2.5 COMPLEXITY, UNCERTAINTY AND RISK-TAKING IN GENERAL INSURANCE AND THE ROLE OF THE ACTUARY

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An introduction to general insurance

General insurance is all about risk and uncertainty. The industry arose out of the desire for those taking risks, for example those financing sea trade, to secure some financial mitigation for that risk, initially by sharing the risk between groups of similar investors. Such mutual insurance began in the 17th century and still exists today, albeit in increasingly sophisticated forms. Other early general insurance took the form of emergency services secured, should they be needed, by advance payment. This arose as a response to a catastrophic event.

On Saturday 1 September 1666 the Great Fire of London started in a baker's shop in Pudding Lane at 2 in the morning. The resulting blaze lasted for three days and left 200,000 people homeless, with 12,000 houses destroyed. The people set with the task of rebuilding London, decided that a disaster on this scale must *never* be repeated. One of the persons given the task of rebuild was a Dr. Barbon, who charged an 'insurance premium' to cover the cost of a fire amongst a large number of people. The City was also divided into quarters and each quarter was equipped with fire fighting equipment. The first 'insurance fire Brigades' were born. Plates or plaques were fastened to the outside of buildings, to show which insurance fire brigade would put out the fire.

Over time a similar approach was adopted in other countries. This was the start of organised fire fighting, beginning as an 'insurance' industry and eventually being effectively nationalised. While most insurance today provides financial restitution in the event of loss, this early type of service-insurance still exists, for example, in the form of emergency call-out for vehicle break-down, or medical insurance.

General insurance is a means by which the buyer, or the insured, can pay money to buy out their risk. They reduce their remaining uncertainty at a price. The price, or premium, is determined by the insurer by considering the risk spread across a wider group of insureds, their own resources and risk appetite, and with regard to the unique characteristics of the individual. Insurance companies underwrite insurance risks, taking premiums to provide coverage, and paying claims. Such companies are regulated and are required to report on their financial results. The business of these companies is inherently risky and so they have developed a range of approaches to manage the risks they face, some of these required by regulation and others having developed as industry good practice. Actuaries work in general insurance companies, bringing a combination of statistical and analytical skills, together with broader business management capabilities.

Basic financial management of a general insurance company

In this part of the paper I will consider those aspects of financial management of a general insurance company which are most related to the typical work of an actuary. There are other aspects of financial management such as the investment of assets and the management of expenses, which are beyond the scope of this paper.

Spreading risk, capital and diversification

An insurance company is an organisation which offers insurance to others, which allows them to lay off risks that they have in exchange for a charge or premium. By paying a premium the insured transfers his risk, or some defined part of it, to the insurer. The insurer needs to hold enough capital to ensure it can pay claims if and when they occur. The more business a company writes the more it can spread risk and so make more efficient use of capital.
Consider the following example:

An insurance company, A, writes one insurance annual policy with a premium of £100 000 and a 20% chance each year of a claim of £450 000. On average the company will pay claims of £90 000 per annum (which is 20% of £450 000). Ignoring expenses, commissions and investment income the company will make a profit of £10 000 per annum, which is 10% of the premium. This company is required by its regulator to hold enough capital so that there is at least a 99.5% chance of it remaining solvent. This means that the company needs to be able to cover the £450 000 claim should it arise, and so must hold capital of at least £350 000 in addition to the £100 000 premium. The expected profit of £10 000 is only a 2.9% return on capital and so such a company would not be commercially viable, since rational investors would be extremely unlikely to accept such a paltry return when there is a 20% chance they will lose their entire investment capital.

Consider an amended example:

An insurance company, B, writes one hundred annual insurance policies, each with annual premium of £1,000 and each with a 20% chance of a claim of £4,500. Each of Company A and Company B has £100,000 of annual premium and each expects to pay an average annual total claims amount of £90,000 (for Company B this is 20 claims out of 100 policies). Each company expects to make an annual profit of £10,000, which is 10% of its premium. However, Company B has an advantage. It believes that the claim events are independent and that there is a 99.7% probability that there will be 31 or fewer claims in any given year. The company will therefore cover these 31 claims with its premium and capital, but will run the risk of insolvency in the remote chance of 32 or more claims. Company B has a capital requirement of £39,500, in addition to its premium of £100,000, to cover 31 claims at a total cost of £139,500. The £10,000 annual profit is a 25.3% return on the required capital and there is only a 0.3% probability that the investor will lose his entire capital.

This example illustrates one of the fundamental principles of insurance – that of spreading risk, which is called diversification. It is the principle of diversification which allows insurance to exist, because the gathering together of sufficiently many disparate risks can become an attractive investment proposition on terms which are

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equitable to the underlying policyholders who wish to pay a reasonable fee for transferring their risk. Understanding the extent of diversification is an important aspect of the financial management of an insurance company.

Pricing for risk

In general insurance companies it is the underwriters who write the insurance policies and they are responsible for determining an appropriate premium to charge. In many cases they will be assisted by actuaries in making this determination. In almost all insurance the actual chance or probability of a claim is not known (frequency). In many cases the potential sizes of claims are also not known (severity). The example above was in a simplified scenario where the two insurance companies had risks about which they had perfect knowledge. While this knowledge did not remove the uncertainty in the outcome of the claims events, it made the uncertainty readily containable and directly quantifiable. The real world is not so convenient.

