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ASPECTS OF PRICING IN THE LONDON MARKET

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ABSTRACT

Actuaries have become increasingly involved in general insurance, and, in particular, in the London Market. This paper examines the management of the pricing process in the context of the London Market, and deals with concepts such as profit testing, risk and reward, and setting underwriting targets. The key area covered is the communication of a strategy in a meaningful way that can be controlled at the operating level.

KEYWORDS

London Market; Reinsurance; Pricing; Profit Testing; Risk and Reward; Underwriting Targets; Asset Liability Management

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1. INTRODUCTION

1.1 This paper is centred on pricing in the London Market. The paper concentrates primarily on reinsurance business, but many principles still hold good in the writing of direct slip business.

1.2 The paper is addressed primarily at actuaries working (or wishing to work) in the London Market. It may also be of interest to other actuaries and to underwriters and others involved in the London Market. In particular, the authors welcome comments from underwriters and managers of London Market operations on the principles set out in the paper.

1.3 The actuary in life assurance has extended his reserving skills to the pricing of the product, and, ultimately, to the designing and management of the risks through techniques such as profit testing. The actuarial management of the business is maintained through concepts such as the control cycle. The role of the actuary has developed along this route mainly because of the nature of the business; a large number of uniform risks, the majority of which need little or no technical underwriting. These skills have been readily transferred to general insurance in the case of mass markets, as has been ably demonstrated in respect of motor insurance and household property insurance. These specific areas are very much akin to life insurance, in that there are also large numbers of uniform risks which need little or no technical underwriting, and rates can be put down in a rating manual.

1.4 Contrast this with London Market or commercial insurance risks. The risks are not uniform, there is no real rating structure, and each policy is generally individually underwritten. The London Market is also a subscription market, where an underwriter needs to price a contract at such a rate as to attract other underwriters to sign up to a share of the risk. This market is clearly different to those in which actuaries have traditionally been involved. Outside of this, the London Market was one of the first to recognise and need the skills of the actuary, particularly in establishing claims reserves. It is, therefore, not surprising to see the role of actuaries in that market being expanded to one of pricing. The London Market is one of the most complex and varied insurance and reinsurance groupings anywhere, and, accordingly, is a fertile area for new imaginative techniques.

1.5 Using a profit test as an example, this paper aims to give some insight which will help bridge the gap between the actuary's traditional technical discipline and the practical and commercial problems of the market. Communication is as important in general insurance as in any other branch of actuarial work, and this is particularly so in the case of pricing in the London Market.

1.6 It is not the purpose of this paper to concentrate on basic pricing in the sense of estimating the likely loss cost on a particular risk. There is already available a substantial number of good quality papers covering the basic techniques, details of which are given in the references. The more technical aspects are contained in the appendices, and these give a flavour of the contents of some of the other references.

1.7 The main elements of underwriting management may be considered as follows:

— the establishment of long and short-term strategies for the business, such strategies having reference to the capital available, customer base, skills of the business and so on;
— continual testing and refining of the strategy, and, in particular, establishing bases for assessing exposures of capital and the control of such exposures;
— communicating the strategy by converting it into plans which have meaning and can be controlled at the operating level;
— implementation of the plans by the underwriter at the risk level, allowing first for control of exposure (and hence the capacity to underwrite) and then profitability; and
— monitoring and feedback of the results to the various levels.

The paper centres on the third of these elements. The first and second elements are not covered. Appendix 1 concentrates on supporting the underwriter at the risk level for profitability, and not on the control of exposures. The use of capital is discussed only in general terms. Feedback and monitoring are outlined in Section 6, and in Section 7 there are some further considerations relating to the underwriting of risks.

