the issues that were identified, rather than having one imposed by the regulator. However, the FSA warned that it would consider prescribing greater disclosure on pricing if no market solution was forthcoming.

8.27 The first area of concern raised by Citizens Advice in its super-complaint was its view that consumers pay an excessively high price for PPI. In its response, the OFT found that claim ratios for PPI were markedly lower than for other types of general insurance, providing evidence of high profitability compared with other general insurance products.

8.28 It is, of course, arguable to what extent the OFT's finding is an accurate reflection of the PPI market. In many cases, the greater share of the profits may go to the distributor rather than the underwriter. The study also relates to a period of relatively benign economic conditions. Nevertheless, there is a perception at a high level that customers are getting a poor deal from these products.

8.29 It is clear that there is a degree of concern both within the regulator and other bodies such as the OFT about the creditor insurance market, and that this includes issues relating to pricing of the product. It is less clear how things will develop in the future.

8.30 The UK PPI market is somewhat unusual in that it is dominated by sales alongside a credit product, with a very low level of stand-alone purchase. The purchase of insurance is, to the consumer, often a secondary consideration to the credit product. This tends to distort the free market more than for other insurance products where the ability of a customer to shop around for a better price tends to impose some control. Indeed, the pricing of the credit product is often very competitive and companies might see the sale of insurance alongside it as an opportunity to recoup the profits they have had to sacrifice to win the business.

8.31 Arguably, the issues around TCF and creditor insurance provide particular concerns for actuaries. A pricing actuary advising an insurer on the pricing of its creditor business could find himself in the position of having to justify pricing decisions to the regulator.

8.32 Actuaries in this situation might also perceive a conflict of interest between the commercial interests of an employer or client and the notion of a public interest role for the Profession. For instance, the Professional Conduct Standards require an actuary's advice to include consideration of the implications for policyholders of an insurance company. This could cause difficulties for the actuary in cases where there are concerns about the value for money of an insurance product to customers.

8.33 There are a number of conceivable scenarios for how this issue will develop:

- The market could develop its own solution, with a greater degree of disclosure and competition. It could be argued that the market for travel insurance twenty years ago was in a similar state to the PPI market now, with insurance largely available only at point of sale from travel agents, but has since developed into a highly competitive market. This solution would be the FSA's preferred route, but there is little sign of this happening currently.
- The credit market could evolve to provide credit products that reduce or negate the need for payment protection insurance, for instance loans with the option of payment holidays in certain circumstances.
- The regulator could impose regulation. This could take several forms, including greater disclosure of product features, greater disclosure of pricing, provision of information on alternative sources of PPI other than that bundled with the main credit product, or regulation relating to the unbundling of PPI from the credit product.

8.34 It is not clear which, if any, of these scenarios will emerge, and it is beyond the remit of GRIP to pursue this line of enquiry further. However, GRIP recommends that actuaries working in this area keep abreast of the issue as it develops, and contribute to the debate as they feel able.

8.35 GRIP considers that the issues around payment protection insurance represent something of a special case, in that the market forces that effectively regulate prices for many other general insurance products are not present to the same extent for this product. Similar issues do apply for some other products such as extended warranty insurance, but it is not felt that they will apply to the more competitive general insurance markets, such as personal motor or household insurance.

9 Summary of recommendations

9.1 GRIP has considered a range of areas and has a number of recommendations relating to:

- the role of the actuary in pricing
- methods currently used and areas for further research
- communication issues
- the adequacy of the Profession's education and CPD programme
- the need for formal guidance in the area of pricing.

9.2 The background and rationale for these recommendations are set out in detail in Sections 2 to 8. The recommendations emerging from each section are summarised below, together with a comment on implementation.

Role of the actuary in pricing

9.3 GRIP recommends that the General Insurance Board debates the desired role that the Profession should play in the evolution of the pricing aspect of the insurance industry, for example whether new techniques should be the subject of GIRO papers or whether they will be developed within organisations and controlled by intellectual property concerns.

9.4 We also recommend that the Profession should debate and agree how to balance the need for strong governance roles with the desire for actuaries to hold management positions in value adding underwriting/pricing functions.

Methods

9.5 Although GRIP has not sought to write a comprehensive "Premium Rating Manual", we feel that such a document would be invaluable to the Profession and would feed very naturally into the education syllabus and CPD. We consequently recommend that such a manual be prepared. Appendices C, D and E may form an extended "Table of Contents" for such a manual.

9.6 Following consultation within the Profession, our recommended approach to writing such a manual is in the form of a Wiki. As well as members of the UK Profession, other actuaries, for example members of the CAS and IAA, could also contribute. To create and maintain such a Wiki it may be appropriate for a new group within the Profession to be established.

9.7 We have also suggested a range of research topics which we feel would benefit the Profession and the industry. These are described in detail in Section 3 and relate to the following areas:

- integration with ICAs
- expense allocation
- variable capital loads
- catastrophe models
- pricing for latent claims
- implementation and delivery systems
- market prices of insurance liabilities
- game theory pricing
- effect of climate change
- market information
- using pricing models within reserving
- demand and elasticity modelling
- price optimisation.

Communication

9.8 Stakeholder feedback and discussions within GRIP itself have led us to conclude that there are two types of issues relating to communication:

- issues around the communication skills of actuaries in general, and
- specific issues around the communication of pricing matters (some of which are almost factual and not all of which will be "actuarial").

9.9 The first point is recognised by the Profession already and, applying to a much wider field of activity than general insurance pricing alone, is somewhat outside GRIP's terms of reference.

9.10 For issues relating to general insurance pricing, we would hope that the discussion in Section 4 is a helpful framework in which to interpret any broader skills education or training initiatives which the Profession implements in the future. In addition, we believe that there are some specific issues which merit particular attention.

- We set out in Appendix F some of the more common topics which we have found to cause problems with communication. If sufficient interest exists, a catalogue of such pitfalls and tools to tackle such issues (including example wording, forms of graphs, "storylines" of concepts to stress etc) could be developed by the Profession, perhaps as an appendix to a future Premium Rating Manual discussed in Section 3.
- GRIP also feels that it would be helpful if a more common way of defining the terminology within pricing could be established. We therefore recommend that a comprehensive glossary of pricing terms be compiled and published on the Profession's website. We believe that such a glossary would be helpful to those writing premium rating reports under the recently revised version of GN12. We set out in Appendix G some possible example sources of material to assist with the compilation of such a glossary.

Education

9.11 GRIP recommends that the ST and SA examination syllabuses be enhanced to cover the following topics which GRIP considers to be missing or inadequately dealt with in the current syllabuses:

- pricing basics
- policy terminology, including Claims Made vs Occurrence cover
- insurance products (based on CII material)
- data design
- understanding rating factors
- exposure measures
- exposure rating
- experience rating
- trends (exponential and linear)
- profit, expense, risk and catastrophe loading
- generalised linear models
- demand modelling, price elasticity and optimisation techniques
- individual risk rating

- excess and deductible rating
- reinsurance rating
- catastrophe modelling
- medical malpractice and professional liability business
- use of ISO and NCCI information.

9.12 It may be necessary to create a new examination to deal solely with general insurance pricing. Such an additional examination may fit in well with potential changes to the education system currently being discussed.

9.13 As an example of the level of detail we envisage we set out a suggested draft syllabus item for generalised linear models in Appendix H.

9.14 GRIP further recommends that:

- The Profession considers using the CAS and IAA syllabuses as part of the basis for enhancing the ST and SA examinations, incorporating key material for each of these topics into the Core Reading. This task would require significant resources as the relevant CAS and IAA reading will need to be read and condensed.
- A comparison of examination questions as well as syllabus topics should be undertaken as these may reveal further noteworthy differences.
- Certain overseas specific topics of relevance to UK actuaries could be included in the examination syllabus or be made available as CPD.
- The CT examinations, in particular CT6, should be reviewed to ensure that the necessary mathematics has been covered to allow students to tackle pricing topics suggested here in sufficient detail.
- Some of the more "factual" aspects of how to communicate pricing matters effectively (for example some of the issues set out in Appendix F) should be touched on in the examination syllabus.
- At the same time, the Profession should seek to ensure that any changes to the examination syllabus do not detract from the goal of developing well rounded technical professionals who are able to think for themselves.

CPD

9.15 GRIP recommends the following.

- The Profession should organise an annual one day pricing conference from 2008.
- The Profession should materially enhance its website to include an effective search facility. The website should also include core reading from the examinations system.
- The Profession should explore the idea of approaching a third party training company to design a training package around softer skills relating to communication and management.
- The Profession should consider extending the existing professionalism course to cover communication and other wider non-technical skills that should be expected of a newly qualified actuary.
- The Profession should ensure that all CPD initiatives are designed bearing in mind the stakeholder feedback which called for a greater understanding of products and insurance markets. CII education material may help with this in areas relating to insurance products.

Professional guidance

9.16 GRIP believes that further formal professional guidance relating to premium rating is not currently required, and that improvements to the standards and value of actuarial work in the pricing area would instead best be facilitated through enhanced education and CPD initiatives.

9.17 GRIP further believes that the Australian system of classing actuarial activity into two different categories, each having different associated guidance, has a number of significant attractions to pricing actuaries. Notwithstanding the fact that this has wider implications than pricing or indeed general insurance, GRIP recommends that the Profession debates with the BAS the merit of adopting this type of approach in the UK. In addition, there may be a strong case for making a distinction in the Profession's Guidance Notes (particularly GN50 and GN12) between actuaries in public practice and those in business, in a similar manner to that adopted by the Institute of Chartered Accountants.

9.18 In the shorter term, GRIP recommends that *Information and Assistance Notes* (IANs) should be issued to give further help to pricing actuaries on the interpretation of GN50 and GN12. Examples are provided above in 7.15.

9.19 There is a wide variation in the number and scope of pricing guidance notes issued by actuarial and other professional bodies. Many of the US ASOPs which are applicable to pricing include appendices setting out generally accepted actuarial practices. An area for further consideration by the GI Board is the development of similar technical advisory notes for the UK Profession, and indeed some elements of a future Premium Rating Manual discussed in Section 3 could perhaps provide a basis for such notes.

Implementation

9.20 It is not within GRIP's terms of reference to decide how the above recommendations be implemented, and which groups or individuals should be responsible for introducing changes. Nevertheless we set out below some brief thoughts on a possible way forward.

9.21 In the case of the "Premium Rating Manual" Wiki, it would seem appropriate that a new group should be established if this initiative is to be taken forward. In many other cases, it would appear that either the General Insurance Board could address the recommendations directly, or that appropriate groups already exist to implement those changes agreed by the General Insurance Board. For example, the various recommended research topics could be implemented by the GIRO committee and/or the Research Steering Committee, and the educational and CPD recommendations could be implemented through the GI ECPD committee.

9.22 As a result, GRIP does not see the need to evolve into an implementation group. Instead we would recommend that responsibility for championing all the recommendations in this report, and of addressing all other premium rating issues of importance to the Profession in the future, be assigned appropriately. Under the existing structure of the Profession we think this could be best achieved by assigning such responsibility to a nominated member of the General Insurance Board.

A Terms of reference

General insurance premium Rating Issues working Party ("GRIP")

Terms of reference, revised 15 December 2005

Introduction

The GIB considers that reserving and premium rating are two key areas in which GI actuaries work and that, since a taskforce ("GRIT") is already considering actuarial involvement in reserving work, it would be logical for the profession to review its involvement in premium rating work in a similar way.

Issues to consider

Role of the pricing actuary

- To review the areas in which UK actuaries are currently involved within the overall premium rating process, and to identify any areas where actuaries might be able to improve their contribution and/or add further value.

Methods

- To summarise, in broad terms, current methods used by actuaries in GI premium rating.
- To identify areas where types of methods and approaches could potentially be improved (eg expense modelling / capital aspects of uncertainty), and to identify areas where existing methods could be used more appropriately.
- To suggest potential areas for further research.

Stakeholders

- To consider whether and how improvements could be made to the way GI pricing actuaries communicate:
  - with those who use their advice
  - with others involved in pricing eg underwriters
  - within the profession
  - to the public.
- To consider whether there are any implications for professional guidance or communication (eg distinguishing more clearly between "cost" and "price") resulting from commercial pressures within organisations.
- To consider trends in the area of Treating Customers Fairly and to consider what the profession might need to consider in preparation for issues arising in this area.

Professional Guidance

- To consider whether existing professional guidance should be modified/clarified to make its application to premium rating clearer.
- To consider whether there is a need for more detailed best practice guidance that would be issued by the profession setting minimum standards for a direct business pricing assignment.

GRIP does not intend to produce any formal guidance, but instead will consider whether there are areas where further clarification or guidance might be helpful.

Education/CPD

- To consider whether the content of the exam syllabus is adequate to prepare actuaries to work in the pricing area.
- To consider whether more should be done to provide CPD in this area, and if so what.

Again the focus is on identifying potential areas for improvement and possible methods of delivery. The consideration of education/CPD includes both "tools" (eg particular statistical modelling techniques) and "issues" (relating to general subjects, for example expense modelling, as well as specific issues following market or legislative changes, eg structured settlements).

Classes of business

The intention is that GRIP focuses on issues of relevance to Faculty and Institute members involved in pricing direct insurance (individual and account level products) and reinsurance. Some issues may be relevant only to personal lines or particular territories. Areas of GRIP's work which relate to a wider or narrower selection of classes or territories will be identified as such.

Input from within the profession

The group will consult with the profession via workshop sessions at GIRO 2005 and other means, and will liaise with other Institute groups and working parties, including the GI Guidance Note Revision Committee.

Input from outside the profession

As well as seeking feedback from within the profession, it is the intention that in undertaking its work GRIP will seek input from:

- other actuarial associations, in particular the CAS and the Australian Institute
- members of the statistical community
- the FSA.

Further input may also be sought from other groups including the ABI, auditors, consumer groups, market analysts, brokers, reserving actuaries, companies without actuaries.

Deliverables

- Presentation describing terms of reference and initial thoughts at GIRO in October 2005, with workshops to gather feedback and facilitate consultation within the profession.
- Presentation of consultation paper at GIRO in September 2006.
- Final paper issued late 2006.

Membership

Duncan Anderson (Chairman)
Clive Bolton
Gary Callan
Martin Cross
Sheree Howard
Grant Mitchell
Karl Murphy
David O'Connor
James Rakow
Peter Stirling (Secretary)
Gabriel Welsh

B Skills relating to roles

B.1 As discussed in Section 2, the role of the pricing Actuary is very varied within the different operational stage models identified (Tariff, Qualitative Underwriting, Cost Plus, Distribution and Industrial) and indeed, even quite varied within different organisations within these models, as different organisations have different cultures and technical abilities.

B.2 Throughout our work we identified that members of the Profession may already be ingrained in many areas of the pricing process, but we may require a wide range of skills to enter new areas where resistance may be encountered despite receptive senior management. As such, the mix of core competencies required can extend beyond pure technical skills as derived from both the education and initial on the job training, into more personal skills to enable us to challenge the status quo and improve/change systems and processes.

B.3 On examination, we felt that the core skills could be broken down into three areas:

- ***Technical*** - the core actuarial technical skills derived from the rigorous (examination and on the job) training
- ***Soft*** - the people skills that need to be gained through experience and practice (one to one skills)
- ***Management*** - these will be organisation specific, but refer to the ability of organising, monitoring and controlling quality outputs (one to many skills).

B.4 The following outlines the core skills we identified split into the three categories, although this list is not meant to be exhaustive.

Technical skills

- Insurance

  This refers to the detailed knowledge of the workings of insurance contracts and the financial impact of various changes in coverage. This allows insurance problems to be solved using actuarial techniques, by translating the problem into the core actuarial principles.

- Mathematical

  This refers to the ability to solve problems in numerical ways and come up with a solution or a range of solutions that is sound mathematically and solves the core insurance problem.

- Information Technology

  Many mathematical solutions require the use of IT to manipulate data, fit curves or run simulations. This has become a core skill of virtually all pricing actuaries.

- Finance

  When pricing it is necessary to have an understanding of the interactions of the various components on the price, such as the relationship between price, volume and expense loadings. It is also important to be able to translate the company's objectives which may be financial in nature (eg a return on capital employed of 15% p.a.) into a price which achieves this. Further, the possibility of the resultant price being unmarketable and, therefore, needing further adjustment to achieve a commercial price needs to be considered.

Soft skills

- Communication

  Actuarial analysis often needs to be communicated to non actuaries who understand the issues but are not necessarily experts in technical solutions or language. This is particularly the case for the pricing actuary, where there is a need to ensure that end users of the analysis are able to understand the implications and limitations of the work undertaken.

- People skills

  Related to the above, the ability to interact with other non actuarial experts is vital. Again, this is particularly the case for pricing actuaries where input from other professionals who have specialist expertise in areas not familiar to actuaries is essential, for example underwriters.

- Negotiation

  This refers to an ability to influence the outcome by ensuring that the bigger picture is understood.

Management skills

- Organisational awareness

  When undertaking any pricing work, it is essential that the wider organisational context is taken into consideration, including being aware of the systems and capabilities of the organisation.

- Management processes

  Related to the above, understanding the organisational processes in place is also essential, especially in relation to how the company organises, monitors and controls its activities. This way the pricing actuary is able to demonstrate that he is thinking of the organisation first rather than being professionally detached.

- People management

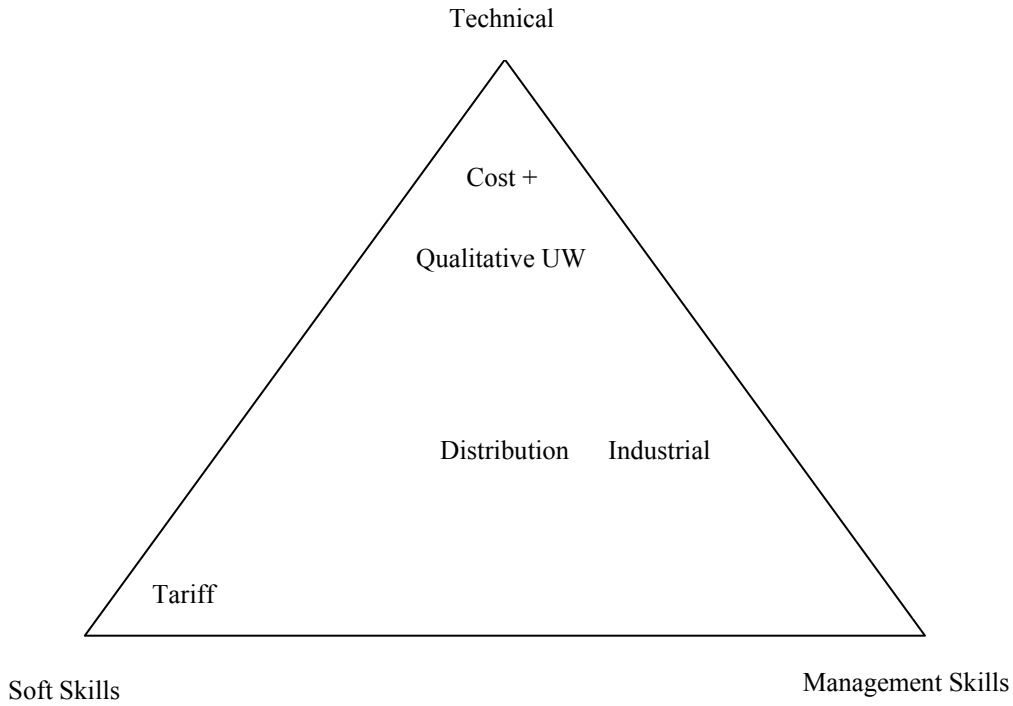
  This relates to both direct team management and in the wider context of aligning the key stakeholders with the key pricing objectives.

- Change management

  Dependent on the organisation, there may also be a need for the pricing actuary to change the way things are done, with the technical experts communicating a vision of a more knowledgeable future.

Triangle of skills

B.5 The following illustration plots the respective positions of the business models identified in Section 2 relative to the skills sets required. It should be noted that there is obviously subjectivity in these positions and this is for illustrative purposes only. GRIP would welcome the views of other members of the Profession on the relative positioning of each of the models identified.



C Capital allocation methods

Introduction

C.1 Perhaps the first thing to point out is that there is not necessarily a correct way of allocating capital between different lines of business or between contracts. The extreme cases would be that either capital would be allocated to a contract based on the marginal increase in total capital required, or alternatively on the basis of the contract being entirely stand-alone (the latter perhaps representing the capital that the insured would require to self-insure the risk). Certain capital allocation methods have the desirable property that the capital allocated to all lines of business sums to the total capital requirement. There are other desirable properties, however, such as the result producing a stable requirement from year to year or following changes in the business.

C.2 Some capital allocation methods are described below.

Using regulatory or rating agency formulae

C.3 A simple method of allocating capital to a class of business or to a contract is to consider the capital required by either a regulator in order to avoid any regulatory intervention or alternatively by a rating agency to maintain the desired rating. Historically, these have been relatively straightforward formulae, often involving a percentage of premiums.

C.4 However, given that the FSA and the rating agencies are moving away from formulae-based capital calculations and towards using internal models, this approach may not be as straightforward in the future, and may require some approximations (perhaps based on the ECR formula).

Coherent allocation methods

C.5 These methods of allocating capital apply the weights used by any coherent risk measure to losses (ie claims less premiums) by individual line of business. For example, using a TVaR measure to calculate an overall capital requirement involves calculating the average loss above a percentile (giving a weight of 0 to any simulations where the total loss is less than the percentile, and a weight of 1 to any simulation where the total loss is above the percentile). In order to allocate capital between lines of business, the same weights used in the TVaR calculation can be used to calculate the average loss by line of business.

C.6 Further details can be found in *Kaye*.

Myers Read method

C.7 This method allocates capital by equalising the expected policyholder deficit (as a percentage of premium) across different classes of business. Further details can be found in *Myers and Read*.

Shapley method

C.8 This method is based around game theory, and considers the capital charged to a line of business by calculating the capital for all combinations of classes and taking an average capital across the different "games". For example, for a company with three lines of business (A, B and C), the capital allocated to A is the average of the increase in capital for a company with:

- no business, with A added
- line B only, with A added
- line C only, with A added, and
- lines B and C, with A added.

C.9 This method can be computationally quite intensive, especially as the number of classes of business increases.

C.10 Further details can be found in *Denault*.

Covariance method

C.11 The method allocates capital by considering the variance-covariance matrix of an aggregate loss distribution, and allocating capital to a line of business as the sum of the appropriate row of the variance-covariance matrix divided by the sum of all elements.

C.12 Further details can be found in *Brehm*.

VaR method

C.13 The VaR method can be applied by considering the losses by class of business for the individual simulation which generates the loss (assuming that a stochastic model is used). However, because the allocation is based on a single simulation, a different seed value may lead to a very different allocation.

C.14 An alternative is to apply the global risk appetite to losses at a class of business level. However, summing the capital across all lines of business will exceed the total capital, because of lack of diversification benefits, and so some scaling is required to allow for this. Even this may be flawed, however, because it may not properly allow for tail dependencies between classes of business.