Underwriters and actuaries seek to determine an appropriate price for each insurance contract by considering, amongst other things, the expected cost of future claims. One of the components of this process is an analysis of the frequency and severity of the claims history of the individual risk in isolation. This can be informative, if the data is available, but will often give only sparse data which does not paint a statistically reliable picture. Another approach is to analyse the data for a larger group of policies which are the same or similar to the policy in question. This will provide a greater volume of data, and as long as the group is reasonably similar (homogeneous) then it can provide a more reliable picture of the expected outcome for the individual.

A further refinement, and the subject of a combination of much statistical and actuarial analysis, as well as hard won underwriting judgement, is the application of relative risk differentials between individuals in a group of similar risks. These differentials are called rating factors and they seek to mirror factors which differentiate the risk between individuals. For example, younger drivers tend to have higher annual costs of claims then older drivers, so age can be a rating factor, and by carrying out a statistical analysis of motor claims experience by age, an age specific rating scale can be derived.

In fact there are many potential rating factors and so one needs to carry out a range of analyses, for example by age, gender and type of car. An added complexity is that these rating factors are not always independent of each other. There can be correlations and interactions which also need to be allowed for.

Consider the following example:

Analysis of motor claims data over many years shows that young drivers have double the average level of claims. It also shows that drivers of fast cars have double the average level of claims. One might therefore expect that young drivers of fast cars had four times the average level of claims. In fact, in this example, young drivers of fast cars had ten times the average level of claims. This is because the age and car-type factors are not independent and are instead interacting. Such interaction must be allowed for using a multivariate approach, often accomplished via generalised linear modelling (GLM).

Pricing for risk is partly an art and partly a science. Some risks do not belong to groups of large policies but must be priced on an individual basis. An underwriter will

use their experience and judgement which in some ways is like an implicit statistical analysis of the sum total of their experience of risks.

In addition to seeking to determine the expected cost of claims for a policy, part of pricing for risk is pricing to cover a return on the capital which the contract in question will expose to risk. This requires not only consideration of the average expected cost of claims but also the distribution of possible outcomes for the claims. The more volatile the risk, other things being equal, the more capital is exposed to risk, and so the higher the necessary premium so that the exposed capital is given an adequate return.

I will consider the various risks faced by a company and how these are addressed through Enterprise Risk Management. This process may often include the calculation of an overall Risk Based Capital requirement for the company across the board, allowing for all known factors and for the diversification of risks. Often the company will apply a process to allocate the need to provide a return on the aggregate risk based capital back down to the types (or classes) of insurance business, and so, through a risk loading, to the individual policies.

Reserving for claims

There is a delay between an insured event taking place and the claim being paid. During this period the insurance company must hold a suitable amount of money in reserve, without deeming it to be profit, so that it will have the funds available to pay the claims when the time comes. The process of determining an appropriate amount to hold in reserve for all of the pending claims of an insurance company is called 'reserving' and this is a core area of actuarial work in general insurance.

Consider the following example.

On 1 July 2007 there is a collision between two cars, and the driver of one car is insured by Insurance Company C. Both cars receive minor damage and neither driver reports an injury at the time. The incident is reported to Company C by its insured as being the fault of the other driver. Company C sets up a case reserve of £1,000 for the damage to its own driver's vehicle on 10 July 2007. There is no change to this position when the company declares its financial results at the end of 2007.

In this example it eventually transpires in March 2008, that Company C's driver is found to have been at fault. Further, the driver of the other vehicle developed minor whiplash. The total final cost to Company C is the £1,000 damage to their insured's vehicle, plus £1000 damage to the other vehicle, plus £3000 compensation for the whiplash plus £1000 in total legal expenses across the two parties. The total final claim amount is £6000, or six times the original case reserve. Company C took an adverse deterioration of £5,000 on the claim in the 2008 calendar year.

Consider the following alternative example.

On 1 July 2007 there is a collision between two cars, and the driver of one car is insured by Insurance Company D. Both cars receive minor damage and neither driver reports an injury at the time. The incident is reported to Company D by its insured as being the fault of the other driver. Company D sets up a case reserve of £1000 for the damage to its own driver's vehicle on 10 July 2007. There is no change to this position when the company declares its financial results at the end of 2007.

In this example it eventually transpires in March 2008, that Company D's driver is found to have been blameless and he is able to recover the costs of repairing his car, and compensation for whiplash, and his legal costs from the insurer of the other driver. The eventual outcome for Company D was a zero claim. Company D experienced a favourable movement of £1000 on the claim in the 2008 calendar year.

These two examples illustrate the delays between the occurrence of an incident and payment of a claim, and also the inherent uncertainty in the process of setting case reserves. In practice some events may take many years before they emerge as reported claims, such as compensation for industrial diseases which may have a long latency period. For most types of insurance there is a degree of uncertainty in the final outcome even after a claim is reported. This is especially so where blame, or the extent of any injury is either unknown or potentially open to dispute.

Companies do not only hold case reserves, but they hold an additional claims reserve called 'Incurred but not Reported' or IBNR. This reserve covers the expected amount of claims to be paid from events which have happened but for which case reserves have not yet been set up because the event has not yet been reported to the insurance company. IBNR also includes, often implicitly, a component which covers any inadequacy in the overall case reserves for claims which have already been reported. This component is called 'Incurred but not enough Reported' or IBNER. Claims management professionals set case reserves and actuaries are often used, supported by other insurance professionals, to determine aggregate reserves. Actuaries use a variety of actuarial techniques to perform their calculations, in most cases involving some form of analysis of past experience and extrapolation to the future.