2. BASIC PRICING

2.1 The process of pricing, in general, involves the estimation of two parameters, or distributions. The first parameter is the expected number of claims which may hit the contract, typically called frequency. This may be considered as a number of claims, in the case of working layers (i.e. those which pay claims regularly), or as event return periods for catastrophic events. The second parameter is the expected claim size of events relating to the treaty being underwritten, typically called severity. The rate is then obtained by multiplying the two expected values, or, in more sophisticated cases, by convoluting the process, whereby the distribution of expected number of claims (or return period) is multiplied by the likely cost related to that number, and the total added up to achieve the rate. In the past the convolution was achieved by analytical formulae and integration, but, nowadays, it is more easily achieved by the use of standard risk-modelling add-on packages to spreadsheets.

2.2 This process should be compared with, for example, motor rating, where each risk has prescribed characteristics which are used in a (normally additive) rating table to obtain the rate. In the reinsurance market there are no standard rating factors. There are standardised tables which may be used as benchmarks, but these benchmarks often have unknown origins, which may be totally unrelated to the risks involved. It is one of the tasks of the actuary to suggest and research suitable distributions for use in practice, often based on scarce data.

2.3 The major problem is, therefore, assessing the distributions of claim numbers and claim amounts, and hence their expected values. This, in itself, can be very problematic. Let us suppose that the risk involved covers high layer losses of a type that has previously not been experienced, in other words there are no data and no real benchmarks. Suppose, further, that the data in the lower layers exhibit a Pareto distribution with parameter 1.7 (this is the distribution parameter for the famous 80/20 rule). To extrapolate the data on the assumption that the rare events will also follow the same distribution may seem reasonable, but the variance in the parameter estimation will give rise to a range of likely outcomes which, when applied to the return periods, produces a significant potential deviation in the price.

2.4 Given that there are problems in estimating the individual parameters, the role of the actuary in the pricing may be considered as a technical assistant to the underwriter. The actuarial role in pricing of individual risks may be summarised as follows:

— To establish systems to check, where there are sufficient data, that the rates charged conform with recent past experience, together with changes in policy conditions, recent legislation and underwriting trends. This is the traditional role undertaken by actuaries in what is described as pricing. Given the nature of the risks in the London Market, this type of role is somewhat limited. An underwriter may put his name to a substantial number of risks in any period,

and review many more which are not underwritten for a number of reasons (inadequate price, inadequate reward for the risk, too capital intensive, unbalances the portfolio, and so on).

— To establish systems to create a framework within which individual risks could be evaluated to see if they fall within the acceptable risk/reward criteria. This is beyond the traditional formula-based pricing activity.

2.5 It is imperative that the pricing/underwriting objectives fall within the company's overall objectives. These are usually formalised when a corporate plan is prepared, setting out the direction of the company over the planning horizon. The plan may consider the type of business the company wishes to write and the capital required to support that business. Certain underwriting results, after expenses, would be required from the business written, which, together with any investment income, should be sufficient to provide the required return on the capital and to generate sufficient surplus to meet any growth targets included in the plan.

3. Risk and Reward

3.1 In an ideal world, the profit loading on each contract written should reflect the marginal contribution it makes to the risk of the company's total portfolio of business. A stochastic asset/liability modelling (ALM) exercise should be performed on the company's portfolio, with and without the newly arriving contract. Using its pre-set risk-willingness criteria, the company can compute the marginal extra capital required to support the new contract, and the marginal contribution to profit that the contract should make.

3.2 Stochastic ALM is a very sophisticated tool with heavy computation requirements. Some of the monoline catastrophe underwriters in Bermuda calculate prices on this basis. However, the current state of capability for a multiline London Market reinsurance company is to apply stochastic ALM at line of business level only. It would use stochastic ALM to investigate the risk and reward of different strategies at a portfolio level, for example, choices of mix of business, retrocession purchasing strategies and suitable asset mixes.

3.3 Having chosen a suitable overall strategy, the company is then in a position to assess the marginal capital required to support each line of business within that strategy and the contributions to the company's total profit target required from each line. Typically, this would be calculated by performing a stochastic ALM exercise, splitting the company's portfolio into no more than 20 or 30 revenue centres, chosen to reflect existing underwriting accountabilities. This would normally be carried out in detail only once a year, as part of the normal business planning process in autumn, prior to the renewal season of 1 January, which dominates the finances of so many London Market companies. The output parameters from the exercise, capital requirement and profit target for

each line of business, would probably stay fixed for the next year, unless there were substantial changes in circumstances.