Concentration charge

C.15 This method was developed in relation to catastrophe reinsurance pricing, and allocates capital to contracts by considering the impact of an event on the surplus of a book. Depending on the effect of the event on the total surplus, capital will need to be replenished quickly or slowly to avoid regulatory or rating agency action. The inverse of the replenishment period yields a replenishment load called the concentration charge which is applied to any additional loss by writing a new contract. The concentration charge therefore depends on the concentration of risk in the existing book of business.

C.16 Further details can be found in *Mango (1998)*.

Capital loading method

C.17 Once capital has been allocated to a line of business, there is the question of how to load it into the pricing formula.

C.18 The traditional method is to simply treat capital required as a regular cashflow, being negative when the policy is written, earning investment income whilst held, and being returned at the end of the contract.

C.19 A recent paper by Donald Mango, applies a loading by splitting capital into consumptive and non-consumptive elements. When capital is not consumed (in other words losses not made), it attracts a rental charge. However, when capital is consumed (burned), it needs to be replenished. The analogy is to renting a hotel room. The intention is that the hotel room is borrowed for a period (such that it cannot be used by anyone else), but then returned; however, there is a possibility that the occupant will accidentally set the room alight, or even worse set the hotel alight. Both of these elements need to be costed into the room rate. For further details, see *Mango (2005)*.

D Personal lines methods

Introduction

D.1 This Appendix describes the main methods in use for the pricing of personal lines. The focus is on methods used to determine the technical price (expected cost of claims plus expense and capital loads etc) rather than methods which can be used to determine commercial prices.

D.2 There are certain characteristics of personal lines business that result in the techniques appropriate for personal lines pricing being rather different from those appropriate for London Market and commercial business. Such characteristics include:

- there are generally large volumes of data, and data is reasonably readily available
- coverages are fairly homogeneous
- segmentation (or differentiating between risks) is vitally important for most lines of business
- the relationship with a customer is very important for some insurers, allowing for profit margins on future business and with other products held by the customer
- there is more certainty within the risks compared to (say) London Market business.

D.3 A lot of focus is placed on deriving appropriate relativities by rating factor within personal lines pricing. Given the degree of segmentation within insurers' rates, this is vitally important from the perspective of avoiding anti-selection by competitors. A lot of emphasis is placed on analysing data better, finding new "interactions" within the data, and finding new rating factors that help differentiate risks in a better manner.

D.4 The areas covered include:

- generalised linear models (GLMs), which are the main tool used for determining relative claims experience
- other relativity methods
- classification techniques, used for classifying things like postcodes into rating areas
- expense modelling
- technical base rates, used for determining overall rate levels
- implementation of rates, including comparing technical rates with rate books and with competitor rates
- lifetime customer value models, which look at the value of a customer over their complete lifetime and product range

- a brief section on classes of business with additional characteristics that need to be considered
- a section on issues that actuaries in other countries may have to pay more attention to because of market or regulatory conditions.

D.5 All references to papers quoted are detailed in Appendix J.

GLM theory

D.6 The main method used by UK actuaries for determining relative rates by rating factor involves fitting generalised linear models (GLMs) to claims experience.

D.7 GLMs are a form of regression model which provide a much more flexible modelling environment than standard classical regression. This flexibility allows a range of different model structures to be fitted (in terms of both the link between parameter estimates and the fitted values, and the structure of the variability of the fitted values), and this extra flexibility provides a more natural model for insurance processes.

D.8 From a technical point of view, the model fitted is:

$y = h(X\beta) + error$

where X is known as a design matrix and is a function of the explanatory variables and the model being fitted; β is a vector of the parameters being fitted; h is a monotonic function; the distribution of y comes from the exponential family, which includes distributions such as normal, Poisson, gamma, inverse Gaussian and binomial.

D.9 The fitting process is an iterative process, and involves X, y, the first derivative of g (g being the inverse of h), and the variance function, the latter being determined by the chosen distribution. g is commonly known as the link function. The variance function provides a link between the fitted values and the variance of the fitted values. For the distributions listed above, the variance functions are:

Normal:	1
Poisson:	μ
gamma:	μ^2
inverse Gaussian:	μ^3
binomial:	$\mu(1-\mu)$

where μ is the fitted value.

Commonly used link functions are:

identity: g(x) = x, ie h(x) = x

log: g(x) = log(x), ie h(x) = e^{x}

logit: $g(x) = \log \frac{x}{1-x}$ ie $h(x) = \frac{1}{1+e^{-x}}$

D.10 The estimated parameters β are commonly solved via an iterative process using a Newton-Raphson approach. Convergence continues either until a measure known as the deviance converges (the deviance is analogous to the sum of squared error in classical regression, and is a function of the variance function selected) or until the estimated parameters β converge.

D.11 Further details of the theory behind GLMs is provided in *McCullagh & Nelder* and in GLIM 4 The Statistical System for Generalized Linear Interactive Modelling, as well as in many of the actuarial papers on the subject including *Brockman and Wright, Taylor*, *Mildenhall, Murphy Brockman & Lee*, and *Anderson et al.*

GLMs in personal lines

D.12 As described above, GLMs are a fairly generic regression method, and can be used for fitting to a very wide variety of processes. Within the context of personal lines insurance, GLMs are used for fitting models to the following responses:

- claim frequency
- claim average cost (severity)
- burning cost
- loss ratio.

D.13 The response modelled will depend, amongst other things, on data availability, data quantities, and time availability. Ideally, however, separate models would be fitted for frequency and severity, on the basis that relativities by rating factor will be different for each process and a clearer understanding of the risk process will be attained by analysing these two elements separately. In addition, there are occasions where, for example, frequency trends may be quite strong and predictable, but severity trends may be more volatile. In this case, if burning costs are being modelled directly, it will be unclear if a peculiarity in trends is caused by a genuine frequency trend or by a random severity trend.

D.14 In addition, GLMs can be either fitted across all claim types (or perils), or alternatively separate models can be fitted to each peril type.

D.15 Typical claim types used in the UK for motor and household insurance are given below:

Motor

- Accidental damage
- fire
- theft
- windscreen
- third party property damage
- third party bodily injury.

Household (separately for Buildings and Contents sections)

- Theft
- fire
- burst pipes/escape of water
- flood
- storm
- subsidence
- accidental damage
- personal possessions
- liability.

D.16 For motor third party bodily injury claims, large claims are often modelled separately, with their frequency being calculated as the small claim frequency multiplied by a propensity model.

D.17 The explanatory variables used in the model will depend on the class of business being modelled and data availability. A list of typical rating factors for private motor insurance and household insurance are given below.

Motor

- Primary driver:
  - age
  - sex
  - marital status
  - age of licence
  - type of licence
  - occupation
  - residency
  - convictions
  - accidents/claims in last n years
- insured only driver/any driver/named driver
- if named drivers, for each driver:
  - age
  - sex
  - marital status
  - age of licence
  - type of licence
  - occupation
  - residency
  - convictions
  - accidents/claims in last n years
- vehicle details including:
  - vehicle group
  - vehicle value
  - immobiliser/alarm

- rating area
- overnight parking
- excess
- NCD (No Claims Discount)
- whether NCD is protected
- use
- policy duration.

Household

- Policyholder age
- policyholder sex
- marital status
- number of children
- occupancy
- age of property
- number of bedrooms
- sum insured
- type of property
- level of cover.

D.18 The rationale for fitting models separately for frequency and severity and by claim type can be found in *Taylor*, section 5.2, *Murphy, Brockman & Lee*, section 3.1, and *Anderson et al*, section 2.4.

D.19 It is now common to include as much detail within each factor as is available. For example, usually individual age data will be used rather than grouping ages prior to modelling, as ages can be grouped within a GLM, further details being provided below.

D.20 External factors can also be included in the list of rating factors. More details are provided in the section on Classification.

D.21 Generally in the UK, models are not directly fitted to loss ratios, on the basis that no allowance is made for historic premium movements, and that a better understanding of risk can be attained from analysing frequencies and severities separately. Loss ratios are more commonly modelled in the US, however, partly because methods traditionally used in the US (and less commonly used in the UK) tend to be based on loss ratio trends.

Fitting the appropriate model

D.22 There are many options available when fitting GLMs to data, both in terms of the model structure, and the explanatory variables selected, and there are a range of methods available to assist in the process.

Error structure and link function

D.23 The error structure and link function are the two specifications required for setting up the structure of the model.

D.24 The error structure provides the link between the variance of the observations and the fitted values. If the error structure is not appropriate, then the model residuals will show a systematic bias. There is a range of residuals than can be considered for this, including Pearson residuals, deviance residuals and Anscombe residuals (see *McCullagh & Nelder*, p38 for further details). *Brockman & Wright*, section 2.4.3 and *Anderson et al*, section 2.60 to 2.61 discuss the interpretation of residuals in the context of personal lines insurance.

D.25 For certain processes, however, residuals may not show a classical shape; for example, for some frequency datasets, the majority of observations have not had a claim, leading to "odd" looking residuals. Further details can be found in *Cox & Snell*, and in *Murphy, Brockman & Lee*, section 3.7.

D.26 Determining an appropriate link function can be considered with reference to a "Box Cox" transformation that defines a link function with respect to a scale parameter. By testing a range of scale parameters and considering the likelihood, the "optimal" link function can be determined. Further details can be found in *Anderson et al*, sections 2.63 to 2.73, and in GLIM 4 The Statistical System for *Generalized Linear Interactive Modelling,* section 11.6.6.

Outliers

D.27 Individual points can have an important effect on the model fit. Cook's distance statistics can be used for determining the most influential points, and the "leverage" statistic can be used to determine which observations have the most potential to influence their fitted values. Using either of these statistics consideration can then be given as to whether the points should be excluded from the model fit. Further details can be found in *GLIM 4 The Statistical System for Generalized Linear Interactive Modelling*, section 11.6.5 and *Anderson et al* section 2.62.

Selecting the most parsimonious model

D.28 Once the model structure is determined the next phase is to select the most parsimonious model - in other words the simplest model that describes the data well.

D.29 Models can be simplified by:

- excluding factors from the model
- grouping levels within a factor
- replacing a categorical variable with a continuous variable, either as a polynomial, a piecewise polynomial or by fitting cubic splines.

D.30 Equally models can be made more complicated by fitting interactions (such that the effects of a factor depend on the level of one of the other factors). Interactions themselves can be simplified in a similar manner. Further details can be found in *Taylor*, section 6.6 and in *Anderson et al*, sections 2.74 to 2.103.

D.31 There are a range of tools available for deciding on the better of two models.

D.32 Firstly, trends in the models should be assessed for reasonableness and consistency. For example, we may expect trends by policyholder age to show an increase or decrease.

D.33 Secondly, the consistency of trends can be assessed over time by fitting a time interaction with a factor. In the event of a trend in the parameters being exhibited consistently from accident period to accident period, it is likely that the trend is a genuine one. Further details can be found in *Murphy, Brockman & Lee,* pages 119 to 120 and in *Anderson et al*, sections 2.39 to 2.41.

D.34 Finally, there are a range of formal statistical tests that can be used for comparing two model fits. An F-test or a chi-squared test can be used for considering "nested" models (ie where one model is a sub-set of the other). Further details can be found in *Brockman & Wright*, sections 2.3.2 and 2.3.3. Non-nested models can be compared by using AIC or BIC tests (Akaike and Bayesian Information Criteria tests) or lift curves (see below). The overall statistical reliability of a factor can be assessed using a Wald test, which has the advantage of not requiring two models to be fitted; however, it is considered to be an inferior test. Finally, the GLM fitting algorithm means that each parameter estimate comes with an associated standard error, and this can be used for determining the statistical reliability of an individual parameter. Details can be found in *Taylor*, section 6.5 and *Anderson et al* sections 1.148 to 1.153 and 2.26 to 2.34.

Model combining

D.35 Once all models of individual components are finalised, it may be necessary to combine together individual models into a single structure. The necessity of this may depend on whether the rating engine used can combine together several structures within the rating algorithm or whether a single set of rating tables is required.

D.36 The combining process involves calculating fitted values for each component and combining together to get the fitted risk premium. Expenses can be loaded at this stage to derive a fitted office premium. The final stage involves fitting a GLM to the fitted risk (or office) premium to derive a single set of relativities. This last stage is a smoothing process more than anything else, and there is no randomness within the response variable. At this stage, reserving and inflationary adjustments may be required.

D.37 Parameter estimate standard errors from the model fitted at this last stage are small as there is no random error, just model error. The standard errors representing the uncertainty underlying the claims experience are more difficult to calculate in this case. This is also true if a fixed adjustment is made to either the claim cost (eg an excess) or the technical price (eg a policy fee).

D.38 Further details on model combining can be found in *Brockman & Wright*, section 8, *Murphy Brockman & Lee*, section 3.4 and *Anderson et al*, section 2.104 to 2.109. Details of the calculation of standard errors for the combined risk premiums can also be found in *Brockman & Wright*, Appendix J.

Offsetting

D.39 The process of offsetting involves fixing the parameter values for one or more rating factors, and allowing other factors to find their correct level given these values. This is useful for two purposes.

D.40 Firstly, it can be used if additional smoothing is required on the model output over and above that which can be achieved by grouping factors or fitting curves.

D.41 More importantly, if relativities are required to be set for regulatory or commercial purposes, offsetting the factor enables the model to best fit the data given these constraints. Offsetting only has a significant impact on factors that are highly correlated with the offset factor, and if the offset parameters are significantly different from the "natural" parameters. The classic example is for a No Claims Discount scale, where it may be necessarily to adhere to a published scale. If the natural parameters are significantly different, then the parameter values for correlated factors, such as Policyholder Age or Driver Experience, will adjust to attempt to compensate in order to fit the data better.

D.42 Further details on offsetting can be found in *Anderson et al*, section 2.110 to 2.117.

Modelling retention/conversion

D.43 As well as using GLMs to fit to risk premium components, GLMs can also be used for modelling response rates, such as:

- new business conversion rates
- renewal rates
- cross-sell rates.

D.44 Typically more and/or different factors will be required than the rating factors listed for modelling risk premium components. For example, loyalty factors may be included for modelling response rates, as well as any information available about market premiums.

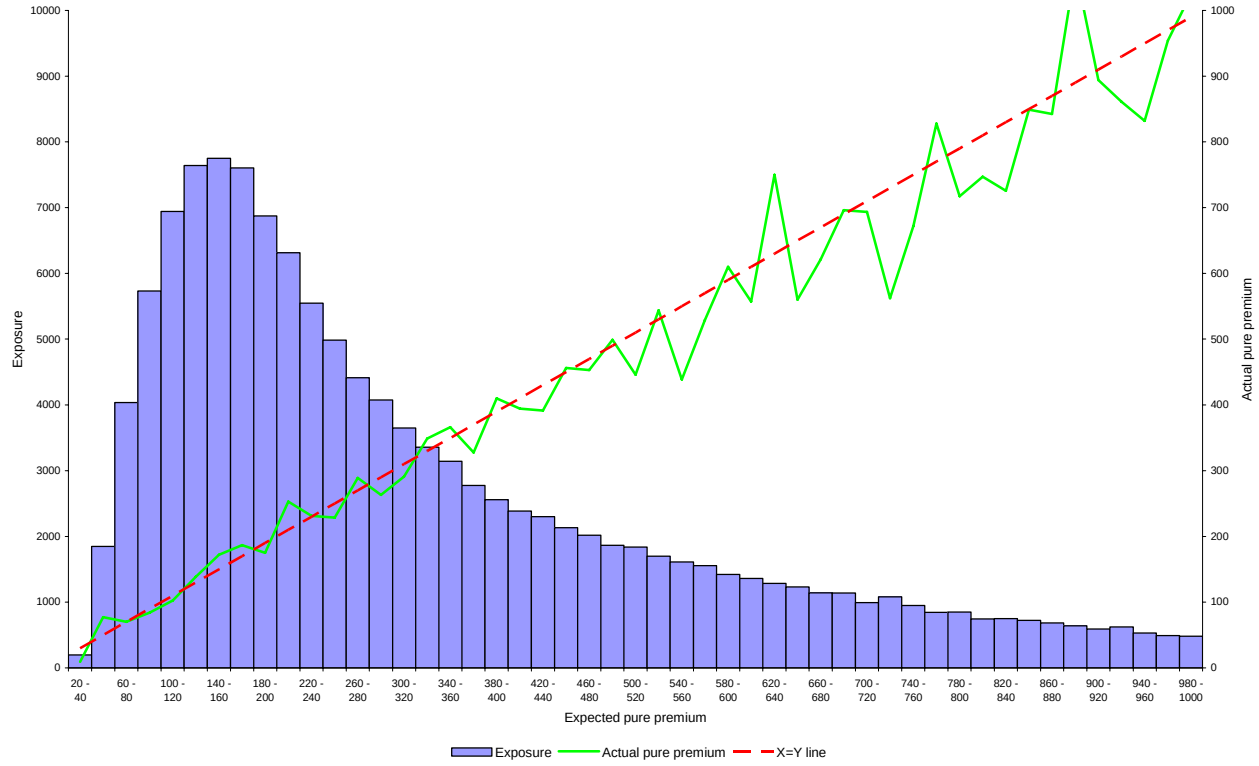
D.45 Further details can be found in *Bland et al* and *Murphy, Brockman & Lee*, section 4.

Model validation

D.46 Model checking comes in two forms: formal statistical checking, and checking the predictiveness of a model. The former is outlined in the different sections above, and a useful reference can be found in *McCullagh & Nelder*, chapter 12.

D.47 For the purposes of validating the predictiveness of a model, out-of-sample tests can be performed. Validation samples of, say, 20% of the total data can be withheld from the modelling process. A range of tests can then be undertaken on this validation sample comparing actual experience with that predicted by the selected model.

D.48 One possible method of validating a model is to produce graphs such as the one below.



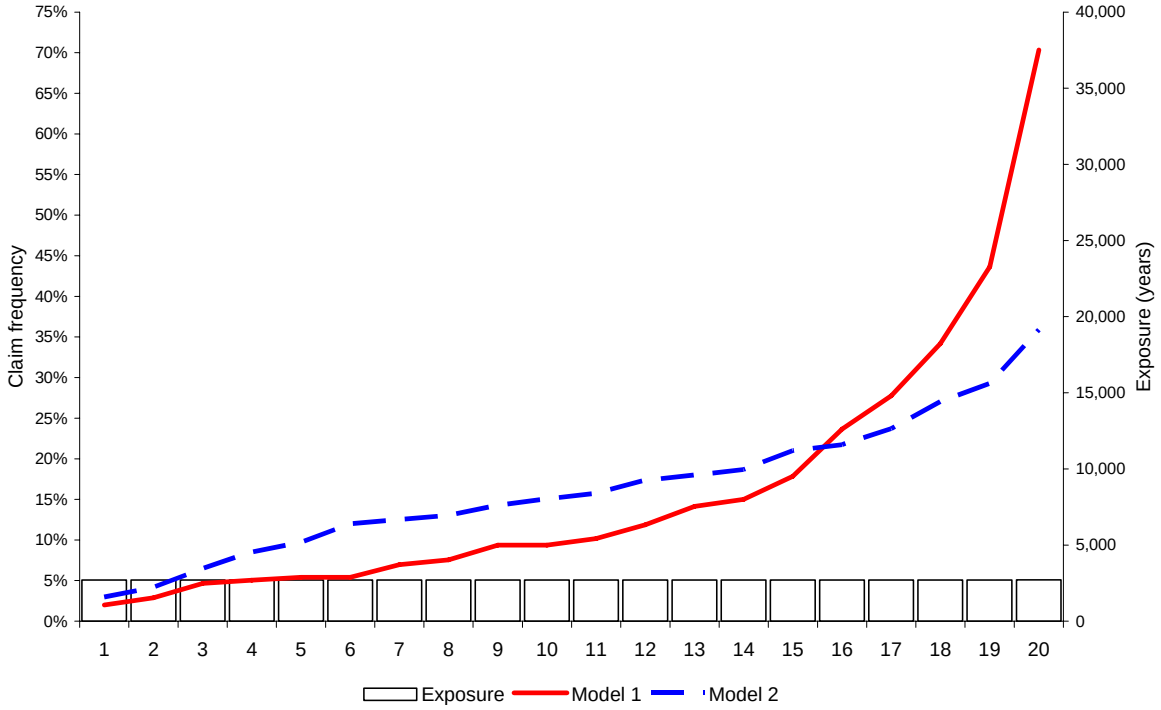
D.49 This graph shows the number of policy exposures (on the first y-axis) that have different expected claims costs (on the x-axis) according to the model being tested. The solid line (on the 2nd y-axis) shows for each band of expected claims cost the actual claims cost experienced. If actual experience completely matches that predicted, the solid line would lie on the dashed x=y line. No model will be perfect, and the solid line will never lie exactly on the dashed line. Systematic differences, however, can indicate poor model fitting. For example if the gradient of the solid line is consistently less than one, this may indicate that the model being tested is over-parameterised (the model is "not as predictive as it thinks it is").

D.50 The distribution of exposure on the graph just provides information which is helpful when interpreting the results - departures of actual from expected are more concerning when such departures apply to a significant proportion of the portfolio.

Lift curves

D.51 Another related way of assessing the predictiveness of a model is to calculate a "lift curve" on an out-of-sample model validation dataset. This method is also useful for comparing two models of different forms. One approach is to rank all policies in the validation dataset in order of expected experience (according to the model being tested), and then to group the policies into bands of equal exposure based on this ranking. The actual experience for each group can then be calculated and displayed as a curve. The steeper the curve, the more effective the model is at distinguishing between high and low experience.

D.52 The below graph shows an example of such a comparison between two claim frequency models. It is clear from the graph that Model 1 is the more predictive of the two.



Other relativity methods

Introduction

D.53 There are of course many other methods available for deriving relativities other than GLMs, although it is fair to say that GLMs are now probably the most widely used of the various methods. We outline below a series of these other methods.

One-way analyses

D.54 A one-way (or univariate) analysis is a simple data summary in table form which summarises various key statistics (eg claims frequency, loss ratio, burning cost, etc) for each possible value of an explanatory variable (rating factor) but without taking account of the effect of other variables. One-way analyses can be materially distorted by correlations between rating factors. For example if young drivers tend in general to drive older cars, and young drivers appear on a one-way basis to have worse claims experience than older drivers, it will not be clear how much of the effect is due to their being young and how much is due to the fact that they drive older cars.

D.55 One-way and two-way tables are still useful in the modelling process. Such tables are examined for each explanatory variable to gain an overview of the data and to help identify which factors may be suitable for use in the modelling process. Any unusual features identified at this stage are investigated.

Standardised one-ways

D.56 One method of addressing the problems with one-way analyses involves attempting to standardise the data in such a way as to remove the distorting effects of an uneven business mix. This could involve standardising for the effect of one or more of the other factors when considering a one-way analysis by a particular explanatory variable, for example by adjusting the exposure measure. Similar to one-way analyses, no consideration is given to interdependencies between variables not included in the standardisation.

D.57 It is worth noting that iteratively standardising a series of one-way tables can eventually result in relativities which are identical to those produced by a GLM (for some link and error assumptions), but this process is computationally inefficient compared simply to fitting a GLM. In particular, no diagnostics are produced, less flexible allowance for the random processes is possible, and the solution is not always easily tractable. Such an approach can be formalised as a minimum bias procedure.