Actuarial claims reserving is a complex process and the final claims outcome is almost always uncertain, in many cases with a wide range of potential outcomes. An important part of the role of the actuary in reserving is to understand the drivers of the uncertainty and to communicate them and their effects to the users of their work in as clear and helpful a manner as possible. Much attention has been given to improving this communication in recent years and this will be discussed further below.

Risks and uncertainties faced by a general insurance company and enterprise risk management

As we have discussed above, it would be very convenient if an insurance company could exactly define the risk profile of all of the contracts it wrote and to have independence of all of its insurance policies. Many of the risks faced by an insurance company are in large part a result of the fact that this happy state of affairs does not exist in the real world.

Insurance policies are not independent of each other and so sometimes can all go wrong together. Claims frequencies and severities are not known. We use past data to analyse but the older data is less relevant because things keep changing. The more recent data is unreliable because the claims have not all been settled and so we must use the case reserves and IBNR which might turn out to be too high or too low. So, writing an insurance policy is risky because we don't really know what claims we can reasonably expect, and, because of reserving uncertainty, we don't know how much money we made last year or the year before from similar policies. And we don't really know how volatile the claims experience might be, or how much business we might be able to write, so we don't really know how much capital we need.

In the sections which follow I set out some of the key risks faced by an insurer, developing these high level themes.

Underwriting risks – premiums

Adequacy of premium

Premiums may be inadequate or overly high across the board. This can arise because past data has been incomplete and so the analysis of expected claims has been based on data with some of the bad news missing. It could also occur because adjustment has been made to past data for trends to update it to the current time, for example for inflation, but these adjustments may have been overly optimistic or pessimistic. Another cause can be the failure to allow for trends which have increased or decreased the frequency and or severity of claims between the time of the historical data and the present day. The premiums being too high or too low presents risk; too low and losses or inadequate profits arise per policy, and in a competitive market a high volume of inadequately priced business may be written; too high and business volumes may fall which can expose a company to its fixed cost base.

Anti selection

This arises when the overall level of pricing may be about right but where some subsets of the premium rates are too high and some are too low. In a competitive market the insurer will grow its volume where the prices are inadequate and lose volume where its rates are too high. It is said that the policy holders are 'selecting against' the insurer by exploiting his under pricing and walking away from his over pricing. Because the book becomes unbalanced the insurers suffer worse overall experience than he would on the basis of his overall premium levels.

A company seeks to mitigate these premium risks by regular claims experience reviews, the skills of its underwriters and pricing actuaries, and the careful monitoring of policy retention rates and quotation conversion rates against expectations.

Underwriting risk – claims

Claims frequency

The frequency of claims is an unknown which can sometimes be modelled by actuaries using statistical distributions. There are certain circumstances when claims frequencies can be very high at a specific point in time. Such a circumstance arises when there is an accumulation of risk from a common cause. For example, an insurance company may insure a large number of homes in an area hit by a flood. The company would receive a large number of claims at about the same time. Such events are called catastrophes, and can be man-made, such as terrorist attacks, or natural disasters, such as floods, storms and earthquakes. Catastrophes test the controls and financial resources of insurance companies.

Companies mitigate these risks by detailed modelling of the aggregate exposures by type of event and by region, so they have a clear idea of what their potential is for loss from a large number of hypothetical catastrophes, known as 'realistic disaster scenarios'. Specialist software can be utilised to carry out this modelling and actuaries are often involved in running the models.

The company may decide to cap the amount of business they will write in certain regions to avoid over-exposure to certain catastrophe events. They may also

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buy reinsurance which is insurance for an insurance company. In exchange for a premium the company may buy protection for all losses arising from a particular catastrophe, once the loss has exceeded a set retention – such as $10,000,000. There is almost always an upper limit which the re-insurer will pay out, even if the insurer's catastrophe losses exceed that amount.

Claims severity
For some types of insurance the claims sizes are always fairly similar. For other types of insurance the claims can vary in size hugely. Very large individual losses can occur somewhat randomly and the potential for such occurrences is a risk for a company. This risk could spoil what would have otherwise been a good year, or it could make a bad year a disaster.

To mitigate the risk of large individual losses the insurer will seek to control the risk it is taking on, potentially by applying limits to the sizes of claims it will pay. It may also buy reinsurance to protect it against individual claims going above a certain threshold which it is content to retain. When the insurer uses re-insurance to mitigate his claims, he is ceding profit to the re-insurer over the long term in exchange for more stable financial results. More stable results means a lower need for capital. The insurer can optimise his purchase of reinsurance, to give maximum return to his shareholders for the level of risk they find acceptable, by using stochastic modelling and Enterprise Risk Management, which is discussed below. Actuaries are often deployed for this reinsurance optimisation work.

Underwriting risks – reserving

Under-reserving
Arguably the most important risk faced by an insurance company is reserving risk. An under-reserved company can stay under-reserved for several years before claims payments push through and make the situation visible. In that time the company will have been deluded into thinking it was operating more profitably than it really was, and so it may well have been under-pricing each successive year of business. Under-reserving can lead to losses year after year until the rot is stopped. Many if not most of the insurance companies which have become insolvent have had a large component of under-reserving leading up to their downfall which facilitated unwitting loss making trading.