3.4 The allocation of the line of business profit target down to individual contract level then takes place on a more approximate basis. The output from the underlying rating calculation, itself, can be used to assist in this process. The simplest approach is to take the risk premium for each contract, i.e. the expected cost of claims before any loadings, and decompose it into an expected frequency and an expected severity (average claim cost). The shape of the probability distribution of these components is either known from the rating process or else an assumption must be made. Popular assumptions, in practice, are the Poisson distribution for claims frequency, and either the Pareto or the Log-normal distribution for claims severity. Then the level and distribution of expected claims across all the contracts in the line of business can be modelled, using a standard risk-modelling add-on package to a spreadsheet. The variability of the claims cost of the individual contract relative to the variability of the claims cost of the line of business is used as the basis for setting the profit load required from the contract.

4. PROFIT TESTING

4.1 The output from the stochastic ALM work is a set of profit targets, both at line of business level and at individual contract level. These need to be converted into underwriting targets that can readily be used by underwriters. The central tool is the profit testing calculation, and this can be carried out at several different levels:

— individual contract level;
— line of business level; and
— whole company level.

4.2 The technique of profit testing is routinely used in the life insurance industry, but less frequently in general insurance and reinsurance. There may be many reasons for this apparent lack of use. For instance:

(1) the focus may be on determining the expected loss cost and its variability, which is normally less problematic for life business than for reinsurance business; and
(2) general reinsurance business is typically not as long term as life, which tends to reduce the importance of reserving strain.

This is of particular relevance to Lloyd's syndicates, where, despite having long-term liabilities, the annual structure of the syndicate and Lloyd's accounting policy tend to discourage any matching of assets to liabilities, at least with reference to mean term.

4.3 Investment income is a significant part of the total insurance result, and hence taking account of all cash flows caused by the insurance transactions in a

profit test is very valuable, both for pricing individual pieces of business as well as for business segment studies. In Appendix 2 an example of such a profit test is developed for application to general reinsurance. The application that is considered is the evaluation of a block of business, for instance a territory or a class of business.

4.4 A profit test should carry out a present value calculation of all cash flows and reserve movements caused by the considered business, and subsequently compare this present value against the required risk weighted target return on capital where this return is expressed in consistent units, for example £ or $. A list of the cash flows to consider for general reinsurance would include:

— premiums receipts;
— claims payments;
— external acquisition costs;
— internal expenses of management;
— outwards reinsurance costs;
— potential reinsurance recoveries;
— technical reserves on a statutory basis (i.e. undiscounted, or discounted at a fixed rate, as appropriate);
— investment income on technical reserves and capital base; and
— capital base allocation.

4.5 By making assumptions about investment returns, setting the return on capital to the target one, and subsequently solving for the ultimate loss ratio, it is possible to compute an implied maximum target loss ratio for the business segment under consideration.

4.6 Finally, by varying the parameters over which the reinsurer has some control, e.g. acquisition costs, expenses, outwards reinsurance costs and capital base allocation, one can study the effect on profitability of writing varying premium volumes for a business segment, and the effects of using different allocation bases for these parameters. For example, writing a larger book of business for a certain line normally results in reduced profitability for the extra volume, it affects retrocession costs and capital allocation, and often reduces the management expense ratio. A profit test can study the compound impact of all these changes.

4.7 In all the analyses proposed above, it is also of fundamental importance to study the sensitivity in the resulting answers. One can often learn just as much from studying the sensitivity in the profit to interest rate or loss ratio assumptions as from the actual computation of the profitability.

4.8 A description of a typical profit test table and some sensitivity tests that may be applied are set out in Appendix 2. Further applications of the approach, including profit testing in a stochastic framework, may be found in Sanders *et al.* (1995).