Minimum bias procedures

D.58 Minimum bias procedures include a range of methods which include the Bailey-Simon method. These procedures use a set of equations which relate to the observed data, the rating variables and the set of parameters to be determined. A solution to the system of equations is found by using an iterative procedure. These methods, however, lack a statistical framework which actuaries can use to assess the quality of the modelling work. For instance, there is no systematic way of testing the statistical significance of a particular variable or producing a credible range of the parameter estimates. It has also been shown that many (but not all) of these methods correspond to generalised linear models.

D.59 Further details of minimum bias procedures can be found in *Mildenhall* and *Anderson et al*.

Neural networks

D.60 A neural network is a structure consisting of processing elements (called "neurons") interconnected via unidirectional signal channels (called "connections").

D.61 A neuron can receive any number of incoming connections and has a single output connection that branches into as many collateral connections as desired (but each carrying the same signal).

D.62 A neuron can have a local memory and processes information locally. The processing that goes on within each neuron can be defined arbitrarily but with the restriction that it must be completely local. Each neuron has a "transfer" function which uses local memory and the input signals to produce the neuron's output signal.

D.63 Good candidates for transfer functions are bounded, monotonic, continuous and differentiable everywhere. An example of a good transfer function is the commonly used Sigmoid function

$$g(S) = \frac{1}{1 - e^{-DS}}$$

D.64 The neuron output signal produced can be of any mathematical type desired.

D.65 Neural networks need to be trained. A neuron's transfer function usually has a sub-function (called a "learning law") that is responsible for adapting the input-output behaviour of the transfer function in response to the input signals. This adaptation is usually accomplished by modification of the values of variables stored in the neuron's local memory. However, it is also possible for connections between neurons to be created or destroyed, or for the transfer function to be replaced by a new one.

D.66 A neutral network's adaptation takes place in accordance with a training regime. The network is subjected to particular information environments and learns to achieve the desired end result. Typical techniques include supervised training, graded training or self organisation. More details on how to train a neural network can be found in Lowe and Pryor.

D.67 Neutral networks are particularly useful where one is trying to make some sort of prediction. One application is therefore in underwriting to suggest either accepting or rejecting an insurance application. It is more difficult where there is a gradation in risk (such as in insurance premium rating) since the actual risk is not immediately available for training the model. Neutral networks are not transparent and can be hard to interpret. There is also a danger that these models either under or over fit to the data. Neutral networks can be unstable for new types of policies.

D.68 Further information can be found in *Smith* and *Francis*.

Generalised additive models

D.69 Generalised additive models ("GAMs") are an extension to generalised linear models. They extend GLMs by replacing the linear form $\sum(x_j \beta_j)$ with the additive form $\sum f_j(x_j)$. We assume that the response variable is a member of the exponential family of distributions. In this case the mean is expressed as:

$$E(\underline{Y}) = \mu = g^{-1}\left[\sum_{j=1}^{P} f_j(x_j) + \xi \right]$$

D.70 In a GAM, some variables may enter the additive predictor linearly but the effects of others can be modelled in other ways. *Hastie and Tibshirani* (1990) discuss various general "smoothers" that can be applied to the x variable values. A smoother is a general nonparametric function of one or more of the predictors which summarises the trend of the y variable and is less variable than y itself.

D.71 Examples of smoothers include:

- *Bin smoothers* - partitions the predictor values into a number of disjoint regions and averages the response in each region
- *Running-mean or moving average smoothers* - takes the average of a certain number of the y values to the left or right of the particular x value under consideration
- *Kernel smoothers* - assigns weights to neighbouring points (defined by the kernel) and takes a weighted average of the y values on either side of the x value under consideration. Usually the weights reduce in a smooth manner as one moves away from the target point
- *Regression splines* - a spline is defined as a series of functions with each function defined over an interval bounded by two "knots". The functions are constrained to join smoothly at each knot. The degree of smoothness defines the type of spline, for example cubic splines must be continuous and have the first and second derivatives equal. In a regression spline the position of the knots is specified by the user and the model determines the optimal parameters given these knots
- *Smoothing splines* - these are similar to regression splines, except that one knot is placed at each data value. This results in the model over-fitting, and so a curvature penalty (based on the integral of the square of the second derivative) is added. In order to determine the optimal value of the curvature penalty it is necessary to segment the data and use an iterative re-sampling approach. This adds considerably to the computational overheads.

D.72 When selecting models one can compare the deviance as described under the GLM section (with the exception of smoothing splines).

D.73 Many of the standard statistics computed by GAMs are similar to those obtained by generalised linear model fitting procedures. For example, predicted and residual values for the final model can be computed, and various graphs of the residuals can be displayed to help identify possible outliers, etc. The main result of interest, of course, is how the predictors are related to the dependent variable. Scatterplots can be computed showing the smoothed predictor variable values plotted against the partial residuals, ie the residuals after removing the effect of all other predictor variables. This plot allows the nature of the relationship between the predictor and the residualised (adjusted) dependent variable values to be evaluated (see *Hastie & Tibshirani*; in particular formula 6.3), and hence the nature of the influence of the respective predictor in the overall model.

D.74 With the added flexibility of non-parametric and additive regression models there is always the risk of over-fitting the data and interpreting spurious features in the fitted curves. Use of the standard-error bands, deviance tests and residual plots should provide details of any spurious fits. As a test, the predictiveness of the model could be validated on an out-of-sample validation set of data and/or comparing the quality of the fit to the fit obtained via a GLM. The added complexity of a GAM is often not necessary to obtain a satisfactory fit to the data.

D.75 GAMs are not easily interpreted, particularly when involving complex non-linear effects. This could lead to difficulties in predicting results for new types of policies. Further details can be found in *Hastie and Tibshirani*.

Generalised non-linear models

D.76 In a GLM the basic structure is linear with the linear predictor being defined as a linear combination of the explanatory variables. This linear predictor is then transformed by the application of the inverse of the link function to allow a wider range of model forms. A generalised non-linear model ("GNM") goes further by removing the linearity restriction completely, allowing the mean to be any function of the underlying explanatory variables. Examples include the following:

Mixed additive multiplicative model

D.77 The linear predictor is replaced by a form which is a mixture of additive and multiplicative, eg $X\beta + e^{z\lambda}$

Alternative mixtures

D.78 The linear predictor is replaced by a form which is a mixture of different effects, eg

$$X\beta + C\gamma e^{Z\lambda}$$

or

$$\frac{1}{1+e^{X\beta+Pe^{Z\lambda}}}$$

D.79 Fitting non-linear models to the data is computationally difficult. It is possible in some situations to use similar techniques as fitting GLMs by making adjustments to the design matrix. The iterative process of fitting GNMs then requires the adjusted design matrix to be recalculated for each iteration.

D.80 Many of the comments made about GAMs are relevant for GNMs and possibly to an even greater extent. One particular issue with GNMs is that some of the parameters within the various components of the non-linear predictor can be correlated (eg the intercept of the additive component and the intercept of the multiplicative component in a mixed additive multiplicative model) which makes estimating these parameters difficult. The fitting process can be adjusted to allow for this issue, although this may rely on manual judgemental selections of some parameters.

D.81 Further details can be found in GLIM 4 The Statistical System for Generalized Linear Interactive Modelling and in *Murphy*.

Non-parametric methods

D.82 When there are significant interactions in the predictors a tree-based approach to regression can be effective.

D.83 One method would be to split the data into two parts based on the values of the predictors so that the resulting groups are the most homogeneous possible with respect to the response (this corresponds to a splitting point which produces the smallest total within-group variance in the two groups). The process is then repeated on each of the two parts of the data. This binary-style splitting can be summarised by a binary tree. The tree is then used for predicting the response of a new observation by determining in which subgroup its predictors lie.

D.84 As another approach, rather than starting at the top it is possible to start with every observation separately and group together the two most similar ones. This process is then repeated on each part of the data to construct the binary tree. There are a number of variations on these types of method.

D.85 An effective algorithm to undertake this splitting is the Classification and Regression Trees ("CART") program. CART methodology has the ability to make effective use of observations that are missing by creating surrogate variables. The tree is however piecewise-constant and so is difficult to smooth.

D.86 Further details can be found in *Breiman, Friedman, Olshen and Stone*.

Multivariate adaptive regression splines

D.87 Multivariate adaptive regression splines ("MARS") is a multivariate non-parametric regression procedure introduced in 1991 by Jerome Friedman (see *Friedman* 1991 and also *Francis*). The MARS procedure builds flexible regression models by fitting separate spline basis functions to distinct intervals of the predictor variables. Both the variables to use and the end points of the intervals for each variable (referred to as knots) are found via a search procedure. Variables, knots and interactions are optimised simultaneously by evaluating a "loss of fit" (LOF) criterion. MARS chooses the LOF that most improves the model at each step. In addition to searching variables one by one, MARS also searches for interactions between variables, allowing any degree of interaction to be considered.

D.88 The "optimal" MARS model is selected in a two-phase process. In the first phase, a model is grown by adding basis functions (new main effects, knots, or interactions) until an overly large model is found. In the second phase, basis functions are deleted in order of least contribution to the model until an optimal balance of bias and variance is found.

D.89 MARS can also be used in conjunction with CART. CART can be used first to extract the most important variables from a very large list of potential predictors. MARS can then focus on the top variables from the CART model, resulting in faster MARS analyses and more accurate and robust models.

D.90 MARS is a form of GAM.

Classification - introduction

D.91 Classification is a process whereby rating factors with a large number of discrete levels are grouped into a smaller number of groups of similar claims experience. The most common example is the grouping of postal codes into rating areas, although these techniques can also be applied to:

- vehicle make-model codes
- occupation
- accident and conviction codes.

D.92 The nature of the problem relates to having a small amount of exposure at any one level, making the experience of an individual code quite unreliable.

D.93 The most established of these, where techniques are most advanced, is the sphere of geographical classification. Geographical classification also has the advantage of there being a relationship between postal codes in that we may postulate that postal codes that are close to each other have similar underlying claims experience.

Geographical classification

Overview

D.94 Geographical classification is a multi-stage process encompassing:

- developing a realistic and accurate estimator of the risk for each location code
- grouping the location codes on the basis of this estimator to give a rating district
- establishing relativities for the new rating district.

Drivers of geographical variation

D.95 There are four main drivers of geographical variation in claims experience. These are:

- *Mix of business differences by location*

  Differences in experience between postcodes would be expected because of different mixes of standard rating factors.

  Typically the effect of mix of business would be captured from historical claims experience via a GLM model fitted to the standard policy factors.

- *Actual geographical differences by location*

  In addition to standard factors, geographic factors (such as census variables, socio-demographic information etc) will explain differences in experience between different postcodes. Data providers also provide a view of differences with natural peril models. Again, the effect of these are typically captured from historical claims experience in a GLM environment.

- *Residual spatial or geographical variation*

  This component represents true underlying geographical variation that is unable to be captured in the GLM environment by the external factors above. Other techniques including spatial smoothing are required to isolate this component.

- *Random noise in historical claims experience*

  The remaining differences in experience are caused by random noise.

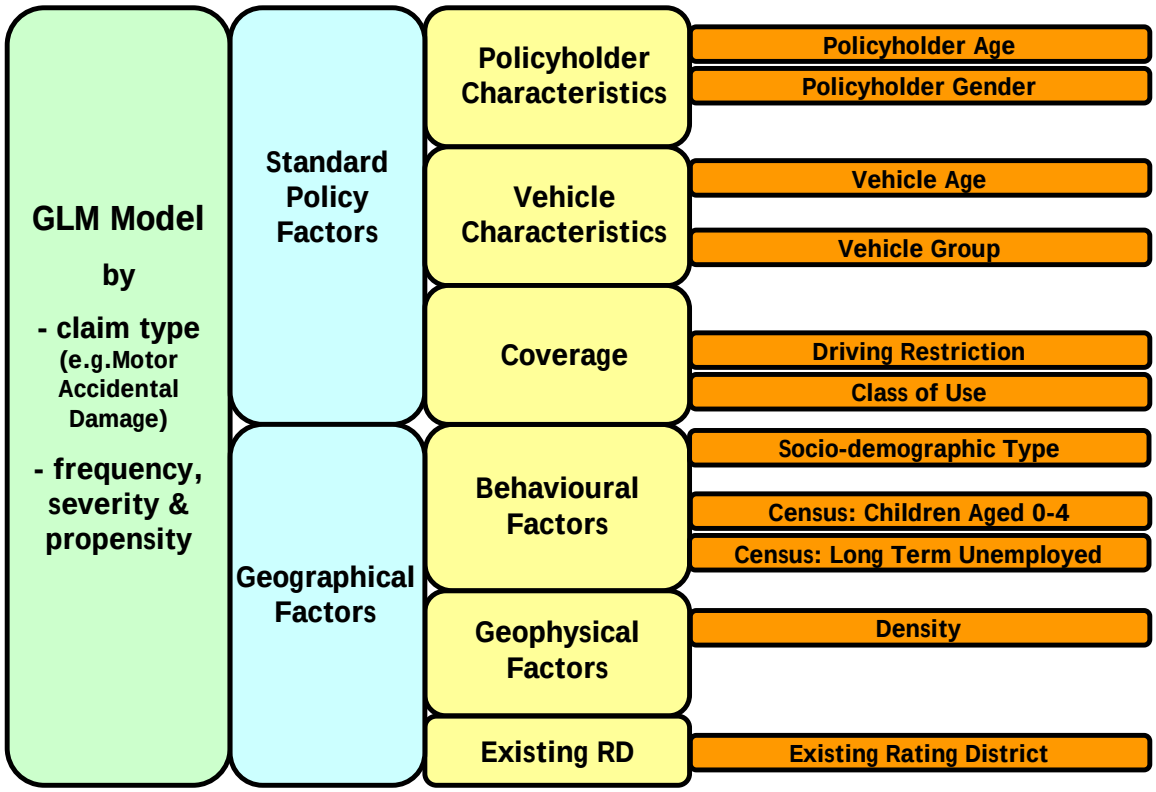
D.96 For geographical classification purposes, isolating the second and third of these drivers allows rating areas to be constructed.

Construction of GLM Models

Models

D.97 The first stage of the classification process is the construction of appropriate GLM models, in order to capture the first two drivers of geographical variation. To capture these drivers as accurately as possible, the models need to be constructed by section (if applicable), by peril or claim type, and separately for frequency and severity, as described under the section describing GLMs.

D.98 Prior to the classification stage itself, the models include a range of geographical factors including any available external data (see motor example below).



D.99 Post-classification, the geographical factors are replaced by the new rating district in order to determine relativities for the new rating district itself and to allow the relativities for the other factors to adjust appropriately for the new classification.

External data

D.100 A wealth of external data, including natural peril data, socio-demographic and marketing data (such as Mosaic and Acorn), is available to supplement insurers' own data. Some data can be costly, but is a key contributor to enhancing any analysis of claims experience for geographical classification purposes. Even simple (and cheap) data such as measures of urban density can materially enhance the predictiveness of a model.

D.101 The data is linked on to the historical data by location code, and assessed and calibrated in the usual way in the GLM environment for:

- Predictiveness
- Range and steepness of relativities
- The ability to differentiate between geographical units, ie the spread of geographical units between scores/levels of the external data.

D.102 Further details of external data providers can be found in *Coughlan et al*.

Residual variation

D.103 Claims models enhanced with external data capture a lot of the drivers of geographical variation. However, a significant amount of the underlying regional experience often remains, resulting in a potential misallocation of geographical codes in the classification process if not assessed and identified separately.

D.104 Reasons for this residual variation include:

- inadequate models, such as a lack of interactions, over-simplification, under-simplification etc
- insufficient quantities or quality of external data used within models
- external data used is not always produced for insurance purposes, so a score or level of an external factor in one part of the country can mean very different things in another part of the country.

D.105 This effect can be seen clearly when looking at a one-way summary of fitted average values against observed average values split by a broad regional grouping not used in the analysis - for certain regions, the trends diverge indicating effects not captured.

Capturing residual variation

D.106 The key here is a comparison of the observed historical claims data against the fitted GLM values in order to assess any discrepancy, and then to correct for that discrepancy.

D.107 Much of the work is typically carried out on standardised data, using the relativities from the GLM models to standardise for the first driver of geographical variation, namely mix of business, to leave just the geographical variation in the data for assessment.

D.108 Amongst commonly used techniques for this assessment and correction are:

- credibility methods
- spatial smoothing methods
- residual methods.

D.109 These approaches are used in isolation or in combination to split the discrepancy between true underlying residual variation (the third driver of geographical variation) and random noise (the fourth driver).

Credibility methods

D.110 Using standard credibility approaches, allowance for the discrepancy between the fitted models and underlying observed data is given by setting the adjusted standardised (for mix of business) fitted value for a geographical location code (eg postcode sector) to be a function of the standardised observed and standardised fitted values for that code:

Z * Standardised Observed + (1 - Z) * Standardised Fitted

where

- $Z = \left(\frac{w}{W_0} \right)^{POWER}$
- w = weight in code
- W_0 = weight in code for full credibility

D.111 Where there is greater historical exposure in a location code, more credence is given to the historical observed data.

D.112 Further details can be found in *Coughlan et al*.

Spatial smoothing methods

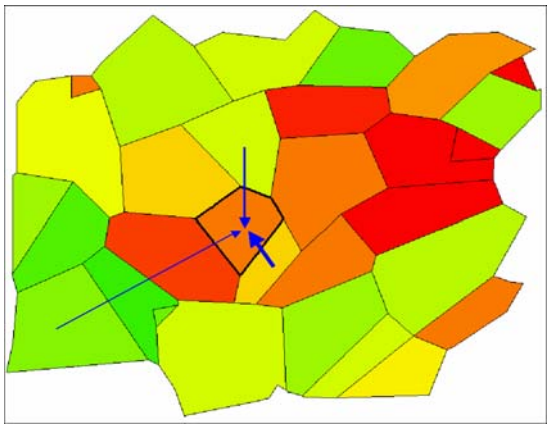
D.113 Using the assumption that each location code will behave similarly to neighbouring location codes, knowledge of the surrounding areas can be brought in to enhance the estimates of the underlying risk in each location code using spatial smoothing methods. In essence, these methods are extensions of credibility weighting methods, this time looking across location codes rather than just within a given location code.

D.114 Two main forms of spatial smoothing are typically employed:

- distance-based smoothing
- adjacency-based smoothing.

D.115 The features of each form of smoothing make it more or less appropriate to use depending on the underlying processes behind the loss types being modelled.

Distance-based smoothing



D.116 Distance-based smoothing incorporates information about nearby location codes based on the distance between the location codes - the further away a location code, the less influence (or weight) is given to its experience.

D.117 This is true regardless of whether an area is urban or rural, and whether natural or artificial boundaries (such as rivers) exist between location codes.

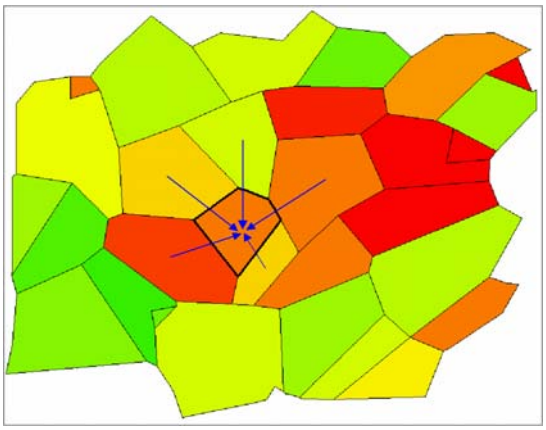
D.118 As such, distance-based smoothing methods are often employed for weather-related perils where there is less danger of over- or under-smoothing urban and rural areas.

D.119 Distance-based smoothing methods have the advantage of being easy to understand and easy to implement, as no distributional assumptions are required in the algorithm.

D.120 Distance-based methods can also be enhanced by amending the distance metric to include "dimensions" other than latitude and longitude. For example, including urban density in the distance metric would allow urban areas to be more influenced by experience in nearby urban areas than by nearby rural areas, which may be appropriate.

D.121 Further details on distance based smoothing can be found in *Brubaker*, in *Christopherson and Werland* and in *Anderson*.

Adjacency-based smoothing



D.122 Adjacency-based smoothing incorporates information about directly neighbouring location codes. Each location code is influenced by its direct neighbours, each of which is in turn influenced by its direct neighbours; distributional assumptions or prior knowledge of the claims processes can be incorporated in the technique. The algorithms are therefore iterative and complex to implement.

D.123 As this smoothing method relies on defining which location codes neighbour each other, natural or artificial boundaries can be reflected in the smoothing process.

D.124 Location codes tend to be smaller in urban regions and larger in rural areas, so adjacency-based smoothing can sometimes handle urban and rural differences more appropriately for non-weather-related perils.

D.125 Further details can be found in *Boskov and Verrall*.

Degree of smoothing

D.126 Employing too low a level of spatial smoothing (near or neighbouring location codes have little influence on the location code in question) can result in some of the random noise element (fourth driver) being captured together with the true underlying residual variation, thereby causing distortions. Conversely, employing too high a level of spatial smoothing can result in the blurring of experience so that some of the true underlying residual variation is lost, again causing distortions.

Residual methods

D.127 The residual for each location code is defined as the ratio of the historical observed data to the fitted GLM values (ie capturing the third and fourth drivers of the geographical variation).

D.128 Various adjustments to these residuals can be made (to remove the random noise element) using established techniques and/or judgement.

Manual checking and correction

D.129 When using any of these techniques in isolation or combination, manual adjustment of the relative ranking of location codes may be required for some of the location codes falling into the following categories:

- areas with low or zero exposure
- areas known to be particularly good or bad
- areas known to have changed in experience post-analysis
- coastal areas and islands, as smoothing techniques may be distorted in these regions
- any areas that require specialist local knowledge.

Clustering methods

D.130 Having established a best estimate of the underlying frequency and severity by claim type (and by section, if appropriate) for each location code using a combination of GLMs and techniques to capture residual spatial variation, the estimators are combined to an appropriate level. This is across frequency and severity, together with relevant reserving/trend/inflation assumptions, for peril-level rating allocations; and additionally across claim-types/perils and/or sections for combined rating allocations.

D.131 The resulting risk premium estimators give a relative ranking of location codes, which then need to be grouped or clustered into a new rating district.

D.132 The aim of the clustering process is to minimise within-group heterogeneity whilst maximising cross-group heterogeneity.