Actuaries are normally responsible for the reserving and so they are closely involved in the mitigation and communication of this risk. A key component to this is the availability and use of good information – including numerical data and a range of objective and subjective information from underwriters and claims professionals. Actuarial judgement and experience are also important, which together need to include a thorough appreciation of the potential weaknesses of some of the standard actuarial reserving methods.

Under-reserving seems to be most frequent when the insurance market is in a downturn and profitability levels are low. It seems that companies and their actuaries sometimes find it hard to believe that the business can really be as bad as the emerging claims experience would suggest and they remain in denial, holding on to their more optimistic prior conceptions. This is known as 'anchoring error' and it can sometimes be important to have a good understanding of the psychology of making decisions about emerging facts, especially unwelcome ones, in order to guard against this potentially damaging cause of under-reserving.

Latent claims

Some claims can take many years to emerge. A problem can be lying dormant in the old years of business of an insurance company. The premiums have long since been received and all known claims seem to be paid or to have gone away. Then suddenly a spate of new lawsuits emerges, such as for a new kind of industrial disease, and the historical policies from these older years start to generate a wave of new reported claims. The emergence of new kinds of latent claims is a risk for an insurance company, because the IBNR, which allows for unreported claims, will likely have been modelled using data which did not have such surges of new claims in it, and so the modelling will not predict them in the future either.

It is hard to mitigate the risk of latent claims. Many insurance policies are known written on a basis so that claims will only be valid if the claim in made within a certain time limit. This prevents some latent claims risk, although it does not deal with the risk already in the books from before these clauses were introduced. Part of the capital of a company is required to protect it against some latent claims risk.

Other risks

There is an enormous range of other risks faced by insurance companies, from fraudulent claims, unreliable data and changes to the sizes of damages awarded in courts, to a mismatch between the currency of the company's assets and its liabilities. I will not seek to lists all of the other risk categories one might wish to consider, but I would point out that the most problematical risks tends to be those which have not been identified and categorised – the unknown unknowns. These may not have been mitigated and should they arise they can be the undoing of a company. Although the term can include many other risks also, the term 'Operational Risk' tends to be used to describe the sum total of everything else bad which could happen.

Enterprise risk management

The understanding, tracking, measuring and mitigating of all of the insurance company risks discussed above, as part of an integrated control process, embedded into the management structure of a company, is called Enterprise Risk Management. This generally involves risk registers, control processes, and complex stochastic simulation modelling of large numbers of potential sets of circumstances. Such modelling allows management to test the robustness of their capital and reinsurance arrangements, and to demonstrate their solvency to rating Agencies and Regulators. Enterprise Risk Management generally involves all parts of the company and may be overseen by a risk officer, finance officer or actuary.

General insurance planning and uncertainty

General insurers create annual business plans setting out one or more possible sets of financial results, in the face of all of the uncertainties I have discussed. These plans adopt certain conventions in relation to typical risk areas and I discuss some of these, in the context of the overall planning process, below.

Reserving and pricing inputs to planning

An insurance company will produce a number of financial plans through its annual cycle. A financial plan will include a forecast of the volumes of premium expected to be written, subdivided for example by class and territory. In each case the plan will include estimates of the likely claims which will arise from this premium. The expected claims divided by the premiums is known as a loss ratio. So, a loss ratio of 100% means that the same amount of money is paid out in claims and has been received in premium. As companies have to pay commissions and incur expenses such as staff and building costs, even with the benefit of investment income loss ratios as high as 100% are generally loss making.

The financial plan for a general insurance company will set 'plan' or 'target' loss ratios for each segment of the business. These plan loss ratios need to be consistent with the strength of the premium expected to be written and so need to be informed by the current pricing levels of the company. Further, the recent experience of the company for each class of business is relevant to the expected future experience. It may seem likely that if a company has been experiencing loss ratios of around 70% for a particular class of business for the last few years, that 70% is a sensible level at which to plan next year's loss ratio. The past history of the loss ratios arises from the reserving, in that the ultimate claims estimate includes paid claims, outstanding claims and IBNR.

As I have set out above, the strength of the premiums and the estimation of the reserves are both subjects of potentially great uncertainty. This means that the starting point parameters for the plan are uncertain.

Cats, large losses and attritional claims

The pricing strength of current business and the reserving for past experience are not the only uncertainties faced in financial planning for a general insurance company. Another major uncertainty is the potentially wide range of possible outcomes for the year to come in terms of loss events, such as major earthquakes, hurricanes, train crashes or floods. There is complexity in relation to the drivers of this uncertainty, including the areas of claim frequency and severity discussed above.

In order to plan for a general insurance company, in the face of this uncertainty and complexity, the analysis supporting the plan will often break down expected claims into three categories, catastrophe claims, large losses and attritional claims. In this way the company is able to subdivide the uncertainties by cause, which allows for clearer and more explicit assumptions in planning.

Catastrophe claims
As discussed above there can be a large accumulation of claims from a single event, which is known as a catastrophe, or Cat. In planning a company will consider the various Cats which could occur, man-made and natural, and will model or otherwise estimate the potential exposure to each such event, known as the aggregate exposure. The magnitude of these 'aggregates' will guide the company as to how much reinsurance to purchase, so that they know what level of risk they are retaining.