5. Target Underwriting Ratios

5.1 The profit-testing calculation considers all the cash flows from the underwriting operation, as well as reserve movements and capital flows. It can use a sophisticated array of discount rates chosen to reflect the risk or variability of the different items. The final output is a target underwriting ratio that has been calculated on a trial and error basis to produce the target return on capital from the earlier stochastic ALM work. This underwriting ratio is the ratio between claims plus direct acquisition costs and premiums. The figures in this ratio are neither revalued for inflation nor discounted for the time value of money. On the surface it would appear to be a relatively unsophisticated ratio, but it has the strong merit of containing the three major financial items that are under the direct day-to-day control of the underwriter, and with which he feels familiar.

5.2 In essence, the profit-testing calculation is the translation mechanism between the complex financial theories of risk and reward, and the real world of the premiums and claims figures as actually carried around in brokers' slip-cases and the London Market's centralised processing systems. The actuary will not prosper in the London Market unless he is willing to talk the two languages interchangeably, and to adapt his dialect to his audience.

5.3 This principle has a strong application in the case of communicating underwriting targets with the underwriters and senior managers. Since these targets will form the basis by which their financial contribution to the company will be judged, they will naturally wish to understand as much as they can about the main drivers behind the results of the calculations. They will most likely not find the profit-testing calculations the most appetising route to comprehension, and, in practice, the tabular style of layout, set out in Table 1, has been found to be an effective means of communicating the results.

Table 1. Underwriting target table

	Property risk	Property cat	Casualty short-tail	Casualty long-tail	Marine
UCB = Underwriting capital base	35.00	100.00	45.00	80.00	60.00
ROI = Return target	15%	15%	15%	15%	15%
PMR = Profit margin required	5.25	15.00	6.75	12.00	9.00
IIC = Investment income credit	6.00	12.00	14.00	40.00	10.00
TOR = Target operating ratio	100.75	97.00	107.25	128.00	101.00
Retro XL cost	3.00	12.50	1.00	1.00	5.00
Expenses	5.50	8.50	7.00	8.00	7.50
TUR = Target U/W ratio	92.25	76.00	99.25	119.00	88.50

Note : all numbers, except return target, are expressed as a percentage of premium

5.4 The figures in Table 1 are for the purposes of illustration only. All results are expressed as percentages of premiums, not because they have been calculated

that way, but for convenience. They represent suitable extracts from the proper profit-testing calculation. They also have the appearance of being laid out in the order of calculation, although this is not the case in practice. The target operating ratio (TOR) is the correct figure derived from the solution to the profit test, and the profit required (PMR) is the output target profit amount from the original stochastic ALM exercise, divided by the premium. The investment income credit (IIC) is then the balancing item between the PMR and (100 minus TOR). It is derived in this table only for the purpose of illustration to underwriters. The IIC bears a strong relationship to the present value of investment income earned by the underwriting year, although it is not identical. Interestingly, it is the balancing item between an undiscounted number (TOR) and the true present value of all cash flows and reserve movements (PMR). The items underwriting capital base (UCB) and target return (ROI) are also generated in this table to give the appearance of multiplying together to produce the true PMR. The UCB figure will bear a strong relationship to the marginal capital required to support each line of business.

5.5 Table 1 then represents the translation mechanism between the profit test and the underwriter. The actuary is concerned to ensure that the TOR and the PMR figures correctly represent the results of highly technical calculations. The underwriter can also follow the logic of the table:

— UCB times ROI gives PMR;
— (100 minus TOR) plus IIC gives PMR; and
— TOR less expenses less retro cost gives TUR.

The manager will note that the TUR contains those financial items (direct acquisition costs, claims costs and premiums) which are under the direct day-to-day control of the underwriter, and that, if he plans his portfolio to meet this target, then he has contributed appropriately to meet the company's overall return on equity targets.