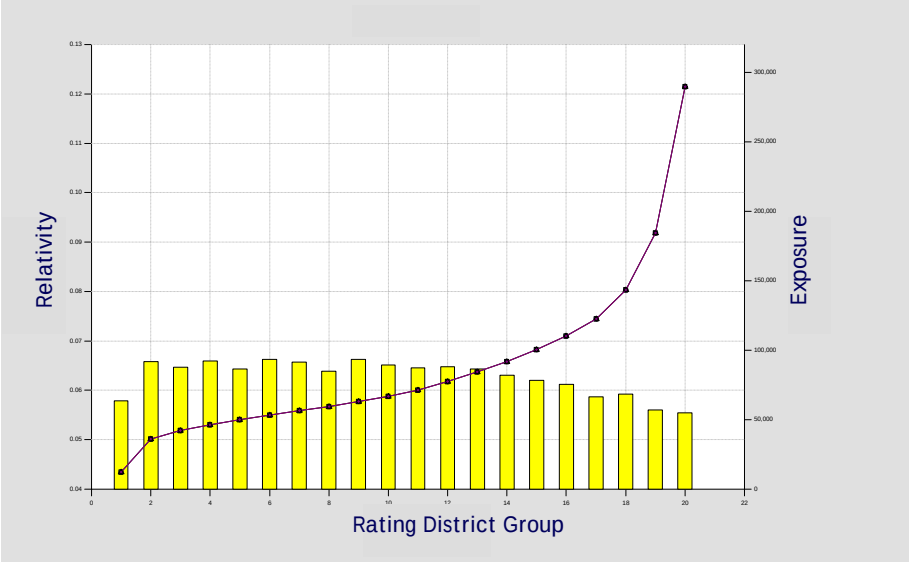
D.133 Three main forms of clustering are typically employed:

- quantiles
- equal weight
- similarity methods, of which Average Linkage, Centroid and Ward are typical examples.

D.134 The different techniques result in different distributions of exposure in each rating district group, with knock-on effects on the slope and shape of the relativity trend. The graphs below illustrate this effect.

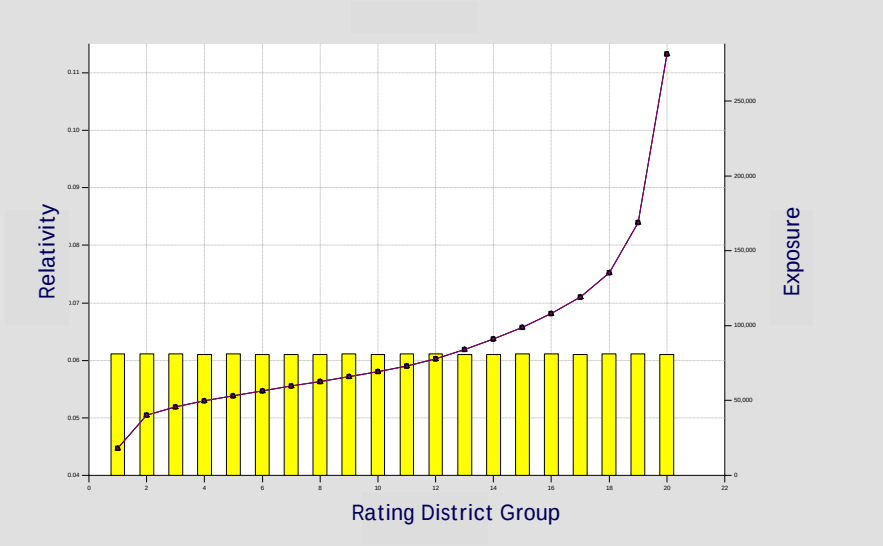
Quantiles

D.135 Having ranked the location codes by the risk premium estimators, the codes are divided so that an equal number of codes are present in each rating district group required.



Equal weight

D.136 Similar to the Quantiles method, the codes are grouped so that there is equal historical exposure in each rating district group required.

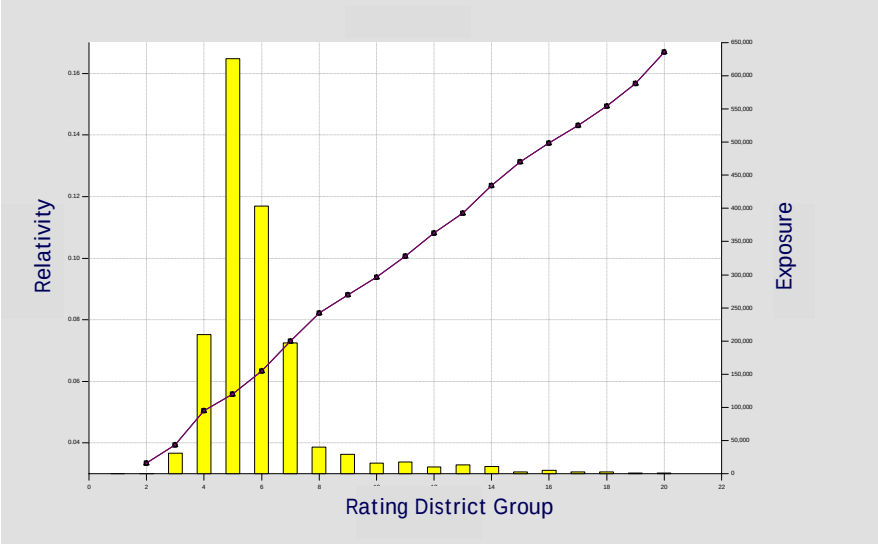


Similarity methods

D.137 Similarity methods of clustering group together the "most similar" pairs of observations (or groups of observations, or "clusters"), repeating until the required number of groups or "clusters" is attained. The similarity measure is defined as the "distance" between the clusters.

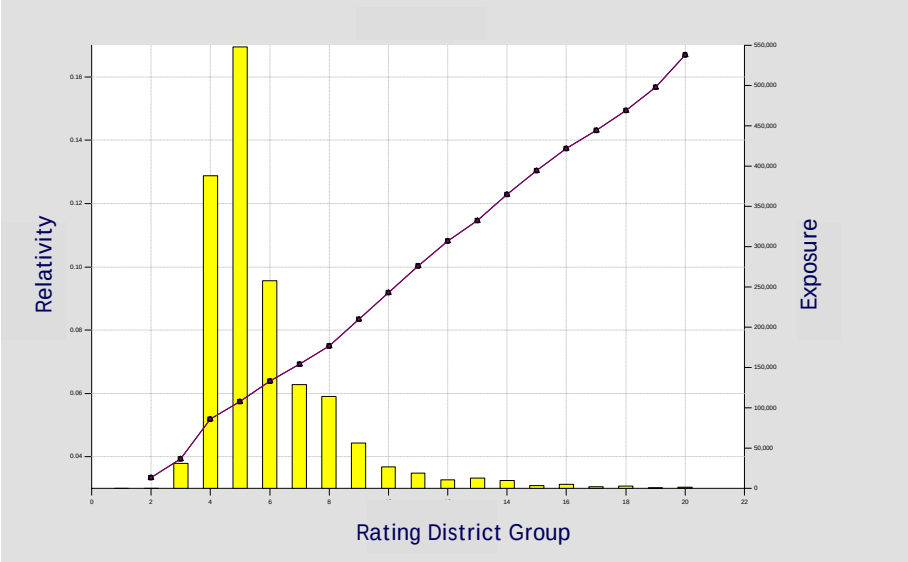
Average linkage

D.138 Here the distance between the clusters is defined as the average distance (difference in values) between pairs of observations, one in each cluster.



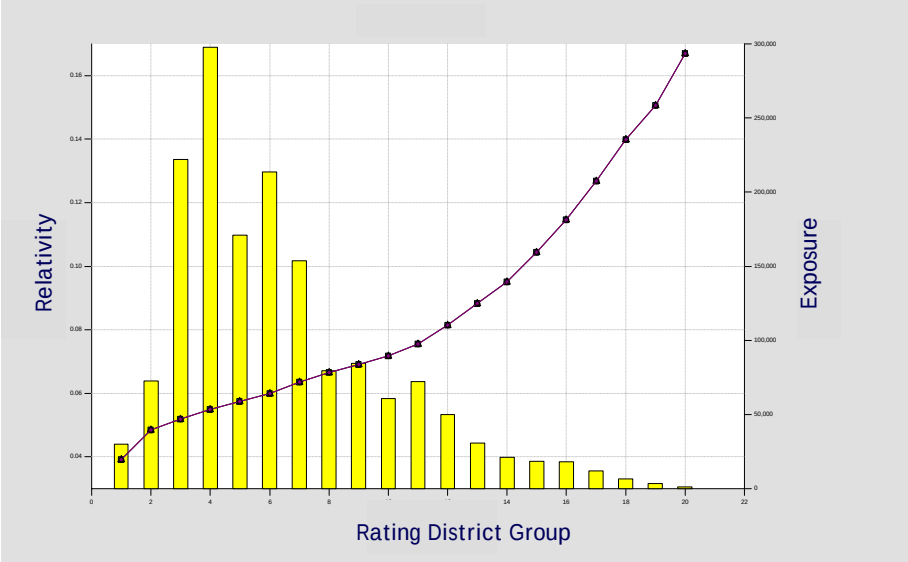
Centroid

D.139 Here the distance between the clusters is defined as the difference between the mean values of the clusters squared.



Ward

D.140 This method of clustering is similar to the Centroid method of clustering but is more biased towards producing clusters with equal weight.



D.141 Typically the Ward method of clustering gives a good balance between meeting the aims of the clustering process (minimise within-group heterogeneity whilst maximising cross-group heterogeneity) and ensuring sufficient exposure at the higher rating districts for stability. As such, it is a widely used method for classification.

D.142 A myriad of further information on clustering methods can be found on the internet.

Level of detail

D.143 The level of detail selected for analysis is a balance between a sufficient level of detail to recognise and capture genuine differences between areas, and having sufficient data to carry out a credible analysis.

D.144 In the UK, geographical location codes are defined at the following levels:

- Postcode Unit KT17 1HB
- Postcode Sector KT17 1
- Postcode District KT17
- Postcode Area KT.

D.145 Typically, geographical classification is carried out at postcode sector level with unit level exceptions.

Vehicle classification

D.146 The current system of vehicle grouping devised by the Association of British Insurers has been around in its current form since 1992 and classifies vehicles into one of 20 groups based on similarity of characteristics. The grouping of a particular vehicle is decided by a board who meet once a month to consider newly registered vehicles.

D.147 The factors used to establish the groupings are:

- damage and parts costs
- repair times
- new car values
- body shells
- performance
- car security.

D.148 This system of classification is currently under review by the ABI, with the intention of extending the scale to 50 groups.

D.149 The techniques described above for geographical classification can be applied to vehicle make-model analyses, in particular if a suitable "adjacency" map of make-models is established for spatial smoothing techniques in multiple dimensions. In this way the underlying drivers of vehicle risk by claim type and by frequency/severity can be established, including residual effects not explained by standard factors.

Other classifications

D.150 Other factors, such as occupation codes, can be similarly classified, although without the advantage of spatial smoothing or an ABI-type vehicle classification.

D.151 For other factors, such as accidents and convictions, often a "score" factor is generated, based on the number and severity of (say) convictions.

Expense modelling

D.152 Given the level of sophistication that is built into risk premium modelling, it is perhaps surprising that expenses are not treated in a more sophisticated manner. Loadings are often made at an overall level, with no explicit allowance being made for acquisition expenses (other than commission), policy processing costs, claims handling costs etc. Often expense loadings are derived without actuarial involvement, and it can be unclear as to whether loadings are to cover fixed or variable costs.

D.153 There is very little actuarial literature about deriving Activity Based Cost (ABC) loadings for general insurance; *Brockman and Wright* discuss deriving office premiums given particular expense assumptions, but do not discuss their calculation. Some details can be found in the reading for SA3, Unit 13.

Technical base rates

Introduction

D.154 As important as relativity analyses is the calculation of the base rate, and this needs to be sufficient such that total premiums collected will pay expected claims, expenses, and meet profit objectives.

D.155 The technical base rate needs to be appropriate for the policies to be written in the period for which the rates are applicable. In other words, the base rate needs to be appropriate for:

- the mix of claims expected to be experienced by the portfolio written, which in turn will be dependent on the expected mix of business to be written
- the expected ultimate cost of such claims
- the expected timing of these claims, allowing for claims severity inflation and frequency trends
- the expected claims and policy expenses, allowing for the impact of inflation and expected volumes of business
- an appropriate profit loading to cover the cost of capital.

D.156 These need to be considered in the context of the actual historical data used for pricing and the timing of the claims and so on.

Deriving expected ultimate costs

D.157 Historic claims data must be adjusted to take it to ultimate position using loss development factors appropriate to the claim type and degree of development. Such adjustments allow for IBNER on known claims and for IBNR claims.

D.158 Usually the loss development factors applied are those derived from reserving on a strict best estimate basis; this may be different to the reserving basis used for establishing technical reserves.

D.159 One-off adjustments for any actual or expected factors that will alter the expected ultimate cost of claims are required, for example changes in claims department initiatives and any changes in the economic or legislative environment. For example, historic claims may be adjusted to allow for the introduction of periodic payments for motor injury claims.

D.160 As well as adjusting historic data, it is important to allow for future trends within the base rate, including any changes in frequency or severity.

D.161 Trends within the relativity analysis (together with any reserving adjustments) will provide historic frequency and severity trends. An understanding of the levels of these, and the underlying drivers, is useful in setting levels for the expected future claims frequency trends and claims severity inflation.

D.162 In addition, the ratio of the multivariate effect of calendar year of exposure to an overall one-way measure of claims cost by calendar year can yield factors which allow past experience to be restated to remove effects which can be attributed to changes in the mix of business over time. This can allow easier interpretation of past experience when selecting underlying overall rate levels and trends.

D.163 Trend and inflation assumptions are required to adjust the technical rates for the time period between the historical claims data and the expected timing of the claims expected to occur on policies written using the new rate series.

D.164 Ideally these trend and inflation adjustments are established at claim type level to allow for the changing importance of various claim types over time, for example, a reduction in the importance of theft claims and an increase in the importance of third party bodily injury claims for motor.

D.165 The adjustments to the technical base rate described so far are all carried out at a micro level. It is always helpful to perform a second aggregate check on the technical base rate. This can be achieved by applying the technical base rate and relativities to the expected profile of business written to derive the expected claims costs. The results of recent reserving analyses (adjusted appropriately for mix of business and trends) can be used to assess whether the proportions of expected claims costs by claim type and the overall level of the rates are consistent with the aggregate reserving results, or whether adjustments to the technical base rate (by claim type) are required.

Event/catastrophe loadings

D.166 Historic data will contain an element of volatility relating to items such as different prevailing economic conditions, differences in weather between years, and volatile large claims experience. Consideration should be given as to whether the historic data used represents an average year for such events. This may involve considering a longer time horizon for certain perils.

D.167 Consideration also needs to be given to catastrophic events in addition to "regular" event years, and appropriate loadings included.

Cost of reinsurance

D.168 The cost of reinsurance needs to be added to the technical base rate, although of course credit should be given for claims under reinsurance treaties.

No Claims Discount scales

D.169 No Claims Discount scales are mentioned within the context of a process known as "offsetting" within the description of generalised linear models above. This assumes, however, that there is stability to the mix of business (in other words that the proportion of business at each level is consistent from time period to time period). If this is not the case (perhaps because a No Claims Discount scale has just been introduced), then an adjustment is required by carrying out projections of the proportions of each level for the forthcoming year. If a new NCD scale has just been introduced, consideration also needs to be given to the impact on future claims experience.

Expense loadings

D.170 Deriving expense loadings are discussed in a little more detail above. The types of expenses that may be derived include:

- a percentage of premium
- a percentage of the risk premium
- a fixed per policy expense element
- a risk-related expense element (for example, a per claim expense related to a frequency model)
- a multivariate expense loading varying by policyholder characteristics.

Sensitivity checking

D.171 Normally some sensitivity checking would be applied to a technical premium calculation in order to ascertain the impact of changing certain assumptions. For example, the impact of a potential change in a legal ruling might be tested.

Implementation

Introduction

D.172 The pure technical price reflects the expected future cost of claims and expenses, and the desired level of profitability. The determination of this theoretical technical price has been the focus of this section.

D.173 In many situations, however, it is not appropriate for the pure technical price to be implemented directly in the market. Potential issues to consider when selecting the final commercial tariff include:

- IT system constraints, including those of the distribution channel, affecting the form of the rating structure
- legal or regulatory constraints or other business constraints (eg distribution channel) affecting which and how rating factors can be used in calculating the premium. For example, in many motor insurance markets a particular set of discounts is expected for the No Claims Discount scale which is usually significantly different to the theoretical relativities based on historic claims experience
- demand related issues, relating to the competitive environment and policyholder price elasticity.

D.174 In these situations a range of further analyses are required to get to an appropriate commercial price.

Restrictions on which and how factors can be used

D.175 For those factors which are required to follow particular effects in the pricing structure it is possible to adjust the underlying theoretical models to compensate. In this case, the required parameters for the particular factor are added as an offset in the model. The effects of the other factors included in the model, which are correlated with the particular factor, change to compensate as best they can. This is explained under "offsetting" in the GLM section above. It is good practice to assess how well other factors have compensated for this restriction. This is discussed in *Anderson et al* sections 2.116 to 2.117.

D.176 Where a particular rating factor can not be used the theoretical models can be adjusted by removing the factor and where possible including other rating factors which are correlated with the factor and therefore may be used as a proxy. The other factors in the model can then be left to absorb the particular effects of that factor.

Restrictions on the structure

D.177 Many insurers follow a "component" pricing approach, where the premium quoted to the policyholder is calculated separately for each cover component at the point of sale. These are then added together to give the total premium quoted.

D.178 As discussed previously, the theoretical modelling is usually performed separately by different claim type or peril. Where a premium is calculated or quoted by each peril separately, the multipliers are simply the product of the multipliers in the underlying frequency and severity models. If the log link function has been used, the parameter estimates can simply be added. The models' standard errors can also be calculated simply. Risk premium standard errors here are the square root of the sum of the squares of the standard errors from the model for any given factor level.

D.179 Where a single rating structure is required by cover, then it is necessary to construct a single rating structure which approximates the per peril approach.

D.180 In this event, the current exposure can be considered as an approximation to the exposure about to be written. The expected frequency and average claims amounts for each claim type are calculated on this exposure, and combined to give an expected total cost of claims as described in D.36 to D.38 above. Care is needed where particular covers are present only for some policies - in this case the exposure should only be considered when the cover is present.

Impact analyses

D.181 Where the theoretical pure technical price has been adjusted it is good practice to investigate the extent of approximations underlying the commercial price. This comparison can be done by (a) comparing the parameter estimates for each individual factor included in the models or (b) comparing the ratio of the pure technical price to the commercial price for each policy in the portfolio (eg as in the graphs in section 2.121 to 2.126 of *Anderson et al*). This indicates where the cross-subsidies exist within the final pricing structure.

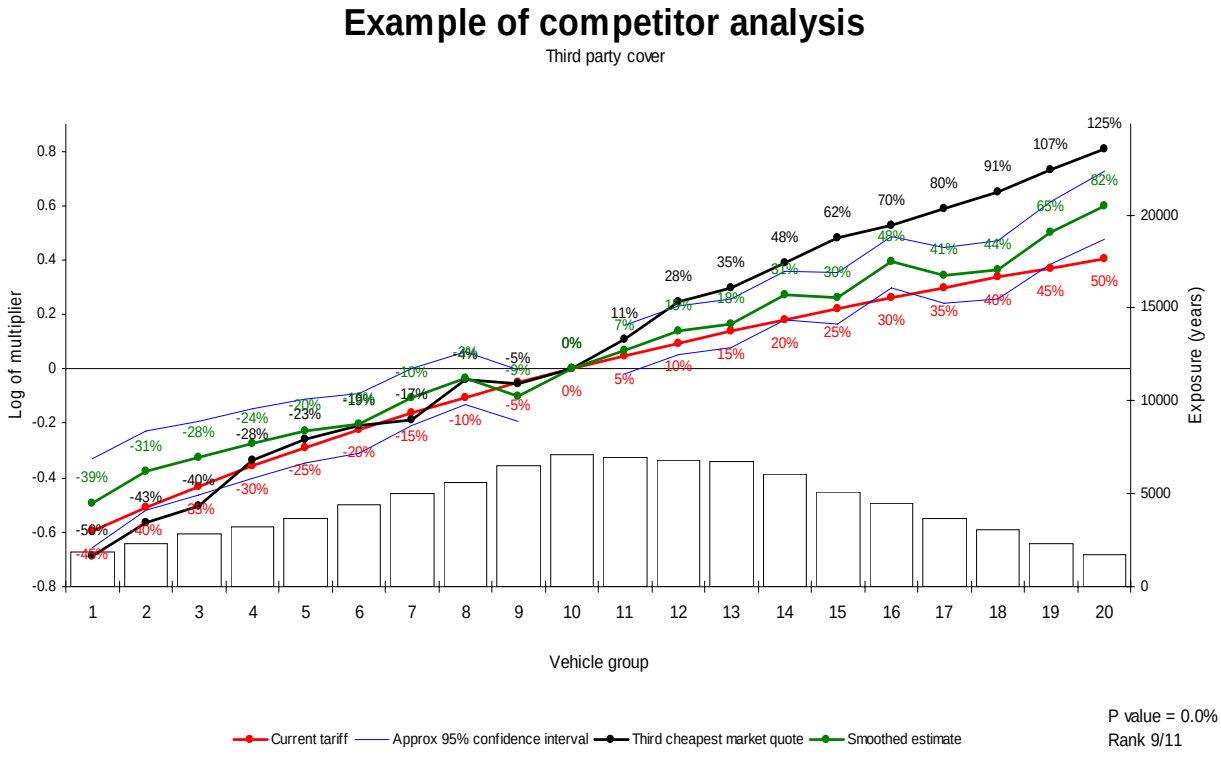
D.182 Similar comparisons could be undertaken between the pure technical price and the current price, the technical price and the proposed price, and the technical price and competitor prices.

Competitive environment and policyholder behaviour

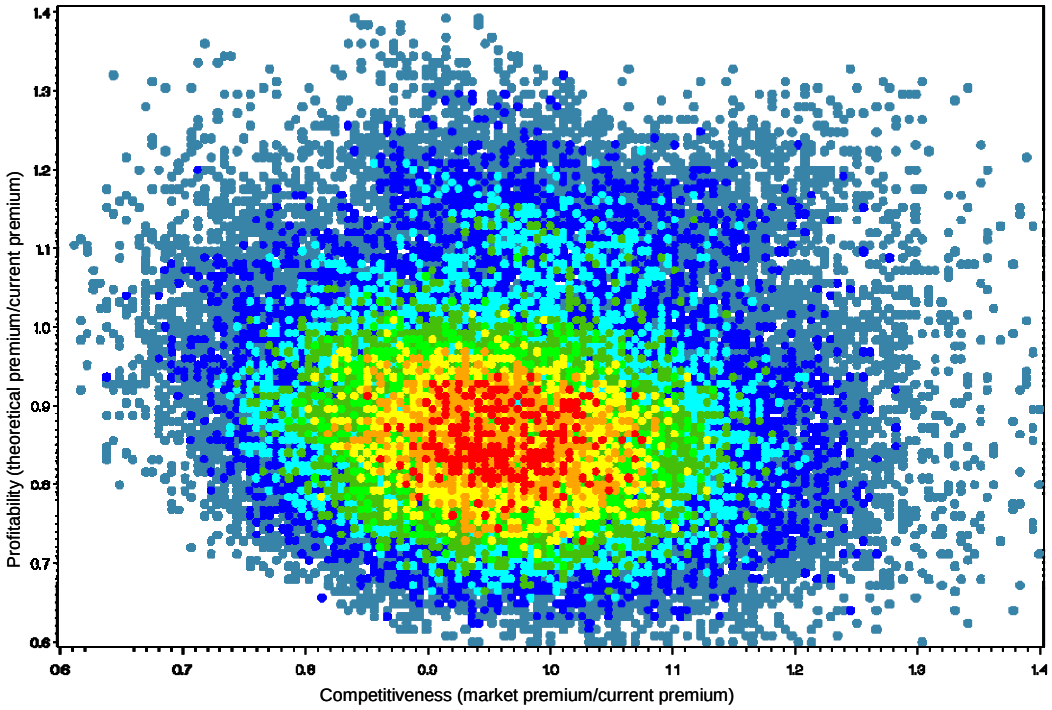
D.183 Comparisons of the technical price, the current price and some measure of "market" premium (eg cheapest quote, third cheapest quote, average of the three cheapest, etc) can provide an indication of the competitiveness of the price.