The company will have a view, from any available models and bearing in mind current political or environmental circumstances, how likely major catastrophe events are to occur. (Climate change is currently an area of interest for insurers in considering the probability of major flood and hurricane events). The probability of

such events is highly uncertain. By considering a large number of possible Cats either explicitly or through stochastic simulation modelling, the company will form a view of the average expected level of Cat claims in any given year. This is usually expressed as a percentage of the relevant premium, and as such is referred to as the Cat Loss Ratio.

In practice, particularly for the larger Cat events, the most likely outcome is that there will be no Cats in the year. In these cases the financial outcome, other things being equal, will be better than the plan by an amount equal to the Cat loss ratio. The possible but unlikely outcome is that there will be Cat event, in which case the actual financial results will be significantly worse than the plan. The Cat loss ratio can be thought of as a contingency in the plan, equal to an estimate of the average long term cost of Cats.

Large losses

Large individual losses from a single policy also need to be considered in planning, particularly for some classes of business with the habit of generating such claims. Modelling of past experience will give a guide to the likely frequency of such events and of a distribution of potential severities. The plan will need to include a Large Loss – Loss Ratio, which will be calculated as the expected annual cost of Large Losses. The planned reinsurance programme, as well as catering for the exposure to Cats, will be structured with the Large Loss exposure in mind, in the context of the level of risk the company is happy to retain.

Attritional claims

After a company has decided, perhaps specifically for each class of business or perhaps across the board, how it defines a Cat event and what it means by a Large Loss, then the claims that are left are known as attritional. These are the 'ordinary' claims which arise from a wide range of normal situations. There are no material accumulations from a common cause and no abnormal large individual losses. If the Cat and Large Loss categories have been defined well then the remaining attritional claims should have a much reduced degree of uncertainty in terms of claims frequency and severity. Whilst this uncertainty is reduced, it is not eliminated, but the greater residual uncertainty in the eventual attritional claims outcome is that arising out of the uncertainty in the pricing strength and general expected performance, which I discussed above.

Planning volumes 'in' and 'out'

In addition to planning the performance of the business, through the expected loss ratios, the company must also plan how much business it intends to write, which is called its volume 'inwards'. The plans will bear in mind, amongst other things, the expected competitiveness in the market place, the amount of capital the company has against which it can take risk, and the capital intensiveness of the different types of business it can write.

The 'outwards' premium, or volume, relates to the amount of money the company plans to spend on reinsurance. This will have interdependency with the inwards volume. The more business a company will write, the more risk it takes on and the more reinsurance it will need relative to the same capital base. If outwards reinsurance is expected to have limited supply then this may constrain the amount of inwards business a company can write off its capital base. There is also a relationship

between the planned volume and the planned loss ratio. If the market is very competitive then a growing company will likely suffer deterioration in its loss ratio.

How general insurance actuaries communicate uncertainty

Here I look at some of the professional guidance and discussion on how general insurance actuaries should handle and communicate uncertainty. I set out a number of extracts from three professional papers which I have co-authored and introduce each with a brief discussion of the themes which the extract handles. I have also included my own introductory discussion on the use of centiles in communication in order to put the extracts from the second paper into a better context. In each extract I have included a section of the paper unchanged, except for the nomenclature. The full references for each paper can be obtained from the Institute of Actuaries' website (http://www.actuaries.org.uk/).

Best estimates and centiles

In the context of reserving, where they may be a very wide range of possible final outcomes, an actuary is often asked to calculate or provide a 'best estimate'. It can be very important for companies, as well as having some understanding of the potentially material uncertainties, to also be able to adopt a specific number, not least so that they can submit accounts and other financials returns for regulatory purposes. As a profession we have contemplated what is, or should be meant by the term 'best estimate'. There follow two extracts from the 2007 GIRO paper 'Best Estimates and Estimating Uncertainty' (Gibson *et al.,* 2007) which discusses some of this debate. In the extract which follows the word 'losses' is used to mean the cost of claims.

Best estimates
What is an actuary's 'best estimate' of an outcome, for example, of ultimate losses?

> *It is her/his subjective derivation of the mean of all possible outcomes, taking into account all available information about the business being analysed.*

This definition allows for the subjective interpretation by the actuary of the available data and the choice of models and methods used. As a default it also excludes allowance for events not reflected in the data such as unanticipated major new types of latent claims, although in some cases it could be argued that all available information includes knowledge about the risk of such new claims potentially arising.

Subjectivity is included in the definition because it emphasises that even with a standard definition of 'best estimate' one would still expect different parties to produce different estimates. The uncertainty about the random process being estimated and the data provided gives grounds for different judgements to be made about how the future will unfold. Also, different actuaries may understand the 'available information' to include or exclude different matters. Therefore a variety of reasonable best estimates is possible, even with a common definition.

However, if the actuary diverges from the above definition then we would recommend that a detailed description be given, defining exactly what is being estimated. This should include comment on:

- Why the above standard definition is not being used in a particular instance and why an alternative definition is thought to be a more appropriate single

point estimate, 'best' summarising the true underlying random probability distribution. Other summary statistics which might be favoured include the mode and the median.