5.6 The above structure can be applied at any level, either line of business or individual contract, where a separate profit test has been carried out. Its application in a pricing calculation is straightforward. Suppose that you have a property risk excess of loss treaty to price, where you have assessed the risk premium at 2.32% of subject gross net premium income (GNPI). Suppose that the applicable commission rate is 10%, and you are using the portfolio level profit target without splitting it down to individual contract level. Then the target underwriting ratio of 92.25% gives a target loss ratio of 82.25% and a fully loaded premium rate of (2.32%/0.8225) = 2.82%. Suppose that the cedant's GNPI is £25 million and that the reinsurer's share of the treaty is 15%, then it is helpful to lay this information out in a format similar to Table 2, which separates out the components of the premium.

5.7 In any particular renewal situation, the premium offered is unlikely to be exactly equal to the loaded premium calculated. In this case it is necessary to distinguish between a quotable rate, which is the risk premium loaded according

Table 2. Profit target

Premium rate		2.82%
GNPI		25,000,000
Share		15%
Premium	100.00%	105,775
Risk premium	82.25%	87,000
R/I cost	3.00%	3,173
Expense load	5.50%	5,818
IIC	–6.00%	(6,347)
Profit target	5.25%	5,553
Commission	10.00%	10,578

to the company's profit targets, and the quoted rate, which is the premium on offer. Suppose that the quoted rate is 2.95% of GNPI. Then the expected profit outcome is as set out in Table 3.

Table 3. Profit outcome

Risk premium	2.32%
Target underwriting ratio	92.25%
Commission	10.00%
Quotable rate	2.82%
Quoted rate	2.95%
GNPI	25,000,000
Share	15%
Premium (100%)	110,625
Risk premium	87,000
R/I cost (3.00%)	3,319
Expense load (5.50%)	6,084
IIC (–6.00%)	(6,638)
Cost of capital	5,553
Commission (10%)	11,063
Extra/(less) profit	4,244

The phrase 'profit target' has been replaced by the phrase 'cost of capital'. In this example the loadings have been applied to different items. The loadings for reinsurance cost, expenses, investment income credit and commission have been applied to the new quoted rate. The loading for cost of capital has been applied to the original quotable premiums, in the belief that this item depends more strongly on the underlying cost of claims.

5.8 On the surface the acceptance decision for this treaty is straightforward — the price quoted generates more profit than the required cost of capital. In practice it is likely that the cedant is offering you a share of several treaties across more than one line of business, or the broker is bringing you a whole portfolio of business across the year. Some of the contracts on offer will be well priced, some less so. With the output from the pricing calculations shown above, the underwriter is in a strong position to negotiate on prices and shares to enhance his total return from the packages on offer.

6. RESERVING, MONITORING AND FEEDBACK

6.1 *Reserving*

6.1.1 The reserving process may be considered as the periodic evaluation of the underwriting performance. The reserving process makes use of the known information (paid claims, incurred claims, exposures, written or signed premiums, for example) together with assumptions about the unknown (future claims levels, inflation, future claims payment patterns, estimated ultimate loss ratio). The actual development of claims is then tracked against the assumptions used to determine the reserves, and the assumptions are modified in the light of the variation in the experience from that hypothecated by the reserving process.

6.1.2 When no historic credible data are available, the reserving process effectively starts with the plan (or some similar) assumptions. The reserves should be based on up-to-date premium estimates, current paid and incurred loss ratios compared with those assumed for the plan for the period, and allow for the future expected development patterns of premiums, paid losses and incurred losses. The development patterns may be based on the company's own experience for previous underwriting years, adjusted for any available market statistics.

6.1.3 If the actual reported losses are adverse compared to the expected losses, the adverse movement may be investigated in more detail to determine scope for further deterioration, and the plan (and actual) reserves may be strengthened accordingly. This type of reserving process is recognised in the London Market, for example the Bornhuetter-Ferguson method, or regression type approaches (Benjamin - Eagles).

6.1.4 In the reserving process, more up-to-date information becomes available at both the individual risk and the portfolio level. This information may help shed light on movements in any risk factors used in the pricing process. Information may become available on how the historic years are materialising, and if any marked changes have occurred in premium receipt and loss development patterns. For example, changes in terms of trade may mean that premiums are being collected quicker, and thus any reliance on loss ratio development in assessing the reserves will need to take this into account. In addition, in analysing loss movements, further information will become available in respect of specific individual large losses, or losses by regions or for individual reinsureds.