D.184 Such information can be considered in a variety of forms. For example:

- graphs can be produced which compare current relativities, theoretical claim relativities, and measures of competitor rates, eg:



- colour contour scatterplots can be used to show in one diagram (for the current rating structure) the amount of the current portfolio that has differing expected profitability (eg the ratio of current rates to theoretical claims cost) and differing competitiveness (eg the ratio of the current rates to the third cheapest quote from a selection of competitor companies), eg:



D.185 Comparisons of the technical price and the current premiums can indicate significant theoretically indicated increases or reductions for individual policies. Implementing such large movements in practice may not be appropriate. Where the premium increase or decrease charged at renewal is to be constrained this can be done either by amending the multiplicative structure or, for example by the use of a premium moderator. A premium moderator is a function which is applied at point of sale and limits the premium quoted as a function of the current premium (and potentially measure of market premium also) for example by capping the change in renewal premium by a maximum or minimum percentage.

Lifetime Customer Value models

D.186 The focus of the methods so far have been on technical rates over the coming year; this is obviously of great importance when it comes to determining prices for policies, but focusing on a one year profit horizon for a single policy may not give sufficient credit for total profit emerging over the lifetime of a customer.

D.187 Lifetime Customer Value (LCV) models attempt to take a more holistic view of the value of a customer, with applications to pricing and non-pricing areas (in particular marketing), as well as determining overall business strategies. The importance of these models depends a lot on the distribution channel used; the LCV between business sold through direct channels with plenty of opportunity for cross-selling will be very different from that for a single-line insurer sold through an intermediary.

D.188 Factors to consider when building LCV models include:

- retention rates, which will vary significantly by segment (further details are found in *Murphy, Brockman and Lee*)
- allowance for changes in claims experience, either because of natural changes in rating factors (such as ageing of policyholders) or improvements because of durational effects
- allowance for changes in cover, such as moving from non-comprehensive to comprehensive motor cover or including additional sections on a household policy
- profits from add-on policies (eg legal expenses added to motor policies), cross-sold insurance policies (eg cross-selling household policies to motor policyholders), and from other services (eg instalment income if premiums are not paid in advance)
- expenses
- investment returns on funds held
- an appropriate discount rate
- whether additional risk loadings are required to reflect the fact that the further into the future the emergence of profit, the more uncertain the profit
- the lifetime capital requirements of the policy.

D.189 Further details of LCV models can be found in *Brown et al*.

Price optimisation

D.190 Personal lines price optimisation is a developing area and a range of related methods is currently used in the market. All methods seek to combine a detailed understanding of claims, retention, conversion and other customer behaviour (eg cross-selling) to derive premiums which maximise a defined business objective, subject to specified constraints.

D.191 The methods generally involve projecting, at an individual policy level, the likely profit and volume (and other KPIs) emerging over time from a given rating action, and then optimising rating parameters (which could be multipliers in a rating structure, premiums at an individual policy level, or parameters in a dynamic point of sale pricing algorithm) to maximise the required success criteria.

Lines of business with additional features

D.192 The methods used above can be applied reasonably generically to many personal lines classes of business, including motor, household, travel and pet insurance. It is worthwhile discussing two extra classes that have some distinct features.

D.193 The first of these is extended warranty insurance. Rating for extended warranty products tends not to be as sophisticated as for motor or household business, although many of the same techniques can be used. The additional complication with warranty business relates to the significant change in risk over the duration of the policy. It is important, therefore, to include an additional duration factor within any analysis, which will quantify this change in risk by duration.

D.194 The other class of business with additional features is creditor insurance. Again the market tends to be less sophisticated in terms of factors used; indeed many products do not differentiate by factor, and rather schemes have to be priced at an overall level taking into account the "average" of the factors. From this perspective, some of the characteristics of creditor business are more akin to London Market pricing. For single premium policies, the risk also changes over the duration of the loan, and so this needs to be allowed for. A significant source of profit for creditor policies can also relate to the cancellation of loans, where sometimes a "Rule of 78" calculation will apply, and this cancellation penalty is also applied to the insurance premium. In addition, many creditor schemes have significant profit commission elements, and these need to be priced in. Finally, creditor experience is significantly affected by economic factors, both in terms of the frequency of claims and the duration of claims in payment, and so particular attention is required on a suitable base rate, allowing for potential changes in economic conditions over the duration of the loan. Further details can be found in *Byrne, Jeffery and Bolton*.

International issues

D.195 The methods described above are commonly used for pricing within the UK market, and are adapted to UK-specific issues and policy coverage.

D.196 It is worthwhile briefly mentioning other issues that other actuaries around the world may need to consider in more detail, depending on local conditions.

D.197 Regulation in the UK is mainly concerned with the regulation of the overall solvency of companies, and the FSA is not generally concerned with the pricing decisions made. In other countries, this is not the case; in many states in the US, for example, rates need to be filed and approved by regulators, and often have to be justified from an actuarial perspective; Italian motor rates need to be actuarially certified as being fair.

D.198 In Ireland, the Equal Status Act 2000 requires that discrimination on a number of grounds (including age) is only allowed as long as there is "actuarial or statistical data obtained from a source on which it is reasonable to rely" to support the discrimination. There have been a number of legal challenges to insurers based on this act, some of which have required actuarial involvement to justify loadings and discounts by age.

D.199 In some continental European markets, third party material damage motor claims falling under market inter-insurer agreements (such as the French IDA agreement) will typically be modelled separately, further subdivided into "responsible" and "non-responsible" claims. The non-responsible claims may result in insurers recovering more from the third party's insurer than needed to fund the repair to their insured's vehicle. This can result in negative incurred claims which are not easily modelled with commonly used GLMs. As a result such amounts are often transformed with an additive adjustment prior to modelling, with the fixed amount being removed from the fitted values produced by the resulting models.

D.200 Loadings for natural catastrophes are described above, but generally does not warrant much analysis because of the relatively low impact on risk premium in the UK; in other countries, however, natural catastrophes are of more importance, and greater emphasis is placed on their pricing from an actuarial perspective. A considerable amount of literature on this can be found within CAS papers.

D.201 Similarly latent claims are often ignored for pricing purposes in the UK; again more literature is found within CAS papers.

D.202 As mentioned above, the lack of UK regulation means that most rating factors can be used within a rating table; certain factors are not used because they would breach other regulations, so (for example) ethnic origin is not rated on. In the US, actuaries also have to be careful about indirectly rating by race, and so "red-lining" (excluding or pricing certain geographical areas out of the market) is an issue in case it could be proven that the geographical location was a proxy for race.

D.203 One factor that is used extensively in some states in the US but not in the UK is credit score, and several CAS papers can be found on the topic. Credit score is usually not used in the UK because of certain clauses in the Consumer Credit Act, even though the US evidence is that it is a very powerful rating factor.

E London Market methods

Introduction

E.1 This section discusses the main methods used for pricing London Market business.

E.2 The characteristics of London Market business are very different from personal lines, which means that different emphases and analyses are necessary when pricing business. These characteristics include:

- data volumes are generally small and sparse, and often not readily available
- coverages are often not very homogeneous between different risks and between the same risk in different years
- there is much more variability within the risks compared to personal lines insurance.

E.3 Topics covered in this section include the following:

- overview: experience rating and exposure rating
- estimating the loss cost
- pricing excess of loss
- stochastic and other methods
- exposure measures
- data issues
- Increased Limit Factors
- attachment of cover
- contract structure
- other contract complications
- large claims and latent claims
- other pricing factors
- catastrophe models in pricing
- developing models for underwriters
- rate monitoring.

E.4 References detailing some of the methods outlined are set out in Appendix J.

Overview: experience rating and exposure rating

E.5 Most London Market contracts, where there is any degree of data available, will be priced using Experience Rating, Exposure Rating, or in most cases a combination of both. This Appendix considers the methodology used in both rating systems, as well as considering other factors which must be taken into consideration, many of which are specific to London Market business.

Experience rating

E.6 This approach represents rating based purely on the experience of the historic risk presented. Experience rating methods vary from simple "burning cost" analyses, ie claims costs over time in relation to a given set of values, to detailed actuarial reviews and mathematical methods.

E.7 The key advantages of these methods are that:

- they allow (or can be made to allow) for all material features of the risk presented
- the risks of anti-selection are reduced.

E.8 Key disadvantages of experience rating are that:

- other than for simple models, considerable amounts of time and expertise may be required
- not all risks will have a sufficient volume of relevant loss history to accommodate experience rating.

E.9 Unless data can be presented in identical formats for all risks, a full actuarial experience rating analysis conducted from scratch may be extremely time consuming. Generally this method would be reserved only for the most important risks, ie those with the highest premiums or largest potential downsides.

Exposure rating

E.10 Exposure rating systems use information about a risk's exposure to determine a rate to charge. In the strictest sense, exposure rating methods do not consider a risk's loss history, although, in practice, the loss history is often used as a rating factor.

E.11 The key advantages of using exposure rating systems are that:

- they can be effectively monitored, calibrated (if there is enough loss data) and managed
- they are quick and simple to use.

E.12 Key disadvantages of exposure rating systems are that:

- they effectively place risks into groups and apply the same rate for each risk in that group. In particular, an insured's loss history and risk profile may not be adequately reflected in the calculated premium
- without a large volume of relevant loss and exposure data, it can be difficult to assess an appropriate level for the various base rates and adjustment factors that are required.

E.13 These disadvantages can lead to anti-selection if the rating system is poorly designed. Competitors with systems that calculate premiums more accurately for the risk presented will be able to cherry-pick the more commercially attractive policyholders. Insurers may lose money, because their insureds have a worse risk profile than that indicated by the model when used to calculate premiums.

Blended rating systems

E.14 The two approaches outlined above describe the extremes of what are viewed as a range of possible techniques. In practice, a mix of approaches is more common. Examples of such approaches include:

- exposure rating with loss history used as a rating factor
- exposure rating with subjective rating factors to allow for non-standard features and loss history
- experience rating using relevant data or information from sources other than the risk in question. In particular, benchmark data can be used to speed up several aspects of experience rating
- hybrid techniques that blend results from both exposure and experience methods.

E.15 It is sometimes possible, and often desirable, to apply more than one technique to each risk. The use of several methods will produce a range of possible technical rates. The extent to which these rates vary illustrates the extent to which judgement is required when selecting a rate to charge.

E.16 In the London Market a great many pricing decisions are made, with several underwriters accepting, declining or merely quoting each risk. For practical reasons, such procedures mean that the vast majority of rating calculations must be quick and simple. This market characteristic is generally manifested by a tendency towards exposure rating with the complex, time-consuming techniques reserved for very high value, high risk or unusual cases.

E.17 In the London Market, where volatile and unusual or unique risks are common, exposure based rating systems may only cover the main exposure and rating factors with all other features of the risk adjusted on a subjective basis. Where a simple system with few factors is used, the underwriter's judgement is essential to prevent or guard against anti-selection. A brief note of the rationale behind any subjective adjustments should be recorded in an underwriting information system.

E.18 The process behind experience rating can be seen as assessing the level of losses that are likely to be incurred during the new period of exposure. This is based on losses that have occurred in the past, whether reported or not. Historic losses are then restated to the new period after taking into account changes in the basic exposure measure, claims cost inflation, trends in claims frequencies, terms and conditions and other factors. The expected loss cost can then be adjusted for the desired level of profitability, the cost of reinsurance, expenses, discounts and investment return, as required.

E.19 Exposure rating can start with a very similar process, but based on a portfolio of policies. Calculating the overall level of premiums requires a second exercise to determine a methodology that estimates an appropriate premium for each combination of risk factors.

Pareto exposure rating

E.20 The Pareto model is sometimes used in rating high layers of excess of loss, where there are not a sufficient number of losses to use experience rating. The model is based upon the single parameter Pareto distribution. Owing to the mathematical properties of this distribution the exposure rate can be easily calculated through the use of standard formulae. The Pareto exposure model is an alternative to using Increased Limit Factors ("ILFs") which are more common in the US and less common in the rest of the world.

E.21 The advantages of the Pareto model include:

- typical ranges exist for the parameters for particular classes, eg
  - liability - Pareto parameter 0.7 to 1
  - Property - Pareto parameters 1 to 1.9
- it can be used with loss experience to rate using a mixture of exposure (the Pareto model) and experience (using the actual losses to estimate the parameter)
- it is simple to express rates as mathematical formulae
- it can be used where other methods are not feasible
- it will generate consistent pricing between layers ensuring sensible progressions.

E.22 Disadvantages are:

- small judgemental changes in parameter values can generate large swings in resultant prices
- it has a heavy tail, but the loadings to be used for excess layers may need to be greater, depending on the situation
- it is over-simplistic, and could be abused to justify a price which may not be adequate.

E.23 Despite its shortcomings the Pareto model offers a good basis for getting a sensible consistent price for a range of layers. Further details can be found in *Swiss Re*.

Estimating the loss cost

E.24 The key task of any insurance pricing exercise is to model the losses to the prospective contract, whether by Experience Rating, Exposure Rating or a combination of both.

E.25 An attempt is made to estimate the probability distribution of the losses to the contract. In many cases, initially at least, the expected value of the loss cost is the main focus. Where the loss cost is volatile and/or where it is closely correlated with the rest of the portfolio, careful consideration will need to be given to the whole loss distribution and not just the first moment.

Calculation of loss cost estimates

E.26 Usually actuaries will prepare their estimates of the loss cost to the contract on a best estimate basis. This is normally interpreted as the mean of the distribution of losses to the contract.

E.27 For high layer contracts, however, the distribution of losses may be expected to be highly skewed. In this case the mean loss may not accurately communicate the possible financial implications of writing the policy. For all policies, but especially for such skew distributions, the return period of various severe loss sizes can be an easier set of parameters to estimate, contain more information, and be easier to communicate.

E.28 For the future policy period, such concerns would usually be addressed via the capital and hence profit requirements, or technical premium calculation, rather than the loss cost calculation.

E.29 Even when the mean of the distribution provides a clear summary of the financial implication, the estimate that the actuary has calculated is subject to a large degree of uncertainty. Confidence intervals of the calculated loss cost estimates are often illuminating, demonstrate the sensitivity of the rate for the contract, and prevent a false sense of accuracy being portrayed.

E.30 Some technical methods lend themselves to analytical calculation of confidence intervals, given the historical data, however this is not true for all methods. Some generic methods do exist, such as bootstrapping the data. The Wikipedia entry for Resampling (statistics) http://en.wikipedia.org/wiki/Resampling_%28statistics%29 contains some details on how to use bootstrapping to estimate the range around the estimated loss cost. However it is often equally illustrative to stress test the best estimates by, for example, removing the best or worst performing years.

E.31 The range of uncertainty in the estimated loss cost lends to a further source of uncertainty in the future performance of the policy. Parameter uncertainty is the uncertainty in the policy result that occurs from the actuary having used only an estimate of the loss cost, which may be above or below the true mean of the distribution of possible loss costs for the period under consideration. This is distinct from the process uncertainty, which the actuary will usually capture in the translation of the pure loss cost to the technical premium.

E.32 Parameter uncertainty, caused either by data being insufficient to determine accurately the true distribution of outcomes, or doubts over the relevance of the data (for example, having used benchmarks in the calculation process), would tend to increase the uncertainty in the range of outcomes. Given the skewed nature of claims distributions, this could cause either an increase in the volatility of the performance of the policy, or an increase in the best estimate of the loss cost (although many refinements to basic methods help to correct for any bias in the estimated loss cost).

E.33 *Mata* provides a useful example of how these theories may be applied in practice.

Estimating the expected loss value

E.34 In this section we focus mainly on the estimate of the expected value loss distribution; this is frequently just referred to as the "loss cost" or "loss pick".

E.35 When experience rating we attempt to estimate the loss cost from the historic data. Broadly speaking this is done in three stages:

- *Trend*: adjust the historic data to allow for inflationary and other trends in claims severity. Any other adjustments to the data to ensure its relevance for the prospective contract period ("As-if"ing) is done at this stage.
- *Develop*: project the adjusted data to allow for development of claims over time in order to estimate an ultimate loss cost for each year of the contract.
- *Exposure Adjust*: adjust the results for changes in exposures over time; this can be done by expressing all the projected results as a rate on exposure, or putting all the results into prospective-year terms by multiplying by the ratio of the prospective year's exposure to the historic year's exposure.

E.36 For excess of loss business the order of these stages, and how the claims cost to individual layers is projected is very material. This is discussed in more detail in the following section on Pricing Excess of Loss business.

Trending

E.37 When using the historic claims data to estimate the loss cost for the prospective contract period it is necessary to adjust for any factors that would mean that the historic claims experience does not reflect the likely future experience. In particular we need to consider the impact of trends on both the frequency and severity of historic claims.

- Claims severity inflation: this can be related to economic inflation (price and/or wage) but there will usually be other important factors such as court awards inflation that result in claims severity inflation being higher than either price or wage inflation alone. There are several other factors that can result in severity trends such as: changes in terms and conditions of policies, changes in limits and deductibles of (original) policies and changes in legislation.
- Claims frequency inflation: there are several factors that can mean the frequency of claims (per unit exposure) varies over time. These could include genuine changes in accident frequency (eg improved road safety for motor claims), a change in the propensity of individuals to make claims, changes in legislation and other changes to the social and economic environment.

E.38 If excess layers are being considered, frequency and severity trends become dependent (ie an increased ground-up severity trend will increase the frequency trend for claims to a layer). This is considered in the next section on Pricing Excess of Loss business.

E.39 Actuaries will usually have "benchmark" estimates of frequency and severity trends for different classes of business and territories. These can (and often should) vary by type and size of claim. For longer tailed classes, estimates of future claims trends as well as past trends are crucial.

Applying trends

E.40 How the severity trend is best applied will depend on what factor is the main driver of the change in severity over time. Often severity inflation will be a calendar year effect as it is related to economic and social effects. However there are also drivers of severity trend more closely related to accident year (eg changes in car design) and underwriting year (eg where the severity of claims is more related to changes in terms and conditions).

E.41 How the trend should be applied depends on the drivers of the trend. For example, for calendar year effects claims should be trended from the historic settlement date to the equivalent future settlement date assuming the claim were to hit the prospective contract period. For outstanding claims, inflation should be applied from the time when the claim was outstanding to the equivalent development period for the prospective contract period. In this way each cell of the triangle is adjusted to an as-if basis reflecting the likely development of the prospective contract period.

E.42 For underwriting year trends each payment and outstanding should be inflated from the past underwriting year to the prospective year irrespective of the development period. The whole data triangle can be adjusted on this basis.

E.43 Note that in both examples each settled and outstanding claim payment is being inflated by the same number of years' inflation. However the balance between past and future inflation is different between the two cases. The two bases will give the same results where the trend is constant over time. (Where there is considerable uncertainty in the magnitude of the severity trend a constant value may be used as there is not enough credible evidence to justify using a varying value.)

E.44 It is important, especially for excess of loss pricing, that consideration is given to potential differences in severity trend for different claims types and sizes. Larger claims tend to inflate more rapidly than smaller claims (eg because they have a greater bodily injury component, or court inflation tends to be larger for the larger awards). This can have a significant impact when excess of loss layers are being priced or where the mix of claims is changing over time.

E.45 Frequency trends are more usually accident year or underwriting year effects and will usually be applied by reference to underwriting year (which for most contracts will also be a reasonable proxy for accident year).

E.46 For ground-up pricing, provided it is reasonable to apply both trends on an underwriting year basis, the frequency and severity trends may by combined into a single claims escalation factor. Similarly, for ground-up pricing, it will often be appropriate to take the aggregate loss triangle of paid and outstanding claims and inflate each cell as one amount.

Trending pitfalls

E.47 Several other problems are encountered when trending claims. Examples include:

- Claims data will often be given net of deductibles. This is a particular problem for excess of loss treaties protecting books of excess of loss business, but can also be an issue for large corporate policies where local entities retain risk to a certain level. Details of original deductibles may not be available. In addition, details of claims lying within these deductibles are unlikely to be known. Applying trend factors to the data net of deductibles will understate the effect of trend on loss cost due to the gearing effect of trend on excess of loss business discussed in the section above.
- Allowing for limits on original policies. If there are limits on original policies it is possible that claims are unknowingly trended beyond the limit. In a hard market where policy limits are, in general, staying constant or reducing, it is easy to over-trend the claims and thus overstate the loss cost. Conversely, where a claim has hit the original policy limit the actuary is unlikely to know what size the claim would have been if a higher limit had been available. In a soft market original policy limits may be increasing faster than trend; in this case simply applying the trend to the limited losses is likely to understate the loss cost.

E.48 If details of the limits and deductibles on the original policies are available then in many cases these can be take into account when trending the claims. Ideally for each claim details of the limit/deductible in place at the time and the limit/deductible currently in force will be available (although even with this information it will still be difficult to deal with the situation where original limits have increased significantly).

E.49 When "as-if"-ing data for changes in deductibles and limits it is important to consider possible biases that can be introduced: it may be that the original insureds with large claims have only been able to renew with larger deductibles or lower limits; it may be that these large claims were just fortuitous and other insureds with lower deductibles and/or higher limits are just as likely to suffer from similar claims in the future. In this situation "as-if"-ing for changes in deductibles and limits may lead to an underestimate of loss cost. This is an example of survivorship bias. (In addition see the remarks below on corresponding adjustments to the exposure base.)

E.50 It is also important to consider whether the limits apply to the total claims costs or just certain elements.

E.51 Where detailed information of limits/deductibles for individual losses is not available the actuary should consider how the limits profile of the original policies has changed over time. *Mata and Verheyen* consider an experience rating approach for the situation where the limits profile is changing over time, using adjustments derived from exposure rating.

E.52 In the situation where original limits are increasing rapidly or where there is little information about original limits and deductibles the actuary will need to consider carefully whether experience rating has any credibility at all.

Other adjustments to data

E.53 In addition to allowing for trends there are other reasons the data may need to be adjusted at this stage. These include:

- For treaty pricing, where the an original assured does not write 100% of each original risk (due to coinsurance or insuring pro-rata treaties), adjustment should be made to claims sizes if the line size changes over time.
- If elements of the historic business have not been renewed the actuary may consider removing these from the base data.