- Whilst the actuary's view of the mean of the whole distribution of all possible outcomes should not vary depending on the purpose of his or her work, the purpose may influence which areas of divergence from this complete mean may be acceptable or desirable. The actuary should therefore comment on the purpose of the best estimate and how this influences the choices made about what, if any, contingencies to exclude from the set of possible outcomes.

- How prudent, optimistic or pessimistic the estimate is intended to be. In this case it is preferable to define any deviation from the standard definition explicitly; for example 'The best estimate is the mean of the underlying distribution of the claims allowing for all possible outcomes, plus a margin of prudence.' (Giving reasons for the prudent stance).

- Whether unlikely outcomes are included or excluded (if excluded explain why). It is worth differentiating between remote events that are significant to a particular insurer and those that could cause significant proportions of the industry to collapse.

- Whether an attempt has been made to provide for latent events.

Mean versus median

There is sometimes a debate about whether best estimates should be means or medians. The mean definition of a best estimate accords with UK professional guidance in GN20 and it corresponds to equivalent definitions used internationally – albeit using different terminology (i.e. 'expected value estimate' of a reasonable provision in the US – ASOP 36 and 'central estimate' in Australia – PS300). It accords with the anticipated reserving requirements under Solvency 2 and IFRS.

The mean is arguably a more intuitive choice and it has the benefit that the expected average surplus equals the expected average deficit. That said some of our stakeholders may assume the best estimate is 'the midpoint', or that it is 'equally likely to be too high as too low', which indicates a median rather than a mean.

The US system, albeit using an 'expected value' terminology, does not necessarily require the actuary to anticipate future contingencies and so, if it is a mean, it is perhaps a mean of a distribution with some of the extreme tail removed. Given the typically skewed nature of distributions of ultimate claims outcomes, such an estimate may be nearer to the median of the whole distribution than the mean. This working party has come down in favour of the mean in this debate.

Centiles

In addition to providing best estimates to communicate the results of their work, actuaries sometimes provide information about more of the distribution of possible outcomes. They might present a graph which shows a part of the distribution of outcomes, they might provide a range to illustrate the scale of possibilities, or they may seek to communicate specific points on the distribution of possible outcomes by use of centiles. In reserving there is a distribution of possible outcomes for the final ultimate cost of claims. One can think of this distribution as being divided into 100 pieces or centiles, each with a 1% probability and each with a progressively higher potential ultimate claims cost. One can say there is a 50% chance that the eventual

outcome will be below the 50th centile (which is the median, as discussed in the extract above). There is 75% chance that the eventual outcome will be below the 75th centile, and so on.

In the discussion of risk based capital earlier I gave examples where we wished to have capital which would be adequate with a probability of 99.5%. This is equivalent to capital at the 99.5th centile. Actuaries can use centiles as a way of communicating the uncertainty in the outcome. This is potentially problematical because, even when the audience has an understanding of what centiles mean, evaluating these centiles is itself highly uncertain. Also, at the lower and higher tails of the distribution the statistical methods used to evaluate the centiles tend to break down, which is discussed elsewhere.[1]

Communication of uncertainty – absolute

In communicating their reserving estimates actuaries may often wish to give a description or discussion of the uncertainty in the reserves in absolute terms. This requires quantification and communication of uncertainty. There follow two extracts from a paper which deals with this area, the 2007 ROC paper, *Quantification and Reporting of Uncertainty for GI Reserving* (Jones, *et al.* 2007). In these extracts the word 'percentile' is used in place of 'centile':

Methods used to quantify uncertainty
There are, as yet, no universally accepted definitive methods for quantifying uncertainty in outcomes, so the actuary will need to use a degree of judgement when selecting the most appropriate approach for estimating uncertainty. GN12 is not prescriptive about the methods that should be employed by the actuary when quantifying uncertainty, however in one or some combination of the following approaches should normally be used:

- Judgemental/Indicative Volatility
- Scenario/Stress Testing
- Statistical Methods

A statistical methodology is not always appropriate and a judgemental approach based on the actuary's knowledge of the account and experience of the relevant wider market issues may be the most practical approach.

In choosing the approach to quantifying uncertainty the actuary may also have regard to the costs and benefits involved. For example an approximate judgemental method may in some circumstances be preferable to a complex sophisticated and time consuming statistical approach, whereas in other cases the latter may be more appropriate.

Practical approach to communicating uncertainty
This section discusses how the quantification of uncertainty in the overall result can be communicated. The numerical quantification of uncertainty will generally need two components corresponding broadly to size and likelihood. The size component is usually stated explicitly, and the likelihood component can generally be communicated in two ways:

- Everyday English

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- Percentiles

It may be helpful to note that Percentiles is a method of communicating uncertainty rather than a method of estimation i.e. the actuary could use a judgemental approach to quantify the reserve uncertainty and then communicate this uncertainty using percentiles.

If the actuary chooses to use percentiles to communicate uncertainty, he should be aware that the precise nature of this form of communication could be interpreted as implying that uncertainty has been quantified very accurately. If in fact the quantification is uncertain, then the actuary should be careful to counter any such mis-interpretation. It may be that Everyday English is a preferable way to communicate uncertainty when the quantification is based on significant areas of judgement. However, Everyday English runs a greater risk of ambiguity, and in some cases a combination of methods could be appropriate.