6.1.5 In some instances such matters may be discussed extensively with the underwriters, so that they become more aware of how the business written in recent years is performing and may be factored into future underwriting decisions. For example, if a specific region is prone to heavy, but infrequent, losses, then the presence of a significant loss will lead to the reassessment of the pricing process for that region, or may lead to a decision to withdraw capacity because of the inability of the insureds to generate the necessary level of premium to support both the normal losses and the cost of the reinsurance cover.

6.2 *Monitoring Variances in Underwriting Targets*

6.2.1 The actual experience will be monitored against the underwriting targets. The variance will need to be analysed in detail and explained, so that the information can be used both to reassess the likely outcome for the current year's plan and to factor this variance into future plans.

6.2.2 As more up-to-date information becomes available about the market conditions, terms of trade and the business actually written, it may be possible to draw conclusions from this information about how the current year is likely to materialise.

6.2.3 New information about losses from the current year and historic years will become available from the reserving process described above. In addition, more up-to-date information about outwards reinsurance costs and expenses will become available, as well as any changes in exchange rates and investment returns.

6.2.4 Efficient collation and use of such information, as it becomes available, not only gives advance indication of the potential profitability of the year as a whole, but also gives information as to the validity, or otherwise, of the assumptions made in the planning and pricing models. This enables any significant changes in the underlying assumptions to be considered immediately and reflected in subsequent pricing decisions.

6.2.5 Such information would also enable the company to take corrective measures relating to types and levels of business to be written and to achieve more effective control and use of scarce capital resources.

6.3 *Early Warning Systems*

6.3.1 In the process of monitoring the difference between the planned underwriting targets and the actual outcomes, information on various risk factors, which are likely to have an impact on the business development, will be collected. The use of the information from the reserving process, combined with effective management information systems, should give early advance indicators about favourable or adverse developments. The use of this information should enable the management of the company or the syndicate to achieve the business development in a controlled environment.

6.3.2 Some of the risk factors which would be closely monitored as part of this process include the assessment of aggregate exposures, rates of premium growth, trends in loss ratios and reasons for any adverse movements, effectiveness of the reinsurance program, trends in expense ratios and acquisition costs, and investment returns. Comparisons of the rate level, from year to year, of risks renewed over a period of time, give indications as to the level of comparable premiums from year to year, and hence give indications of changes in loss ratios on a consistent basis.

6.3.3 Effective management information systems would enable such risk factors to be analysed and tracked at a detailed constituent level, so that the effect of the changes at individual class/risk level can be assessed, as well as the combined effect on the business as a whole.

6.4 *Feedback Loops to Underwriters / Senior Managers*

6.4.1 The actuary would, of necessity, talk to the underwriters/claims staff about the experience of a class at a portfolio level, or of individual risks, in order to understand the business, so that the reserving process can be made more effective. When exploring adverse movements, the actuary will gain an insight into the underlying risk factors which may need to be incorporated into any pricing models. The actuary can also give the underwriters useful information at the portfolio level, so that the underwriters can better appreciate the effect of their underwriting decisions on the financial results.

6.4.2 For the best insight into this process, it is better to review the reserving process in the same light as the pricing process. The pricing process is often a combination of two factors, namely an expected number of claims (or distribution thereof) and an expected loss value (or distribution thereof). Data for reserving are often given solely as a claims or loss ratio development. In many circumstances, splitting the claims into the two components will give a better insight. The combination of the two elements may hide opposite trends in the underlying data (for example more claims at a lower level), which may have a significant impact on future pricing and the management of the risk.

6.4.3 Any sophisticated pricing models, incorporating various risk factors and financial considerations, may assist the underwriters in identification of the obviously good and bad risks, so that they can focus on the more difficult and complicated risks. The actuary can also assist the underwriters with the larger risks which have significant financial impact and where a different perspective may be useful and help justify (or not) underwriting the risk.