E.54 There are, however, some very important considerations when "as-if"-ing the data:

- Any adjustment to the historic claims data will usually need to be accompanied by an adjustment to the historic exposure measure (see exposure adjustment below).
- If claims are being removed from the base experience because the underlying business is no longer written care needs to be taken to avoid introducing a survivorship bias into the loss cost estimate. If a discrete identifiable section of the underlying book has not been renewed and there is a credible reason to believe that the loss propensity of that element of the book is different from the remainder then it may be reasonable to remove the relevant claims (and exposure) from the base experience. However, it may be the case that the non-renewed risks are reflective of the residual portfolio and their poor experience was just a result of random nature of the claims process.
- Even if it is believed that the discrete section is worse performing than the rest of the book, the original insurer presumably originally thought this was good business so it is possible that their judgement is not good enough to avoid similar substandard portfolios.
- While it is fair to consider removing discontinued lines from the base data, consideration should also be given to any new business that is being covered that will not be fully reflected in the claims experience. In this situation the actuary will need to consider whether the historic claims experience is likely to be relevant to the prospective contract; if not then experience rating will be inappropriate.

Developing

E.55 Once the data has been trended it is then developed to allow for IBNR and IBNER (in the case of incurred claims projections). To do this the data is often aggregated and standard claims reserving projection techniques are applied, such as the Chain-Ladder and Bornhuetter-Ferguson method.

E.56 All the considerations that apply when using these techniques for claims reserving also apply to pricing (eg changes in business mix, separate treatment of large claims and catastrophes etc). One slight difference is that in the pricing context the measure of exposure used in the Bornhuetter-Ferguson method is less likely to be premium. Also, it is important to bear in mind that the aims of the pricing and reserving actuaries are often slightly different, with the pricing actuary being more concerned with the current year best estimate, as opposed to the reserving actuary perhaps being more concerned about the total reserve across all years and classes.

E.57 Other commonly used techniques, which are very useful in many situations, are:

- The Cape Cod Method: This can be viewed as an extension of the Bornhuetter-Ferguson with a more objective method of selecting the prior rate. The prior rates for each origin year are selected by taking a weighted average of chain ladder ultimate rates for all the other years after adjustment for claims and exposure trends. The weight given for each year depends on the expected percent developed (from the chain ladder CDFs) and the proximity of each year to the origin year concerned. Further details can be found in *Struzzieri and Hussian*.
- Berquist Sherman Method: *Berquist and Sherman* suggest techniques for identifying changes to the rate of settlement of claims and/or changes in case reserving adequacy. Adjustments are then made to the data triangles to allow for these changes. The adjusted triangles can then be projected using standard methods.

E.58 A factor to consider when using any standard development method for pricing is that the lead diagonal may not represent a complete development period. The data will need to be prepared some time in advance of the renewal date and therefore the lead diagonal will not coincide with the policy anniversary date (third quarter data is common). In this situation data is commonly presented in one of two formats:

- The evaluation dates are at the same time as the development period. For example the development periods may be at months 9, 21, 33, 45 etc. In this case the standard projection methods can be used without adjustment.
- The evaluation dates are at the policy anniversary date except for the lead diagonal, which is at, say, quarter 3. In this case the lead diagonal should be ignored for the purposes of deriving development factors. An interpolation technique can then be used to derive factors to apply to the lead diagonal.

Estimates of inflation

E.59 The claims inflation assumption is key in any pricing exercise. This is particularly true when experience-rating excess of loss business, where the loss cost estimate is usually very sensitive to the inflation assumption(s) used.

E.60 In a London Market context it is usually very difficult to estimate claims inflation with any certainty from the data available. This is due to factors such as:

- sparseness of data
- low data quality
- difficulty in allowing for IBNER on long tailed claims (and particularly in allowing for changes in case reserving strength and settlement patterns)

- difficulty in obtaining ground-up claims data at the 100% level (eg data may be net of underlying deductibles and limits; and line sizes may have changed)
- heterogeneity of data.

E.61 London Market actuaries, therefore, often derive inflation estimates by considering external sources of information. Different inflation indices may be available for the territory concerned (eg wage, price, healthcare costs). A weighted average of the most relevant indices can be taken after considering the drivers for the costs of claims. An additional amount ("superimposed" inflation) is frequently added to cover other sources of inflation not captured by the indices (eg new heads of damage, changes in the basis of court awards etc.). There is a discussion of many of the factors driving claims inflation, which should be considered, in the Claims Inflation Working Party report.

E.62 A similar approach consists of taking a representative claim type and estimating how each element of the claim inflates over time, then weighting the total to get the overall claims inflation.

E.63 Within a class of business, different claims types and sizes are likely to be subject to significantly different inflationary pressures. It is fairly common, therefore, in excess of loss rating for different inflation assumptions to be used for different sizes of claims.

E.64 Occasionally market wide studies of claims inflation may be available, such as the IUA Bodily Injury studies.

E.65 When sufficient high quality data is available, several techniques can be used to estimate inflation from the data. These include:

- considering trends in projected ultimate claims frequencies and average severities across accident years
- considering trends in frequency and average severity for the same development period across accident years
- considering trends in various percentiles of claims severity for the same development period across accident years
- considering trends in average cost per closed claim across calendar years.

E.66 These and other methods are considered in the Third IUA Bodily Injury study and in the Claim Inflation Working Party report.

E.67 Careful consideration needs to be given to the credibility of the estimates derived. They will often be compared with a prior estimate derived independently.

E.68 Clearly the actuary is interested not only in how claims costs have inflated to the present date, but also in how they are likely to inflate in the future. Having an estimate broken down into components relating to different indices and a superimposed amount is likely to help making this prediction, which will be necessarily subjective.

Exposure adjusting and applying frequency trends

E.69 Once the losses for each year have been developed they need to be expressed as a rate on exposure so they can easily be related to the prospective contract period. At this stage any expected trend in frequency (relative to exposure) can also be applied.

E.70 For any line of business the chosen exposure measure should be a reasonable measure of the risk of loss. To be useful the exposure measure should be easy to measure. As this measure is proportional to the risk of loss and is easy to measure the exposure unit will naturally also be a primary rating factor.

E.71 The simplicity of the exposure unit means that in practice the same measure is often adopted as an industry standard. A reinsurer asking a cedant for exposure data will find it relatively easy to get an industry standard measure. However, if he asks for a non standard measure he may find that the data is not available.

E.72 Ideally exposure measures naturally inflate with the loss cost so that the need to modify them is reduced. For example, Fee Income for Professional Indemnity might be expected to increase with time, the complexity and the size of activities carried out by the firm. This should broadly follow the loss trend, (but may not reflect court awards). Contrast this with the vehicle year exposure measure which does not inflate at all to reflect changes in car values or the cost of repair.

E.73 Ideally the exposure base should not be open to manipulation by the (re)insured.

E.74 An adjustment may need to be made to allow for temporal mismatches between the exposure base and the expected losses (eg number of physicians may be appropriate for an occurrence based medical malpractice cover but will need adjusting if the cover is on a claims made basis. Similarly written premiums may be supplied as the exposure measure for losses occurring during (LOD) reinsurance treaties; earned premiums are more appropriate in this case). Considerations relating to exposure bases are discussed in more detail in *Bouska*.

E.75 In primary insurance the exposure measure can be used with little modification to get a rough estimate of loss cost. Experience may suggest that a certain type of business typically has a loss cost per unit of exposure of one per mille. The exposure measure may be 500,000. A rough estimate of loss cost would be 0.001 * 500,000 = 500. Though very basic, this provides a very quick reasonableness check on other calculations.

E.76 The exposure measure can also be used to adjust losses when experience rating. A cedant might have losses in consecutive years of $100k, $180k and $250k which appears to be an alarming trend. However, if the exposure measure is 100, 200 and 300 for the corresponding years then the rate of loss per unit of exposure is actually decreasing.

E.77 When the best available exposure measure has been selected it is important to consider whether it contains any inflationary element. If it does this can lead to a double-count of inflation since we have already explicitly inflated the claims. To avoid this it is necessary to adjust the exposure measure for inflation up to the prospective contract period. For example, if wage-roll is the appropriate measure the historic values would be inflated to the prospective period using an appropriate measure of wage inflation. Similarly for reinsurance treaties, where subject premium is frequently used as the exposure base, the historic values should be adjusted for rate changes to the premium adequacy level for the prospective treaty period. This process is called on-levelling.

E.78 Where rate change information supplied by the reinsured is used this should be checked for reasonableness as rate change indices are easily manipulated (and hence calls into question the use of on-level premium as a suitable exposure measure, though it is frequently used in practice out of necessity).

E.79 Finally the exposure base should be adjusted to take into account any "as-if"-ing of the base claims data. For example if some of the historic claims have been removed from the base experience the exposure relating to those risks should also be removed. Otherwise the match between the exposure base and the claims is lost and the loss cost estimate will be biased.

E.80 Sometimes it can be extremely difficult to "as-if" the exposure in the same way as the claims. For example, in the above example where claims were being adjusted for changes in limits and deductibles it may be extremely difficult to judge the impact of these changes on the premiums charged. In this situation it may be better to use a different exposure base.

Selection of loss cost

E.81 Finally the selection of loss cost for the prospective contract period is made. This is done after examination of the projected rates for each historic contract period.

E.82 If there is no residual trend apparent then a simple average may be taken (of all years, or maybe focussing on the most recent years). Alternatively, a weighted average may be taken where weights may depend on the uncertainty of the projection for each year (more uncertainty in more recent years), and each year's proximity to the current prospective contract period (recent years are more relevant and have been adjusted less); the Cape-Cod weighted average with a decay factor is one way of doing this. Further details can be found in *Struzerri and Hussein*. Where a residual trend is apparent this may be projected forward to the prospective treaty period.

E.83 Frequently the loss cost will be selected judgementally allowing for all the factors in the above paragraph. If large claims are not adequately reflected in the base data, or have been removed/truncated for the purposes of projection, an addition can be made to the loss cost at this point. Additions for large claims and catastrophes are considered elsewhere in this paper.

Pricing excess of loss business

Trending for excess of loss pricing

E.84 Additional care needs to be taken where excess of loss business is being priced. This is due to the interaction between claims severity inflation and the expected frequency of claims to any layer. The escalation of claims costs to an excess of loss program will almost always be greater than the combined ground-up frequency and severity trends. This effect will usually tend to increase as attachment points increase.

E.85 For this reason the data requirements for excess of loss pricing are more onerous. For medium to long tailed business individual loss triangulations should be requested. These should include the full development (paid and outstanding) of all individual losses that have, at any stage during their development, been greater than a selected reporting threshold (usually on an incurred basis). The reporting threshold should be selected such that, for each underwriting year, any claim at the threshold when trended to the prospective contract period will still be below the attachment point for the layer being priced. Each individual claim should be trended separately at each development period.

E.86 If only aggregate data is available, allowance for trend will be extremely subjective; assumptions will be needed about the underling severity distribution of the individual claims.

E.87 Sometimes only the most up-to-date position is provided for each claim. In this case, while it is simple to correctly trend each claim to the equivalent development period for the prospective contract, allowing appropriately for claims development is very subjective (see development section below).

Development for excess of loss business

E.88 Similar techniques are used to develop the aggregate claims cost to excess of loss layers as are used for primary layers. However, in this situation there are additional considerations. In particular it is important to have individual loss triangulations. This allows the following approach to be used:

- trend each loss at each development period
- apply the excess and limit to each claim at each development period
- aggregate the claims for each origin year to create an aggregate triangle of trended claims to the layer
- project the claims.

E.89 The order of the operations is important (Trend-Layer-Develop). Sometimes average development factors are applied to individual claims, which are then applied to the layer. This approach does not allow for the volatility of IBNER development on individual claims and is likely to underestimate the loss cost of higher layers (it is likely to overstate the loss cost of primary layers). If a methodology is to be used that develops individual claims allowance must be made for the stochastic nature of IBNER development (see section on Projecting Frequency and Severity Separately under Stochastic and Other Methods below for more on this).

E.90 When pricing an Excess of Loss treaty programme it is likely that an estimate of the loss cost to several layers will be required. In this case the development factors for the individual layers will be dependent. Consideration should therefore be given to the consistency of development factor selections for the different layers (see *Pinto and Gogol* and *Seiwert*). As we move to higher layers and the experience becomes more volatile we may give more weight to expected development factors based on adjusted factors from lower layers, rather than the modelled development factors from the experience to the layer itself. However, in this situation we may question the credibility of an experience rate to the layer and would be likely to give more weight to an exposure rate.

E.91 If individual loss triangles are not available, projecting the loss cost to Excess of Loss layers is likely to be extremely difficult and will require subjective assumptions unless appropriate benchmark excess of loss development factors for the class and layers concerned are available. Ground-up development factors are rarely appropriate for developing claims to excess of loss layers.

Stochastic and other methods

E.92 When using methods other than those described under Estimating the Loss Cost above - typically stochastic methods - the choice of method will be determined by the available data and methodologies employed (for example, whether ALAE is included within the parameterised claims distributions, or whether separate ALAE results are also modelled), and will impact on the choice of stochastic distributions, and the method of modelling the claims experience stochastically.

E.93 Aggregate methods are not ideal, as an aggregate distribution is likely to describe the possible range of outcomes less well than a more detailed compound distribution, however they are quicker and have the lowest data requirements.

E.94 Average cost methods require a separate frequency and cost analysis, but may give a better approximation to the true aggregate distribution, especially when the expected number of claims is very low (ie high layer, or clash contracts).

E.95 Individual severity methods require individual claim data, but provide the best fit to the aggregate distribution. In general, these methods produce aggregate claims that are more skew than either aggregate or average cost methods.

Projecting frequency and severity separately

E.96 It will frequently be desirable to estimate separate distributions for the claims frequency and severity. This more accurately represents the claims process and it is often easier to check separate frequency and severity results for reasonableness. It will also be useful if several different layering structures are being priced; pricing from separate fitted frequency and severity distributions should ensure consistency of quotes for the different structures.

E.97 To project the frequency of claims by policy year exactly the same technique as discussed above for aggregate claims can be used. The only difference is that claims counts are projected rather than amounts. For excess of loss rating we are usually only interested in the frequency of claims above a certain threshold (usually slightly below the attachment point of the bottom layer). In this case, after trending the claims a triangle of claims counts in excess of the threshold should be constructed (equivalently project the loss cost to a layer of $1 excess of the threshold).

E.98 Once the ultimate claims numbers by policy year have been projected a frequency distribution can be selected. In many cases the negative binomial distribution will be used as it can allow for dependencies between claims. Even where it is believed that successive claims are completely independent, and therefore a Poisson distribution is appropriate, it may be preferable to use the negative binomial distribution to allow for parameter uncertainty (as it can be considered a mixture of Poisson distributions where mixing distribution of the Poisson rate is a gamma distribution). The two parameters of the negative binomial distribution can be fitted from the projected frequencies for each year, although in many cases actuaries will have benchmark values for the variance/mean ratio for different mean frequencies for different classes of business.

E.99 Fitting the severity distribution is more difficult as we want the distribution of the ultimate costs of the individual claims. Therefore we need to allow for the IBNER development of claims. Projecting individual claims by an average IBNER factor is very unlikely to be appropriate for the reasons given under Development for Excess of Loss business above.

E.100 Any method for developing individual claims needs to allow for the following factors:

- stochastic IBNER - the claims will spread over time
- different treatment of open and closed claims
- original policy limits
- different potential behaviour of different sized claims.

E.101 If sufficient data is available a bootstrapping style technique can be used where individual claims development factors are sampled from historic developments on open claims of the same age and similar size. This approach leads to many possible samples for the ultimate value for each open claim. Where the claims are subject to policy limits these will need to be allowed for (both in ensuring the projection does not go beyond limits, and in selecting the base set of development factors to sample from). This will not be possible if details of the limits are not provided with each claim.

E.102 A parametric distribution can then be fitted to the population of sampled outcomes for all the claims. Details can be found in *Klugman, Panjer and Wilmot*. Where attempting to estimate the severity distribution of unlimited claims it is necessary to allow for the fact that claims in our sample are limited. *Patrik* shows how to do this using maximum likelihood estimation. If the limits profile has remained relatively consistent over time it may be satisfactory to fit a distribution to the limited claims. However, there may be clusters of claims at common limit values and, in this case, finding a single parametric distribution that is a good fit is unlikely to be possible.

E.103 Another approach that can be used, which allows for stochastic IBNER development in an indirect way, is to project claims frequencies to different layers using a standard method. As in the case where we are projecting aggregate costs to excess of loss layers, care should be taken to ensure consistency of development factors for different layers. At higher layers the frequency projection will become less credible; however, at these layers more weight can be given to an exposure based estimate of frequency, which can be derived by pricing a layer of $1 above the selected threshold. In this way claims frequencies at several levels can be estimated and from these the probability distribution function of the claims severity can be estimated. *Mata, Fannin and Verheyen* describe this approach in more detail focussing on the exposure rating approach to estimate the frequency to each layer.

E.104 Where individual claims triangulations are not available, estimating claims frequency and severity distribution will be very difficult and will require subjective judgement. The bootstrapping approach could be used if the actuary has access to the data for a "similar" risk. Otherwise, assuming we have the current incurred value of each claim, scatter plots of the claims amounts versus age of claim could be plotted to get some idea of how the claims amounts "spread out" over time. From this a loss severity distribution could be selected judgementally.

Modelling the stochastic nature of claims experience

Analytical methods

E.105 Analytical methods assume the underlying processes follow specific distributions, and calculate the closed mathematic form that these imply for the loss size at any percentile. They give exact results and can be very quick to calculate once set up. However, the mathematics can become unwieldy if the choice of method is too complicated, and may become insoluble in closed form.

E.106 In general terms, analytical methods can easily be applied by assuming a distribution form for the aggregate losses, but become complicated if the structure is more complicated.

Recursive algorithms / Fast Fourier Transforms

E.107 These are used to approximate the aggregate distribution from its underlying components. Both recursive algorithms and Fast Fourier Transforms work by calculating the probability that losses are at or below discrete sizes - the methods stop calculating once the probability of loss exceedance is sufficiently small. These methods work well when expected claim numbers are low, can be used for frequency/severity modelling, and combining distributions (eg claims/ALAE or aggregate distributions for different perils), even if these are correlated. They require a discrete severity distribution (this is usually solved by "discretising" a standard distribution) and are fastest when the number of severity levels is not very large.

E.108 The best known recursion algorithm is that due to Panjer, which calculates the aggregate loss distribution given a frequency distribution (one of Binomial, Poisson, or Negative Binomial), and a severity distribution (which must be discrete). A useful summary of Panjer recursion may be found in section 3.4.3 of *Sanders*. Its use in calculating the expected loss to a contract with loss sensitive terms is summarised in *Chandaria, Mackie et al* and in *Klugman et al*. Briefly, a continuous claim severity distribution can be approximated with a discrete distribution. If necessary, the approximate claim severity distribution can then be truncated to allow for per loss contract terms (eg so that it represents losses to an individual excess of loss layer). Panjer recursion can then be used to calculate an aggregate loss distribution for the total loss after application of per loss terms. This aggregate loss distribution can be used to calculate the expected value and variance of the aggregate losses allowing for loss sensitive terms.

Monte Carlo simulation models

E.109 The basics of Monte Carlo simulation are shown in a non-insurance framework at http://www.vertex42.com/ExcelArticles/mc/MonteCarloSimulation.html. In the actuarial arena, the theory and algorithms for "Monte Carlo" simulation are covered very fully in unit 11 of the CT6 core reading although no references are given. A possible reference is *Klugman et al*, and further mathematical details may be found in *Wang*.

E.110 It is better to use stratified sampling than true Monte Carlo sampling. The method can be adapted to a vast variety of modelling structures and can be implemented relatively quickly. Added flexibility allows one to apply dependency structures between perils and classes of business, and to apply complex contract terms (see section below on Contract Structure). Speed falls as the complexity increases, and one may need many simulations for stability in the technical premium for volatile and especially low frequency accounts. Monte Carlo simulation may be performed using specialist proprietary packages or alternatively may be programmed into Excel or Access using VBA.

E.111 The basic simulation algorithm uses a discrete distribution (eg Poisson, Negative Binomial) to generate a number of losses each simulation year. For each loss generated a severity distribution (eg Lognormal, Pareto, Weibull etc) is used to generate the loss size. Contract terms (per loss and/or aggregate) are applied to the losses generated each simulation year. The total loss after application of all terms is averaged over all simulation years. A few thousand simulations are usually used. More simulations years are needed where there are few losses to the contract each year (eg very high layers).

E.112 The advantages of Monte Carlo simulation methods is that they are useful where there is complex cover, eg reinsurance pricing with complex features, and are often quick to set up, with flexible results displays. They are almost a necessity for contracts with complex loss sensitive terms.

E.113 Disadvantages are that parameter error can be very large, especially for long tail business. Also, outputs can look impressive and may encourage overconfidence in the results, so it is necessary to explain assumptions and limitations and give a health warning.

Fitting probability distributions

E.114 There are several fitting methods, the method of moments (simply work out the moments of the data), and the method of least squares, where the fit minimises the squares of the distances from the data to the distribution (Solver in Excel can do this). The fit is often evaluated using statistics and PP and QQ plots. There are issues of how to deal with IBN(E)R and inflation, but the claims distribution should ideally reflect the ultimate claims position; for short tail classes (eg property) this works well for liability lines this can be a difficult area to be precise about.

Statistical distributions

E.115 Commonly used continuous distributions in pricing are set out below.

- Gamma
  - can be used to model aggregate or average cost of small claims
  - has a thin tail, so should not be used for individual claims, or any distribution covering large claims.
- Log Normal
  - can be used to model individual, average cost, and aggregate claims distributions. Easy to use and manipulate. Does not generate negative numbers
  - does not have a particularly thick tail so should exercise care when using to fit to large claims
  - can be a good fit for aggregate data.
- Single Parameter Pareto
  - can generate very large claims, has a thick tail
  - some of the claims generated can lack credibility. The mean does not exist if the shape parameter is 1 or less, the variance does not exist if it is 2 or less.
- Generalised Pareto Distribution
  - fundamental distribution underlying Extreme Value Theory. Further details can be found in section 6.5 of ***Embrechts, Klupperlber and Mikosch.***

E.116 Other continuous distributions that are often used include:

- beta
- exponential
- Normal
- Weibull.

E.117 Commonly used discrete distributions in pricing include the following.

- Poisson
  - the easiest distribution to use and manipulate
  - only one parameter is required, the mean, so relatively straightforward to use even with London Market data
  - models events that are independent
  - values are not limited
  - it is important to remember that using the Poisson distribution does involve an assumption regarding the variance
  - when dealing with correlated events it may not give enough variance in value (the Poisson distribution "forgets").
- Negative Binomial
  - can give a better fit than Poisson, useful for modelling correlated events
  - requires an extra parameter and so is harder to estimate accurately.
- Binomial
  - rarely used unless the number of potential events is limited.