Overall therefore, the actuary should consider the appropriate choice between Everyday English, percentiles, or a combination when communicating uncertainty. When giving a range of outcomes the use of the terms 'high' and 'low' without explaining the meaning of these should be avoided, as the reader may draw erroneous conclusions regarding the degree of extremity of these points within the complete distribution of outcomes.

In some circumstances the actuary may wish to communicate outcomes in the tail of the distribution. In these cases, we believe that consistency in how we as a profession communicate with our stakeholders is important. With this in mind we suggest that the following standard vocabulary from Table 1 should normally be used, in the context indicated. However this does not preclude the actuary using additional alternative phraseology if it would assist the audience understand uncertainty better. The rationale for the wording in line 1 is that the dictionary definition of 'likely' is: 'probable, such as might well happen'. This has been applied to the 90 percentile, and the other percentiles graduated accordingly. For line 2 the dictionary definition of 'possible' is: 'that can happen'.

If the actuary wishes to communicate ranges with a different definition than suggested above then he will need to adapt the wordings suggested above as he sees appropriate. For example, if the actuary wanted to communicate say a 5% to 95% confidence interval then the phrase 'likely that the outcome will lie within this range' could be used.

In some circumstances the actuary may wish to communicate a narrower range, say for example a range which the actual outturn could well fall outside. In these circumstances wording of the form below could be used:

'The outcome is as likely to be inside the range as outside it, and is as likely to be above as below.

The actuary may want to combine the wordings for 'Below' and 'Above' and a Percentile communication approach, for example:

'Whilst it is fairly likely that the outcome will lie below this value, there is a reasonable chance that it could lie above. In statistical terms this equates to the 75th percentile, meaning that in my judgement there is a 75% chance that the outcome will lie below this value and a 25% chance that it will lie above.'

Table 1: Suggested standard vocabulary for communicating uncertainty in GI reserving

Indicative percentile	75%	90%	95%	99%
Wording 'below' percentile	Fairly likely that the outcome will lie below this estimate	Likely that the outcome will lie below this estimate	Very likely that the outcome will lie below this estimate	Extremely likely that the outcome will lie below this estimate
Wording 'above' percentile	Reasonable chance that the outcome could lie above this estimate	Possible but unlikely that the outcome will lie above this estimate	Possible but very unlikely that the outcome will lie above this estimate	There is a possibility, albeit remote, that the outcome will lie above this estimate

Source: Tony et al., 2007

Finally there may be circumstances where the actuary wants to communicate only the severity component of uncertainty. This would typically be because the actuary was unable or unwilling to take a view on the likelihood component. An example would be communicating the potential impact of a specific scenario, e.g. the outcome of a material legal dispute. In this case the uncertainty would be communicated in the obvious way - if lost then the financial impact would be £xm, and if won it would be £ym.

It should be noted that if the scenario approach is used in the quantification of overall uncertainty (as opposed to illustrating the causes of uncertainty as described above) then the actuary should consider carefully how the scenario has been incorporated in her best estimate. The potential issue is that if the actuary feels:

- unable to quantify the likelihood component then she should be clear how this has been incorporated into the calculation of the best estimate (which might for example involve calculating, at least conceptually the mean of the distribution of outcomes.)
- able to quantify the likelihood component, then arguably the scenario should not be treated separately, but incorporated into the overall likelihood/severity communication described at the start of this section

The actuary may also wish to have regard to the wordings suggested for communicating the impact of large losses, as set out in the advisory note on wordings for actuarial opinions and reserving reports - large losses (27 January 2006).

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Communication of uncertainty – relative

Actuaries may also wish to give a relative communication of uncertainty. When major loss events or potential causes of claims occur there is uncertainty for all insurance companies but some may have more exposure to this uncertainty than others. To assist companies, and their regulators and auditors, in understanding the relative uncertainty in the overall outcomes generated by certain issues, actuaries have developed an approach to ranking, by using particular 'wordings'. These have become an acknowledged 'code' in the industry allowing a range of readers of the opinions and reports of actuaries to gain a general sense of the relative impacts of key loss events or issues.

There follows an extract from the Faculty and Institute of Actuaries Advisory Note on Wordings for Actuarial Opinions and Reserving Reports – Large Losses (27 January 2006),[3] which sets out the professions approach, and which was referred to earlier (see Jones, *et al.,* 2007).

Wordings for actuarial opinions and reserving reports – large losses

This note considers the situation when there has been a major market loss or event (referred to here as a 'Large Loss') which readers of actuarial opinions and reports would be expected to be aware of, and might reasonably expect to see discussed by the actuary. Under GN20 additional comment is expected when the level of uncertainty is materially increased beyond the norm. This note is intended to be consistent with GN20. I here additionally consider the possibility that, while an event may not materially impact the reserve uncertainty for a particular company or syndicate, the actuary may feel it appropriate to comment on the event and its level of impact, as readers may expect and value a comment, given the scale of the loss to the market as a whole.

I have identified four possible wordings which an actuary may wish to adopt in various circumstances to describe his or her reserving work in relation to a particular Large Loss. The following options are all intended to be additional comments to be included in the Relevant Comments section of the SAO in these situations, and/or to feature in the commentary of a reserve report under GN12. In the SAO case, unless the intention is to qualify the opinion because of the Large Loss, they should all be followed by the statement that:

> *'These comments do not constitute a qualification of my opinion.'*

It should be recognised that for some syndicates or companies it may be appropriate to use different wording options for the different statements of opinion, or for commenting variously on gross, net, by underwriting year, division or other component.