6.4.4 The actuary will also be involved at the macro level, in investigating the business experience and presenting actuarial reports on such experience to the senior managers. At such presentations the actuary may report on variances against the business plan, the reasons for the variances and any corrective measures (if any) required to refocus on the plan. The senior management meeting may also address longer-term strategy issues on capital allocations, return on equity, levels and classes of business to be pursued, effective resource management, investment and taxation matters, cash flow management and dynamic solvency, all of which will involve actuarial input to varying degrees.

6.4.5 The actuary is well positioned to participate at both micro and macro levels, since he has the relevant skills and knowledge. What is important is the need to communicate effectively at both levels, and, in particular, to have the approval of the underwriter when presenting his findings to the senior management of the business.

7. Other Underwriting Considerations

This section covers topics such as determining the underwriting targets, balancing the portfolio of business and individual risk selection. It concludes with comments on the underwriting cycle.

7.1 *Setting the Underwriting Targets*

7.1.1 The underwriting targets may be discussed and agreed when the corporate plan is prepared. The targets may be broad in terms of premium income, target loss ratios and target operational ratios for the business units, or they may be more detailed in terms of units of risks within a class of business in a given territory.

7.1.2 The targets may be constrained by limits on aggregate exposures, which may be determined in the light of the company's outwards reinsurance programme. There may also be limits on risk size for an individual risk groups of risks, or exposure to a given reinsured.

7.1.3 It is important to make full use of the available capacity to achieve, not only immediate targets, but also to develop longer-term relationships with the reinsureds for their mutual benefit. An adequate return needs to be made in relation to the risks accepted, without penalising the reinsured for an exceptional bad experience.

7.1.4 The underwriter will have an understanding of the portfolio of business he has written in terms of the risk profile of the business. An analysis of the portfolio by the number of risks and programme of risks with a given reinsured should be undertaken, and should indicate how that programme has behaved over the past and is continuing to behave. Such portfolio analysis may be carried out periodically at a detailed level to identify the significant risk exposures. There is a need to consider the cost and benefit of such detailed analysis in relation to future profitability.

7.1.5 The detailed portfolio analysis at periodic points will enable the underwriter to consider the current shape of the portfolio and the desired shape of the portfolio, in order to meet his underwriting targets. In this context, it is also important to consider the current security rating of the reinsured, in order to take a view as to the continued existence of the reinsured in the foreseeable future. The underwriter will, effectively, be building a portfolio which is expected to be durable and profitable over the longer period.

7.2 *Balancing a Portfolio*

7.2.1 It is a fundamental concept of insurance business to spread the insurance risk over a large portfolio of insureds to obtain some stability and predictability to the emerging losses. It is, therefore, important to ensure that any insurance operation has a large and diversified portfolio of risks, both within each class and over the whole company. Against this is the constraint that the number of such risks needs to be correctly underwritten and managed.

7.2.2 The underwriting targets at the corporate plan level will attempt to balance the portfolio at the highest level to achieve a desired risk/reward trade off. At a business class level, a portfolio analysis will highlight the current risk profile and the desired risk profile in the future. In this context, the underwriter will be concerned with the benefit of diversification compared to the potential cost of diversification from additional resources required to service that portfolio.

Conversely, a fewer number of risks, well researched and costed, may well generate less volatility.

7.2.3 The risk profile and the balance of a portfolio could be investigated by the formulation of a model office for the classes of business which are currently being written. The model office will include specimen policies representative of the portfolio, and can attempt to simulate losses for those policies on a range of assumptions. The model can be expanded to incorporate various assumptions associated with the insurance operation. The effect on the stability of changing the risk profile can be investigated. A balanced portfolio is one where the aggregate expected losses are stable over time, and do not demonstrate excessive volatility.

7.2.4 The concept of the model office can, in fact, be significantly expanded to model the company as a whole. In this case all the constituents, such as assets, expenses and investment returns, can also be incorporated within the model office. The model office would then consider the volatility of the emerging profits on current conditions and perform various scenario tests to determine the effect on the profitability and the solvency position, on different sets of assumptions.