Quick approximation models

- The Poisson Model
  - assumes all losses to the layer are total losses with a frequency (Poisson lambda) equal to the total expected loss/limit (the "risk rate on line"). This is sometimes used by underwriters to price reinstatement provisions on property risk Excess of Loss. It is suitable for low frequency layers. It could also be used for no claim bonuses or commutation on non-working layers

- Quick Aggregate Model
    - assumes aggregate losses (after applying per loss terms) have a particular distribution eg Lognormal. Estimate parameters from data using the sample mean and standard deviation (may underestimate volatility). Alternatively, fix the mean to something reasonable based on the sample mean from the data and guess a prudent coefficient of variation. Set up a spreadsheet where loss to the contract is calculated at a number of percentiles (eg 1%, 2%...99%) and apply all or any loss sensitive terms before averaging over all the percentiles. This method is simple and transparent but only suitable for working layers where some claims are expected every year so that assuming aggregate losses have a continuous Lognormal distribution (where aggregate losses cannot be zero) is appropriate.

Exposure measures

E.118 Commonly used measures of exposure include:

- (on-level) premium - premium is not usually the best measure of exposure as it is affected by underlying rate changes - see below. However, if robust rate change information is available, premium can sometimes be a good measure of exposure as it can reflect the risk of underlying policies eg higher risk policyholders (eg EL premium for office workers vs. EL cover for factory workers) may pay more premium
- number of solicitors, accountants, dentists, partners etc
- fee income
- Class 1 equivalent physicians - risk adjusted physician count, eg a high risk physician (eg obstetrics) counts as 9 whereas a low risk physician (eg geriatrics) counts as 2.5. Brokers often provide class equivalent exposure but the scale used to produce the class equivalents may not be made available. Also there may be big variations in the class equivalent systems used by different risk
- occupied beds equivalent - in hospitals professional liability numbers of physicians, procedures, occupied beds, births, nurses etc are multiplied by factors to place them on a common scale "occupied bed equivalents". As with class equivalents these scales may vary
- turnover
- wage roll
- number of employees
- vehicle years
- vehicle rental days

- sum insured
- EML. The ABI definition of EML is "an estimation of the maximum loss which could reasonably be sustained from the contingencies under consideration, as a result of a single incident considered to be within the realms of probability taking into account all factors likely to increase or lessen the extent of the loss, but excluding such coincidences and catastrophes which may be possible but remain unlikely." Often used with first loss scales to rate property fac and risk XL business. A loss can exceed the EML and the method of pricing should allow for this.

E.119 Further details can be found in *Chandaria, Hartington et al*, paragraphs 54 to 64.

E.120 In the absence of direct exposure information an approximation can be to use on-level premium. Theoretically if the premiums have been calculated robustly then rate changes can be used to put the premiums on a level playing field.

E.121 One of the common pitfalls of analysing a reinsurance contract is not allowing for the change in limit profiles over time. One way of allowing for this is to adjust the exposure measure, for example when looking at $500k xs $500k give full credit to exposure units purchasing $1m or higher limits, zero exposure to $500k limits and using ILFs to approximate allowance for those with limits between $500k and $1m.

Data issues

E.122 One of the biggest issues facing the actuary working in London Market Pricing is the availability and quality of data. We consider the main data issues below.

Level of data

- aggregate claims data
- individual loss data.

E.123 The quality and level of data given to the actuary can vary enormously.

E.124 Ideally the following information would be supplied per individual claim:

- paid, incurred, split by indemnity and expense
- paid and incurred development, either transactional or by month, quarter or year
- whether the claim is closed or not
- notification date, accident date, closed date if applicable
- unique claim identifier
- policy number (including policy year)
- territory
- currency of payments
- whether the claim is part of a clash event
- type of claim (eg in motor property damage, bodily injury, etc.)
- deductible/excess
- basic details in free text format (depending on rules of confidentiality of insured).

E.125 For the underlying policies, the following would be supplied (where appropriate):

- limit and excess for underlying policy
- limit profile current and historic
- exposure/premium achieved
- signed line
- territory
- unique policy number (linking to claims data)
- coverage/exclusions.

E.126 For exposure data one needs:

- projected exposure for the year of coverage
- historic exposure for the years of claims data available
- if applicable, the inflation on exposure (for example average pay rises awarded).

E.127 Assumptions can be made to compensate for non-complete data but consequent limitations in the results should be clearly explained to the underwriter, if practical a range of results should be supplied.

E.128 Individual claims may not be available, also manipulation of large files can be time consuming and more error prone, therefore if the analysis is looking at ground up cover only, then aggregate claims information may be sufficient. However, this can mask trends in frequency, severity or types of claim.

E.129 If individual claims are available, they are often available only as a latest position snapshot (although aggregate data development would still be required). In this case it may not be possible to use the latest years in assessing claim size. Using claim values which have not developed fully will not capture the volatility associated with future development, historic claims sizes, and hence claims sizes for the policy period being rated. This must be balanced against any trends in claim amounts.

E.130 The actuary may be presented with aggregate data to the layer being priced calculated by the broker. This is not ideal as it does not allow the actuary to directly vary assumptions such as claims inflation.

E.131 In order to produce a technical rate for a class of business or specific risk, underwriters must first consider the types of data that are available. There are a number of types of relevant data that can be utilised:

- account-specific or risk-specific data: eg historic premium, exposure values, rate changes or claims data and the like
- data from similar or comparable accounts
- benchmark data from a third party.

E.132 The volume and relevance of account-specific or risk-specific data to the renewal being priced will depend on a number of factors, such as how long the risk has been in existence, the level at which the business is written, that it is primary or various levels of excess, the underlying frequency and severity of the claims, and the extent to which terms and exposure have varied in the past and are likely to change in the future.

E.133 Any reasons given for sparseness of data should be investigated and mitigated, if possible, by adopting the following approaches:

- consider the use of data from other accounts or benchmark data from third parties
- if the data is sparse simply because of the insurance being excess of a high amount, then a common form of exposure rating is to design a rating structure for the full value insurance and then use ILFs, first-loss curves or exposure curves to estimate the excess premium

- if data is sparse because historic data is deemed irrelevant, investigate whether this data can be re-assessed. This is often not feasible but it may be possible to adjust older claims data to allow for factors such as changes in the discount rate used for court awards.

E.134 If, after all options have been investigated, there is still insufficient relevant data then the following "top down" exposure rating approach may have to be adopted.

- A high level premium "pot" or "pool" for the business can be determined. For example, it may be desired that the class can produce enough premium, net of brokerage and other discounts, to cover £5m of expenses, £10m of reinsurance costs and still have £50m available to pay claims and generate profit.
- An exposure rating structure for achieving this overall premium pot from individual risks needs to be devised. The base rates and rating factors will need to be set judgementally with the overall aim of ensuring that the premiums charged correspond as closely as possible to the level of risk presented.

E.135 From an actuarial point of view this must be considered one of the last resorts, as there is little or no actuarial justification for the size of the initial premium pot.

E.136 *Insurers should record rating information at the time of underwriting*. This discipline permits a more detailed analysis of expected loss costs for each combination of rating factors and reduces the risks of anti-selection due to reliance on a poor rating model.

E.137 Recording all rating factors and potential future rating factors in an exposure database that can be linked to a claims database once the claims develop should be regarded as best practice. By gathering this type of information, it is possible to test which factors are the best indicators of the likely level of loss cost and, if required, new rating factors can be introduced.

Increased Limit Factors (ILFs)

E.138 When ratemaking, insurers generally cap large losses at a suitable limit (class dependant), which would skew the experience of a particular combination of rating factors or set of rates. That is large losses would appear as a full limits loss. The rates then produced would be for a set limit. In order to sell policies for limits greater than this limit an extra premium needs to be charged, the calculation of this premium would be done by multiplying the base premium by an ILF. An increased limits factor is based on a size of loss distribution, and is a defined as the ratio of the limited expected values.

E.139 The formula below shows the Increased Limit Factor from a limit of B to a limit of L:

$$\text{Increased Limit Factor (L)} = \frac{E(f(x;L)) \times E(n)}{E(f(x;B)) \times E(n)} = \frac{E(f(x;L))}{E(f(x;B))}$$

Where $E(f(x,L)) = \int_0^L xf(x)dx + L(1-F(L))$ ie the limited expected value

f(x) = probability density function of x (the severity distribution)

F(x) = cumulative distribution function of x

E(n) = the expected number of losses (From Ground Up)

E.140 As can be seen the ILFs are based purely on severity distributions (the number of losses terms cancel out).

E.141 When calculating ILFs the data may be sparse at high loss severities so a loss distribution will be used to extrapolate the higher factors. Also there is the difficulty for liability lines of inflation and development, in practice inflation only may be used due to the sparseness of the data at higher loss levels. Also it should be recognised that judgement is required in setting ILF factors, in many cases judgement on the factors themselves may be used.

E.142 An alternative formulation of ILFs is the Reibsell approach when a simple rule is used to generate ILFs, based on a constant relationship between doubling the limit and the increase in premium. This allows for a simple formula (based on log base 2) which can be used to generate ILFs. Further details of the Reibsell approach can be found in *Mack and Fackler*.

E.143 Given a set of ILFs they must obey the following consistency rules:

- they are monotonic increasing
- they increase at a decreasing rate. (The difference between successive ILFs approaches 0.)

E.144 Given a set of ILFs it is possible to reverse engineer the severity distribution that was used to create them. This can be useful as it may be easier to explain and validate this distribution than to discuss the ILFs.

Practical check of a sensible program

E.145 When pricing layers it is important to get the relationship between the layers correct. A simple practical method of doing this is to plot a graph of the rate on line by the exposure, and fit a curve to these points. Points significantly above the curve may be over priced, and those significantly below may be under priced. It should be recognised that this is not rigorous and is an actuarial rule of thumb that is of practical value.

Attachment of cover

E.146 Cover on an individual policy may be Risks Attaching, Losses Occurring During or Claims Made. Risks Attaching is the form of cover with which most people are familiar. Occurrence cover (Losses Occurring During) pays out for losses from events that occurred during the policy year. On a Claims Made policy, losses reported during the policy year are covered, events giving rise to these losses may have occurred some years previously.

E.147 A reinsurance policy may cover claims to a group of risks attaching during the reinsurance policy year, the attaching policies may be occurrence or claims made. Alternatively, a reinsurance contract may cover losses occurring during the reinsurance policy year.

E.148 When pricing any of these contracts the measure of exposure used should be consistent with the way that claims attach to a contract.

Claims Made cover

E.149 A Claims Made policy covers losses reported during the policy year. It is used to reduce the tail on liability business by getting rid of pure IBNR. By the end of a policy year all claims to the policy will be known although some may develop further. There is IBNER but no IBNR. Claims made insurance is described in detail in *Marker and Mohl* and in *McManus*.

E.150 A claims made policy may be "mature" or "RDI". In a mature claims made policy, any claim reported during the policy year is covered by the policy even if the original accident took place many years ago. Alternatively, there may be a retroactive (or retro) date such that only claims from accidents that happened after this date, and are reported during the policy year, will be covered by the policy. A policy where the retro date is equal to the inception date is often called Retro Date of Inception (RDI). If a policy is RDI, all else being equal, the premium will be increased at each renewal as the number of years between the retro date and the inception date increases until a mature state is reached. The amount by which the premium increases is called a "step factor". An example of a set of step factors might be:

Years RDI	% Mature Claims Made Premium	Step Factor
RDI	60%	
2 year	85%	0.85/0.6 = 1.417
3 year	95%	0.95/0.85 = 1.118
4 year	100%	1/0.95 = 1.053

E.151 There is no simple consistent exposure measure for claims made cover since losses reported to the policy may arise from exposure from a number of earlier years. For example, a hospital or a law firm may buy Claims Made professional liability cover. As the operation grows, exposure to the claims made policy increases although this growth in exposure lags behind the growth of the operation.

E.152 One way to deal with this is to look at the lag between report date and accident date on historic claims and construct the following sort of table:

Lag	0	1	2	3	4
% Claim Cost	30%	40%	15%	10%	5%

E.153 The Lag 0 entry is the average proportion of cost in a report year from claims where the reported loss occurred less than one year previously, the lag 1 entry is the proportion of cost due to claims where the loss occurred between 1 and two years previously etc. *When setting up a lag table it is important to consider any changes in reporting delay.*

E.154 The lag table can be used to build up consistent report year exposure eg for the 2004 report year:

Report Year	Fee Income	Lag	Cost %	Contributing Exposure
1999	2,300,000	5	0%	0
2000	2,459,748	4	5%	122,987
2001	2,533,540	3	10%	253,354
2002	2,609,546	2	15%	391,432
2003	2,650,000	1	40%	1,060,000
2004	2,700,000	0	30%	810,000
2005	2,850,000		0%	0
2006	3,000,000		0%	0
Total				2,637,773

E.155 If there is not enough data to set up a lag table, so long as exposure is flat or increasing from year on year it is prudent to use this without adjustment. However, some sort of adjustment should be made if there are significant decreases in exposure from year to year.

Contract structure

Binders

E.156 When an insurer devolves some level of underwriting authority to a third party the arrangement is called a Binder. When analysing binder performance, either for initial profitability or ongoing controls, an actuary can use standard techniques, as described above. There are some additional considerations:

- allow for binder and broker commission
- allow for expected profit commission.

E.157 Profit commission (PC) is usually expressed as x% of "profit" where profit is defined as premium less claims and "underwriter's expenses", the idea being that PC is not paid until underwriter's expenses are covered. The cost of PC should be analysed stochastically rather than the PC paid at the best estimate loss pick.

Lineslips

E.158 Similarly when an underwriter delegates underwriting authority to a "lead underwriter" the arrangement is called a line slip. In practice lineslips may allow individual underwriters to pick and chose which individual risk to bind.

E.159 The approach used to analyse a line slip or a quota share would be very similar to a binder, the cede on a quota share replacing the binder commission.

Aggregate stop losses

E.160 An insured may ask for protection against an aggregation of losses rather than one individual claim. Aggregate stop losses contracts can protect against this sideways exposure, eg covering an insured if their loss ratio exceeds x% up to (x + y)% loss ratio.

Clash cover

E.161 Similarly an insured may want to protect against an accumulation of losses from one source which individually are not that large but in total are financially destabilising. For example, a medical malpractice insurer may cover a large number of physicians in a single state for $1m limits, however an individual event could involve a multiple number of its insureds and the claim from this one source could be many millions. The insurer could get Clash Cover from a reinsurer against, say, more than $2m of losses from one event up to a limit of $10m.

E.162 For each of the above contract types, the contract should be modelled stochastically rather than at the best estimate loss pick.

Pricing for loss sensitive contract terms

E.163 Likewise, loss sensitive terms are priced stochastically. Frequency and severity distributions are needed to value per loss terms. Monte Carlo Simulation or an appropriate aggregate distribution is needed to value aggregate loss sensitive terms. The aggregate loss distribution used in this case must be the distribution of losses after any per loss terms have been applied.

E.164 This topic is well covered in the "aggregate features" section of *Chandaria, Mackie et al.*

E.165 When analysing these type of contract terms care should be taken to understand the precise definition of a claim; it could be per insured or per event (eg each Physician or from one Claimant).

Aggregate limits

E.166 In Excess of Loss reinsurance, where claims between the excess or attachment point up to the limit are paid by the reinsurer, usually there is an aggregate limit for the policy period. In multi-year contracts (see below) there may be both an annual and an aggregate limit for the period.

Inner aggregate (otherwise recoverable)

E.167 On a per risk excess of loss contract, recoveries can only be made when the total aggregate loss to the per risk layer exceeds the annual aggregate deductible.

Annual aggregate deductible

E.168 To reduce premiums an insured may take a deductible to take out attritional claims. However, to protect against a large number of small claims the insured may want a limit on the total amount of deductible they pay, this is an aggregate deductible, or annual aggregate deductible for a one year policy.

Drop down

E.169 Some excess layer policies stack up such that if an aggregate limit on a lower layer is exhausted all the layers above "drop down". For example, a hospital's professional liability reinsurance is $10m each loss and in aggregate in excess of a self insured retention of $12m each loss, $50m in aggregate. If the self insured aggregate retention is exhausted the reinsurance will drop down to cover $10m each loss and in the aggregate from the ground up.

Franchise

E.170 On an excess of loss contract with a franchise, losses below the franchise are not paid but losses greater than or equal to the franchise are paid from the ground up. A franchise may operate on a per loss or on an aggregate basis. There may be complicated structures such as ALAE franchises where the expense component of a claim is not paid unless it exceeds some limit in which case it is paid in full.

Reinstatements

E.171 When there has been a loss to an excess of loss layer, a premium (normally related to the original premium) is payable to reinstate the part of the cover exhausted by the loss.

Swing deals

E.172 Premium paid by the client to the insurer depends on total losses to the contract. Deals have a variety of payment structures. A typical swing deal, where rate adjusts on subject premium income (Subj PI), is:

Final Rate = Min(Maximum Rate, Minimum Rate + Loss Ratio on Subj PI*Loss Load)

E.173 A provisional premium is normally set somewhere between the minimum and the maximum. Brokerage may be paid as a proportion of the provisional premium. Swing deals may operate over more than one year.

Profit commission (PC)

E.174 The PC is a common profit sharing agreement. A variety of PCs and other profit sharing agreements exist. On a typical PC an insurer may pay back the client a proportion of profits. The profit that the PC applies to is defined in the policy.

eg Profit = Gross premium - brokerage - claims - an expense allowance (eg 20% of gross premium).

Commutation bonus

E.175 This usually applies to working layer long tail business. There is an agreement that a bonus of a certain proportion of the premium will be paid back to the client if they choose to commute within a stated timeframe. The client is then liable for any further loss or loss development.

E.176 The proportion repaid may decrease over time.

No Claims Bonus

E.177 This usually applies to short tail business such as marine property damage. If the contract has a claim free year a proportion of the premium is paid back to the client. This differs from all the other loss sensitive terms here as it depends explicitly on loss frequency.

Other contract complications

Multi year deals

E.178 An insured may wish greater stability in their insurance coverage and purchasing costs. Multi year deals allow both sides to specify the terms of the insurance for longer periods, typically 2 or 3 years.

E.179 There will usually be get-out clauses from both sides, if the insured's credit rating drops below a certain level or if the claims experience worsens beyond a specified point.

E.180 From the insurer's perspective these deals can reduce volatility of insurance result, particularly in a fast changing rating environment. However, the temptation of locking into current rates in the last soft market meant that many insurers were left with unprofitable contracts in the hard market of 2003 and 2004.

E.181 Often such deals will feature both annual and aggregate limits as well as loss-sensitive features such as Profit Commissions and so need to be modelled stochastically.

Combined single limits or aggregates

E.182 An insured may have a single limit or aggregate for different coverages. Allowance can be made for the reduced capital cost of having lower limits/aggregates being issued. The theoretical saving on having a shared limit or aggregate depends on the correlation between the causes of the claims that will share the limit/aggregate and needs to be considered on a case by case basis.

E.183 Underwriters tend to value this limitation significantly more than the pure theoretical expected cost saving because of the lower limits/aggregate being issued.

Extra Contractual Obligations (ECO) / Excess Policy Limits (XPL)

E.184 Particularly in the US, if an insured is deemed by the courts to have acted in an inappropriate manner (ie bad faith) the court can award damages in excess of policy limits (XPL) or outside the coverage provided by the policy (Extra Contractual Obligations).

E.185 Reinsurers can cover losses of this nature, the pricing of which is difficult for the reinsurer's actuary. In some cases the aggressive stance of an insurer may give rise to sufficient ECO/XPL claims to allow analysis, however usually the approach would be to consider the following factors in discussions with the underwriter:

- claims handling stance taken by insurer
- territory and legal jurisdiction of typical claims
- typical level of policy limits (lower policy limits are more likely to generate ECO/XPL claims).

E.186 Actuaries should be aware that when they attempt to price such cover underwriters may infer a level of credibility in their pricing that is not intended.

Stability and Indexation clauses

E.187 These clauses are essentially inflation proofing of terms in a reinsurance contract, taking into account inflation to the date of payment when calculating the excess and limits.

E.188 When analysing these reinsurance contracts a pricing actuary can either estimate an average payout date and look at a typical value of the attachment and limits or, preferable, estimate precisely the expected attachment and limits for each past (or future) claim using the payment pattern.

ALAE

E.189 For US business (although in the London Market this is rarely done), typically direct claims handling expenses (known as Allocated Loss Adjustment Expenses (ALAE)) are split out from indemnity costs, on both a paid and outstanding basis. There are two main approaches for dealing with ALAE, Inclusive and In Addition. The specific treatment will be detailed in the slip/cover note and will be an important part of the pricing process due to the differing treatments having different expected costs.

E.190 On an "Inclusive" basis the ALAE is added to the indemnity, limits and attachment points are calculated with reference to the entire claim.

E.191 On a "(Pro Rata) In Addition" basis the attachment points and limits are referenced to the indemnity cost only and the ALAE is added on in proportion to the indemnity payment to the layer.

E.192 For example, consider the following claims on a $10m xs $5m excess layer:

Indemnity	ALAE	In Addition	Inclusive
$4.9m	$0.5m	$0 (4.9 is less than 5)	$0.4m (4.9 + 0.5 - 5)
$7.5m	$1.5m	$3.0m (7.5 less 5 + 2.5/7.5 x 1.5)	$4.0m (7.5 + 1.5 - 5)
$15.0m	$1.5m	$11.0m (15 less 5 + 10/15 x 1.5)	$10.0m (15 + 1.5 - 5 limited to 10)

E.193 When reinsuring a contract the reinsurance will often follow the underlying, so if an insurer had a mixture of "in addition" and "inclusive" policies the reinsurer will be insurer on the two different bases depending upon from which contract the claim came.

E.194 The pricing actuary should model precisely the ALAE basis taking into account any change in mix of type of policies written.

Large claims and latent claims

Large claims

E.195 Although these are claims that are non typical, they do occur in almost every class from time to time. The treatment of them may differ and judgement is required. Typical treatments are as follows.

Re-spread

E.196 Cap the large loss at a more typical level and respread the excess over a longer period of time.

Volatility

E.197 When pricing, if using an approach that uses volatility (eg Mean + x% x Standard Deviation) then judgementally load up the Standard Deviation part for the volatility due to large losses.

Separate large loss investigation

E.198 Undertake a separate frequency and severity analysis of large claims specifically and take appropriate action based upon the results.

Limit profile/changes

E.199 Consideration should be given to the ability of large claims to arise in the future, where actions have been taken (such as having smaller policy limits, or excluding certain types of claim) to limit their future occurrence (and if not, should such actions be taken). This needs to be reflected in their treatment.

Large Claims Inflation

E.200 Typically inflation for large claims is larger than for small claims. Also large claims tend to develop more and later than smaller claims, so both of these effects need to be considered in their treatment and selecting their ultimate cost.

Latent claims

E.201 Latent claims are typically claims that materialise after the premium has been calculated and were not expected. This is a considerable issue for Occurrence based cover (eg UK Employers Liability). A pragmatic solution needs to be arrived at, bearing in mind that past data is not really of any use when pricing for potential latent claims.

E.202 Typically the solution will be as much as the market can bear, if the difference between the market price and the technical price does not allow enough of a margin to deal with latent claims then perhaps exiting the market is the next step.

Other pricing factors

Tort reform

E.203 Any allowance for recent/prospective tort reform is likely to be very subjective. Important considerations when judging the allowance to be made include the following.