Case 1:
If the syndicate or company is not or is only marginally exposed to claims from the Large Loss then there is no need to mention the Large Loss specifically in the statement of opinion or report. However, any actuary in this position who wishes to make it explicit that the matter has been considered and that it has been concluded that this is the situation may include the following as a Relevant Comment.

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Wording 1:

> *I am satisfied that the company/syndicate has no material exposure to the Large Loss.*

Case 2

If the syndicate or company has material exposure to the Large Loss but this is in classes where loss determination is relatively straightforward or where the uncertainty arising from particular issues (such as coverage disputes or the outcome of pending court cases) is not material in the context of the total level of reserves, then the following wording would be appropriate as a Relevant Comment.

Wording 2:

> *The company/syndicate has material exposure to the Large Loss. However, this exposure does not lead to a material increase in the uncertainty of the company/syndicate's total reserves [in an adverse direction].*

Case 3

If the syndicate or company has material exposure to the Large Loss and the loss determination is not straightforward, such that the Loss produces increased uncertainty in the overall reserves, but that the overall reserve uncertainty is not significantly more than the norm for the insurance liabilities of the company/syndicate at this stage of development, then the following wording would be appropriate as a Relevant Comment.

Wording 3:

> *The company/syndicate has material exposure to the Large Loss. This increases the uncertainty of the company/syndicate's total reserves, but does not increase that uncertainty [in an adverse direction] significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.*

Case 4

If the syndicate or company has material exposure to the Large Loss and the loss determination is not straightforward, such that the Large Loss produces increased uncertainty in the overall reserves to such an extent that the level of uncertainty for the total reserves of the company/syndicate is significantly more than the norm for the insurance liabilities of the company/syndicate at this stage of development, then the following wording would be appropriate as a Relevant Comment. It should be noted that, while auditors will of course form their own professional opinion, they might consider the use of a 'Wording 4' as equivalent to an accounting concept described as 'fundamental uncertainty', which is a way of drawing special attention to particular issues which could create uncertainty beyond normal levels.

Wording 4:

> *The company/syndicate has material exposure to the Large Loss. The ultimate amounts of these claims are subject to a great deal of uncertainty which, combined with their total size, increases the level of uncertainty for the total*

reserves of the company/syndicate significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.

Lessons for other industries

I do not pretend to have any expertise beyond my own field of the general insurance actuary. However, it seems likely that some of the themes which have emerged in dealing with uncertainty, risk and complexity in my profession may have wider applications, so I here set out a few thoughts which might be of interest to others.

Scope, purpose and audience

When dealing with complexity and uncertainty one needs to bear in mind the fundamental purpose of the work which has been commissioned. There may be areas of great professional interest which are not strictly relevant to the matter at hand. The purpose and the scope of work can be an excellent guide to the degree of complexity required. There may be pragmatic simplifications which are a sensible efficiency in some circumstances and a potentially problematical over-simplification in others.

When communicating about uncertainty one must bear in mind the starting point and perspective of the audience, not just in moderating and explaining and technical language, but also in seeking to address the likely areas of interest and importance from their point of view.

Common vocabulary and frame of reference

It may be helpful if the profession or industry can develop a common vocabulary and frame of reference. The general insurance actuaries are moving towards a common understanding of terms like best estimate, and have begun to develop frames of reference for communicating adverse outcomes in terms of probabilities and in other ways. The use of 'wordings' to address particular loss events or issues gives a wider audience some understood sense of the relative uncertainty generated by an issue. Whilst we are still developing our professional and industry practice in this area, the progress we have made to date appears to be useful to our insurance colleagues and has generally been well received.

Categorise and explain

It may be helpful to break down uncertainty into its key drivers or causes. This may assist in understanding how to mitigate the risks involved and hence in how plans should respond to these risk drivers.

In order to explain the types and drivers of uncertainty, particularly in the context of planning, it may be helpful to consider a range of potential adverse scenarios, much as insurance companies look at possible Cat events. By understanding the impact of adverse scenarios and the limitations of any mitigation steps, the plans will be more robust. Arguably the most important and informative plans scenarios are those which stress the risk mitigation steps to the point which they fail. Illustration of the uncertainty quantitatively may be difficult but useful.

No perfect models

No matter how sophisticated the model or the tool, how multi-faceted the underlying analysis to support the parameterisation, how many years of complete and robust data have been considered and how experienced the modeller, all models are only models. There will always be some contingency not allowed for by the model, or some nuance of interaction not fully understood. It is easy to become seduced by a model, and to believe everything it tells you. This over-confidence may lead to poor decisions.

No model is perfect – it will need to be rebuilt again soon when it next fails! Models need to be considered alongside other important inputs, such as experience and common sense. These two subjective resources can be thought of as more fluid models, constructed in the abstract and parameterised by the experience and capacity of the individual. These can be a lot more developed and sophisticated than their computer counterparts.

References

Gibson, Lis, *et al.* (2006) *Large Loss Advisory Note,* Faculty and Institute of Actuaries Advisory Note.

Gibson, Lis, *et al.* (2007) *Best Estimates and Estimating Uncertainty.* GIRO.

Jones, Tony*, et al.* (2007) *Quantification and Reporting of Uncertainty for GI Reserving.* ROC.