- Will the tort reform hold or will it be overturned in the courts?
- Are there any similar jurisdictions which have implemented similar reforms? What was the effect of these reforms?
- When did/will the tort reform occur? If it occurred in the past to what extent is any reduction in claims already reflected in the experience?
- Was there a tort reform "spike" - ie an increase in claims in advance of the reform being implemented? Is any reduction in claims experience since just a reflection of the temporary acceleration of reporting or is it a long term effect? If the reform is yet to be implemented are we expecting a spike in the prospective policy period?
- How is the reform expected to affect different claims types and sizes? Will the impact be the same all the way up the loss distribution or will smaller "nuisance" claim be more significantly affected? (This is a key consideration for excess of loss reinsurers especially if cedants come under pressure to reduce rates to allow for the reduced frequency of smaller claims. In this situation the reinsurance rate on original premium may well have to rise.)

- In the situation where caps on certain heads of damage are being introduced it should be theoretically possible to adjust the claims data to allow for these, although in a London Market context at least it is very unlikely the appropriate claims detail will be available.

Exclusions and other changes in cover

E.204 If a new exclusion is being applied it may be possible, for the purposes of experience rating, to as-if the claims data to remove claims that would now be excluded. (It may also be necessary to make an adjustment to the exposure base depending on the specific measure used.) Where exposure rating is being used consideration will need to be given to the appropriateness of any rates and exposure curves used.

E.205 Where new exclusions are being applied it is important to consider how water-tight they are likely to be.

E.206 A more dangerous situation in the pricing context is when an exclusion has been removed or additional cover is being granted. In this situation experience rating is not likely to be appropriate without an extra allowance for the additional cover being granted. It is important in all cases that the pricing actuary reads the policy slip, the renewal presentation and discusses the details of the risk with the underwriter so as to be fully aware of any changes in coverage provided. The actuary is then able to communicate exactly what aspects of the coverage have been priced.

Change in claims handling

E.207 Where there have been changes in claims handling the effect of these can be investigated and allowed for in projections. The Berquist and Sherman method may be useful in identifying and adjusting for changes in case reserving adequacy and/or claims settlement rate.

E.208 In more extreme cases, where a more aggressive stance is being taken towards the settlement of claims, there may be a greater likelihood of "bad faith" awards. This will also impact reinsurers covering ECO/XPL.

Change in insurer

E.209 If the insured has changed insurer over the years, the claims from different policy periods will be handled by different insurers with different reserving and claims handling philosophies. In this situation the appropriate development factors will change for different policy periods. Large insurers will tend to have sufficient data to construct benchmark development factors for their major competitors, which can be applied in these circumstances. It may be possible in some circumstances to adjust the older data on to a similar basis to the newer origin years, for example by adjusting for changes in average case reserve strength in a similar manner to the Berquist and Sherman method.

ULAE

E.210 The premium should cover a contribution to the general overheads of the company. This is sometimes included as an explicit load, a proportional increase, or is sometimes included within the profit target for the policy. Further details of expense allocation may be found section 6 of *Clark*.

Reinsurance

E.211 The company's reinsurance will impact the results of the contract and should be allowed for in the calculation of the premium, either as a net cost of reinsurance applied to the gross loss cost, or as a gross cost of reinsurance (allocated to the specific policy) applied to a net loss cost.

Contingency load

E.212 An allowance should be made for any events excluded from the analysis.

Return

E.213 The technical premium should include an expectation for a return to the company. This return most commonly takes the form of a cost of (marginal) capital or an explicit profit load.

Cost of capital

E.214 As each contract is written it commits and places at risk the company's capital. A return on the capital at risk is appropriate from the contract. The pricing actuary needs to estimate the marginal capital that has been placed on risk and an appropriate return on capital. This calculates an additional cash return required from the policy as profit.

E.215 Typically, this capital allocation will be in the context of the company's overall capital management and allocation framework, perhaps using a standard company-wide capital allocation model.

Profit loads & other return measures

E.216 The pricing actuary may wish to include a profit load into the contract, for example calculated as percentage of standard deviation of the loss cost. This may not adequately represent the risk on a highly skew policy. Many alternative methods exist (eg distortion measures, capital consumption) however these are not yet in common use.

Investment returns

E.217 Investment returns may be material in relation to the premium income on the policy, especially for longer tailed lines of business, for example excess US casualty business. The pricing actuary should allow for this additional income associated with the policy, usually by discounting the pure loss cost, or by producing a full cashflow model. Further details of a cashflow model may be found in *Sanders et al*.

Tax

E.218 Tax should be included both inwards (IPT) and in assessing the gross return on capital required to produce an acceptable return to shareholders.

Company targets

E.219 The company may have line specific targets, for example target loss ratios. The premium may need to be adjusted if the policy may have an impact on these targets.

Commerciality

E.220 The actuary should, in combination with the underwriter, consider the commercial environment, and the short and long term strategic aims of their company. If necessary the premium should be adjusted to fit in with these strategic aims.

Brokerage

E.221 The brokerage on the contract should be included such that the premium after brokerage meets the actuaries' calculated premium. It is important to ensure that the inclusion or exclusion of brokerage in the quoted premium is understood by all stakeholders. A useful discussion of brokerage may be found in section 2.2 of *Michaelides et al*.

Catastrophe models in pricing

E.222 Proprietary catastrophe (cat) models use catalogues of hypothetical catastrophe loss events that are supposed to represent the entire range of events of a particular type that might occur in a particular geographic region. For example, an event catalogue for European Storm might consist of perhaps 30,000 hypothetical European storms. Each event is specified in sufficient detail to allow losses to be estimated, for example, the maximum wind speed and duration might be specified in each postcode district. Each event also has an assumed frequency of occurrence. In reality there are obviously an infinite number of possible events, each with an infinitesimal occurrence frequency. The intention with an event catalogue is to approximate all possible storms with a finite number: the frequency of each one actually represents the frequency of all events similar to the particular one chosen for the event catalogue, so it will depend on the number of events in the catalogue.

E.223 As well as the event catalogue, proprietary cat models contain damage factors for different types of property, as a function of the event severity. For example, a windstorm damage factor for detached residential property would give the expected loss (as a percentage of sum insured) as a function of the maximum wind speed, and possibly of the duration of the windstorm.

E.224 To run the cat model, the exposure in each postcode (or other geographic region) has to be specified in sufficient detail to allow the correct damage factors to be applied. At a minimum this would usually be the total of residential and commercial sums insured in each postcode, but it could also be broken down in much more detail (by type of residential property, type of commercial property etc).

E.225 For each event in the event catalogue, the cat model uses the event severity (eg wind speed) to determine the appropriate damage factor for each type of property, then multiplies this by the appropriate exposure, then adds to obtain the total expected loss for the event. This is paired with the event frequency. The events are then sorted by expected loss amount, and the frequencies of loss in excess of any given amount obtained by adding frequencies. This gives a so called "occurrence exceedance probability" or OEP curve, which is essentially the probability distribution of the loss amount given an event, combined with an assumed frequency of an event. The exceedance return period for any loss amount is the reciprocal of the exceedance frequency.

E.226 A typical Catastrophe Excess of Loss treaty covers a limited number of events (for example, first event plus one reinstatement). To correctly price this, it is necessary to combine the OEP curve with a probability distribution for the number of events in a year. The Poisson distribution is often used for this purpose; however, this is not appropriate for two reasons:

- all the main types of natural catastrophe events (eg hurricanes, European storms, earthquakes) do not occur independently but tend to occur in clusters
- the long-term frequency is uncertain: every time an event occurs, this is evidence that the long-term frequency is higher than it appeared immediately before the event, so the occurrence of further events is more likely.

E.227 For these reasons, a distribution with a higher ratio of variance to mean than the Poisson should be used, the Negative Binomial is appropriate for this purpose.

E.228 The Poisson distribution may provide an adequate approximation when pricing treaties with just one reinstatement, but when pricing for third or fourth events it usually materially understates the risk and gives unrealistic premiums.

E.229 Whichever frequency distribution is used, if the treaty covers more than one event the price should be based on the aggregate loss distribution obtained by compounding the OEP curve with frequency distribution. This can be done using Monte Carlo methods, or exact numerical methods such as Panjer recursion or a Fourier Transform method (see above).

E.230 Some proprietary cat models provide event catalogues that include multi-event scenarios, for example, 3 or 4 specific windstorms occurring in a particular year. These are intended to reflect a realistic degree of event clustering and to remove the need for a separate assumption on the probability distribution for the number of events in a year, and remove the need to calculate a compound loss distribution from the OEP curve and a frequency distribution.

E.231 In using cat models for pricing, it is important to realise that they do not necessarily include all components of losses that are covered by the treaty. For example, contingent business interruption losses (arising from insureds not located in the area directly affected by the natural catastrophe) might not be included. Also, the cat modellers may not have correctly estimated the appropriate damage factors, or the event catalogue might not in fact adequately represent the complete range of events that might occur. For example, damage factors might be understated because of a failure to fully allow for 'demand surge': the increase in labour and material costs resulting from an imbalance in supply and demand following a series of major losses. An example of not all potential events being adequately represented in event catalogues was provided by the 2005 US hurricane experience: there were not many hypothetical hurricane events that also included flooding from the associated storm surge.

E.232 London Market business which is not explicitly catastrophe (re)insurance but where there is a catastrophe exposure, eg, a Fine Art book, should be run through a cat model and a catastrophe loading added in the pricing. Also, the output of the model should be analysed as part of the insurer's exposure monitoring.

Developing models for underwriters

E.233 Development of models for underwriters is often a question of balance. Balancing the need for comprehensive data capture versus time taken for data entry or completely actuarially sound methods versus market practice.

E.234 The actuary always wants better data and data should be captured which allows for a sensible pricing approach today and refined pricing in the future. The actuary will need to spend time explaining to the underwriter the need for the extra data capture.

E.235 There are lines of business where the data quality and quantity together with the risk covered means that the actuary has little to offer in the first instance. A sensible way forward is to build a model for data capture which prices the business according to the underwriter's current model. This model may well only reside in the underwriter's head. This approach has several advantages. It gains the underwriter's confidence, captures consistent data and shows where the underwriter deviates from his model. After a period of time there will be enough data to test the rating factors and methodology as well as to notice the circumstances when the underwriter uses a different model.

E.236 It is good practice to store all the data in a database which forces a consistent format. The model should not be open for people to change the rating factors as they wish. The data should be kept in a way which minimises the risk of the data being accidentally or deliberately tampered with. When storing a quote it is best to store the rating factors and the associated parameter values together with the calculated price and the underwriter price. This allows for re-working the data when model parameters change and seeing where a particular premium came from.

E.237 Actuaries working with clearly defined models being used on a portfolio basis should be aware of requirements that may impact the design of the models from the Sarbanes Oxley legislation in the USA.

Rate monitoring

E.238 A rate index is simply a method for monitoring the aggregate impact of all the individual rate change calculations and provides a measure of overall rate change for a portfolio. A technical definition of a rate change is the change in rate per unit of exposure per risk.

E.239 Rate indices are of use to both the internal management responsible for an insurer and to external bodies, such as Lloyd's and the FSA, who are interested in the macro impact on the market of underlying rate movements. This section concentrates on the internal management requirements of rating indices and provides some suggestions to facilitate their construction. It should be noted that if such indices are to be made available for external use then further considerations may need to be taken into account, for example, the degree of consistency between participants.

E.240 In personal lines the rates charged are generally those in the rating algorithm and these rates will be varied through the market cycle. In the case of London Market business, however, there is often considerable underwriter discretion in estimating the true technical rate compared to standard base rates. Additionally depending upon the stage in the market cycle the underwriter may deviate considerably from this technical rate in the actual premium they charge. Therefore it is important when constructing the index that the "base rates" are not used in isolation.

E.241 Internally, rating indices are a vital management tool in many crucial areas - including reserving, measuring capital costs, profitability monitoring and underwriter assessment of risks. However, their most notable use is in the area of planning, giving management a clear understanding of where its business is positioned with regard to the underwriting cycle and allowing management to maximise future business volumes or profitability.

E.242 The use to which a rating index will be put will have an impact on its construction and it is likely that different indices will be required for different purposes. However, there are key components that any rate index should have, such as the incorporation of outputs from technical pricing models and consistency of measurement over time. In addition, rate index construction needs to consider various complexities, which if not incorporated, could lead to a misinterpretation of the conclusions. There are usually several possible ways that issues may be addressed and factors such as consistency, cost and materiality all need to be considered. Further detail is available in the LMA document "Combating the Insurance Cycle - A Modelling Approach", April 2006.

F Communication "pitfalls"

F.1 We set out below some of the more common topics which we have found to cause problems with communication. If sufficient interest exists, a catalogue of such "pitfalls" and tools to tackle such issues (including example wording, forms of graphs, "storylines" of concepts to stress etc) could be developed by the Profession perhaps as an Appendix to a future Premium Rating Manual as discussed in Section 2.

F.2 One significant issue is the communication of uncertainty. Common questions encountered include:

- "What is the chance of a loss with these rates?"
- "How sure are you this is the right answer?"
- "How much of the large loss we had last year should I allow for in this year's price?".

F.3 Issues to consider relating to uncertainty include the following.

- Ensuring that sensitivity to assumptions is clearly communicated, particularly those with significant pricing effect. In particular ensuring that it is understood that changes in some assumptions might have a small effect on the estimated mean outcome but a large effect on the tail of possible outcomes.
- Ensuring that the difference between model uncertainty, parameter uncertainty and process uncertainty is clearly communicated and understood.
- In practice a number of different measures of uncertainty may be needed. Among the commonly used measures are standard deviation, coefficient of variation, value at risk, tail value at risk, downside upside ratio and reward to risk:
  - the coefficient of variation is the standard deviation divided by the mean
  - the value at risk is defined as a loss that will not be exceeded at some specified confidence level over a specified period of time
  - the tail value at risk is defined as the weighted average of all outcomes worse than a certain percentile. For example, weighted average of all outcomes worse than $P_{90\%}$ is known as $TVaR_{90\%}$
  - the downside-upside ratio is the largest downside outcome divided by the largest upside outcome.
  - the reward to risk ratio is the weighted average of all downside outcomes divided by the weighted average of all upside outcomes.
- Explaining credibility theory by linking it to return periods.
- Ensuring that the uncertainty and validity of rates where the cells have limited data and limited credibility is clearly understood.

Other issues to consider, in no particular order, include the following.

- When using generalised linear models ensure that it is understood:
  - that the results make allowance for correlations between rating factors
  - that the result for one factor must not be considered in isolation but in the context of the other factors in the model and the results for those factors
  - that the results for any one factor could be different if other factors were added to or removed from the model.
- When using generalised linear models ensure that it is understood that a base premium (ie the intercept term) is not the same as an average premium.
- Anticipate the reaction that a theoretical risk model cannot be implemented directly because of the changes in premiums which would result, and communicate clearly the process of selecting a commercial rate given a good understanding of a technical price.
- Ensure that it is understood why outstanding claims as well as paid claims are inflated in deriving a future price (a common misconception is that outstanding claims are "already in today's terms so you don't need to inflate").
- Anticipate the comment that the mix of business is different now and thus the appropriate rates are now lower.
- Anticipating the comment that "If it hadn't been for those two claims the experience last year would have been lower" or "I don't need to allow for one of those claims because it was unusual".
- Anticipate comments on pricing property (or other) risks where significant allowance is made for events which do not occur every year, particularly when analysing the results (eg a 10% lower than expected loss ratio this year as a result of no such event does not mean over-pricing).
- Anticipate the comment that a new claims process is now in place and experience will be lower in the future.
- Anticipate the question "How can my competitor get away with charging this lower price?"
- Address implementation issues such as "How many policies will I sell?"
- Ensure that it is understood that volume does not equal profit!

- When discussing expense loadings be aware that:
  - it is not possible to "marginally price" every risk
  - targets will change as volumes change
  - there is a distinction between fixed and variable costs and it is not helpful to use a common loss ratio for all risks, ie a common combined ratio does not mean the same loss ratio.
- Ensure visible consistency between pricing and reserving bases.

G Potential references for a glossary of terms

The following Faculty and Institute references contain material which could assist with a future compilation of a glossary of insurance pricing terms.

David Forfar and David Raymont *Glossary of Terms - General Insurance* (http://www.actuaries.org.uk/files/pdf/library/GeneralInsuranceDefinitions.pdf)

Comparison of UK and US terms (http://www.actuaries.org.uk/Display_Page.cgi?url=/library/proceedings/gen_ins/1999gic/glossary_intro.xml)

Geraldine Kay, Jillian Evans, Sheree Howard, David Loades, Bill McConnell, James Rakow *Ways to Improve the Link Between Actuarial Analysis and Decision Making* (GIRO/GISG 1996 http://www.actuaries.org.uk/files/pdf/library/proceedings/gen_ins/gic1996/0205-0249.pdf)

In addition, there is a wide range of insurance glossary information on commercial websites, for example:

- http://www.lloyds.com/Help/Glossary.htm
- http://www.findalink.net/reinsurance/
- http://www.iii.org/media/glossary/

however there are potentially significant legal restrictions and copyright issues which would need to be addressed before such material could be used.

H Example syllabus for GLMs

(i) Explain the fundamental concepts of a generalised linear model (GLM) and the exponential family of distributions.

1. Be familiar with the principles of Multiple Linear Regression and the Normal Linear Model.

2. Define an exponential family of distributions. Show that the following distributions may be written in this form: binomial, Poisson, exponential, gamma, Normal.

3. State the mean and variance for an exponential family, and define the variance function and the scale parameter. Derive these quantities for the distributions in 2.

4. Describe, in general terms, the Tweedie distribution and define the variance function and the scale parameter.

5. Specify the structure of a generalised linear model with reference to the linear predictor, error distribution, offset, scale parameter, link function, variance function and weights.

(ii) Describe the principles of constructing a generalised linear model, with specific reference to its applications to General Insurance.

1. Explain the failings of one-way analysis as a method for analysing multiple variables.

2. Explain what is meant by a variable, a factor taking categorical values and an interaction term. Define the linear predictor, illustrating its form for simple models, including models involving categorical factors and polynomials.

3. Describe typical forms for modelling: claim frequency, claim numbers, average claim amounts, burning cost and probabilities. Descriptions should include reference to: the error distribution used, the link function, scale parameter, variance function, weights and offset term.

4. State how the parameters of a GLM can be estimated and explain how to convert these parameters into the required expected values using the link function.

5. Explain what claim types are usually modelled for UK motor insurance and why.

6. Explain in broad terms how typical rating factors affect claims experience for UK motor insurance.

(iii) Explain the techniques used to analyse the significance of the factors used in the model.

1. Define the deviance and scaled deviance and describe how these statistics can be used to test the significance of a factor using chi-squared statistics, F-statistics and the Akaike Information Criteria.

2. Describe how standard errors can be calculated to show the uncertainty surrounding the model parameters.

3. Describe other methods for checking the significance of a factor, including interacting with time and comparisons with expectations.

(iv) Describe the techniques used to check the appropriateness of the model structure.

1. Define the Pearson and deviance residuals and describe how they may be used.

2. Discuss typical residual patterns for models of average cost, frequency, burning costs and probabilities.

3. Define Cook's distance and leverage and explain how they can be used to identify data outliers.

(v) Explain how to refine the model using interactions and restrictions.

1. Describe the difference between complete and marginal interactions and interpret the results from each.

2. Describe how to apply restrictions to constrain the model and how this may impact upon the parameter estimates for the other factors.

3. Describe how parameter smoothing can be used to improve the model and state methods for doing so.

4. Describe how factors can be offset, and explain why this might be done.

(vi) Describe how to combine models to produce risk premiums.

1. Explain how to combine frequency and amounts models multiplicatively for one claim type.

2. Explain how to combine frequency and amounts models across additive claim types by fitting a further GLM to the expected cost of claims.

I Response to EXD62

GRIP's response to EXD62 made at the consultation meeting in Staple Inn on 18 January 2006

Introduction

This summary represents the unanimous view of the GRIP taskforce.

GRIP appreciates the need for a clearer stance on guidance in the changing general environment. However, we do not feel that GN12, as currently drafted, achieves this aim.

In initial stakeholder feedback on the role of actuaries in pricing, senior stakeholders said they would like to see actuaries getting closer to the business. If guidance is too onerous this will be a step in the opposite direction.

Problems with GN12 from a pricing perspective

We believe that the **definition of a formal report is too wide** and appears to cover a wide range of formal communication. In a pricing context we consider this would "turn on" GN12 in many pricing circumstances where the person commissioning the work does not require the scope of the work to be as implied by GN12. Indeed the definition seems to extend to reports outside the traditional actuarial role, for example reports on competitiveness of rates, social accountability, call centre management, marketing and commentaries on rate calculations entered by underwriters.

For the member to be compliant with GN12, the additional work involved in documenting the analysis undertaken would need to be accommodated in the work scope, which in many cases could potentially make the project uneconomic or too late to be useful. Given that "pricing" is rarely a reserved role for actuaries in general insurance this could make the use of actuaries significantly less attractive.

We are concerned that GN12 has a **reserving bias** which makes it extremely difficult to interpret in a pricing context. Examples include the following:

- the emphasis placed on obtaining and commenting on "earlier reports" prepared by other members
- disclosure of sufficient data in a report for another member to assess the reasonableness of results
- the assumption (implicit in 7. and 8.) that the report will contain point estimates
- results to be based on several methods
- the references to uncertainty which assume that there is a single number answer

- GN12 is **practice standard** and as such "a material breach … would amount to strong prime facie evidence of misconduct" (PCS 4.1). Given this, we consider that members would want to use the "should normally" opt out in exceptional circumstances only and that they would be uncomfortable using this opt out to cover the generality of pricing work. The fact that GN12 has a reserving bias and the definition of a formal report is too wide (1. and 2. above) makes compliance with GN12 by the pricing actuary difficult and onerous.

Some of the requirements in GN12 would be **onerous** in a pricing context, particularly in the case of personal lines pricing involving multivariate analyses (eg 5. Analysis of Emerging Experience, and 8. Uncertainty) and may not be seen by stakeholders as adding value. Examples include the following.

- the person commissioning a pricing review by a consultant would presumably see this as a "formal" report, but would not necessarily see the scope implied by GN12 as something they want to pay for
- the ground work necessary for a GN12 pricing report may not be part of the current routine analysis carried out by a company.

Solutions

Our preferred solution would be to make GN12 a Guidance Note for reserving only. There is a new Guidance Note, GNPP, which provides guidance to the pricing actuary regarding the professional behaviour expected of members in the field of general insurance. GNPP is Practice Standard. GNPP covers many of the issues in GN12 but in a generic way. With the new GNPP it is not clear that there is really a need for GN12 to attempt to cover non-reserving work.

If this is not viable then our preferred remedies are as follows:

- tighten/narrow the definition of formal report (for example "specifically commissioned as a report required to comply with GN12")
- redefine sections 7 & 8 so that they only apply for reserving work
- modify sections 1 to 6 to work better for pricing work.

Even if the definition of formal report was tightened/narrowed, we believe that some of sections 7 and 8 would need amendment to clarify their application to pricing work.

18 January 2006

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