7.3 *Risk Selection*

7.3.1 In selecting an individual risk, the underwriter may use techniques such as those described in Appendix 1, but, ultimately, he will exercise judgement on whether the risk contributes towards his overall underwriting targets.

7.3.2 The underwriter will be constrained by what risks are presented to him. This will depend on his standing in the market and the perception of his company's image and security rating. If the underwriter is considered a lead underwriter, then his past performance may well be under regular scrutiny. In order for a programme to be fully subscribed by the market, the lead underwriter's rating has to be respected and acceptable to the following underwriters.

7.3.3 An individual risk will be selected, not only because it is adequately technically priced, but also whether it falls within the general underwriting strategy and underwriting authority. Typical considerations are:

— the limits of liability;
— aggregate exposure by territory (including world wide);
— any potential impact on the outwards reinsurance treaty;
— the annual premium income limits set by his board;
— the minimum premium limits per risk; and
— the minimum rate on line.

7.3.4 One of the aims will be to develop and maintain a long-term relationship with the reinsured. In any business, it is more expensive to generate new business than to renew existing business. The underwriter will, therefore, wish to select those reinsureds who are likely to be profitable, show good risk management skills and are expected to survive the peaks and troughs of underwriting cycles.

7.3.5 A group of policies with a given reinsured should be considered, to ensure that the overall returns from these policies are adequate. Good use of underwriting capacity to write catastrophe business can be made by leveraging this against other classes of business relating to the reinsured. There are also other considerations, such as :

— *Exclusivity of risk.* Commercial judgement needs to be made when considering certain risks. For example, a higher percentage line may be taken with the intention of keeping the risk exclusive. A 100% line may be written with the intention of preventing competitors having access to the risk. Writing at a 75% level will open the door to other insurers, and could readily result in the signing down of the risk, as well as a potential loss of information.

— *New line of business.* When presented with a new or unusual line of business, an underwriter may initially accept a small line in order to gather the underlying experience before fully committing himself.

— *High profile risks.* A high profile risk may be underwritten for reasons of prestige.

— *Cross subsidy within a risk.* A lower rate for a particular layer is accepted to access a more attractively priced layer in the same programme. In this case it is the overall combined profit that is important.

7.3.6 Finally, pricing is as much of an art as a science. It is important to ensure that all the technical aspects are fully explored and correctly costed. However, ultimately, the skills of underwriting may be in understanding in depth qualitative information relating to the nature of an individual risk and the quality of the reinsured, and in negotiating the best price for the risk.

7.4. *Managing the Underwriting Cycle*

7.4.1 Underwriting cycles are caused by the actual underwriting experience and the perception of how that experience is expected to develop over the next few years. As a result of adverse claims experience the capacity for writing new business diminishes, putting upward pressure on rates. Then the ensuing hard market leads to a period of profitability, attracting new capital and capacity to the market, which, in turn, puts a downward pressure on the rates. The extent of rigidities in the ability to increase rates or to attract new capital affects the degree to which the cycles are extended and accentuated.

7.4.3 The underwriting cycle is not very smooth. In particular, when premium rates become such that future solvency of the market may be jeopardised, then rates increase in discontinuous spikes. This is particularly apparent after a catastrophe occurs, or following a sustained period of losses following a decline in rates. This process is difficult to model, and is a natural consequence of a market with external controls and influences.

7.4.4 As for predicting the cycles, the reinsurance cycles may precede the insurance cycles. The extent of the availability and cost of reinsurance may affect

the rates that insurers can charge the primary insureds. Conversely, the demand for insurance may be affected by the economic climate. Thus, the supply and demand for reinsurance is very difficult to forecast.

7.4.5 Therefore, managing the underwriting cycle may be less concerned with forecasting the cycles accurately, and more concerned with the ability of the company to respond flexibly, speedily and profitably to an eventuality falling within a reasonably acceptable range of scenarios.

7.4.6 In order to achieve this, the company may consider the likely economic climate and market trends over the foreseeable future, and take a view about a range of expected market conditions. It is possible that different conditions may be expected for different segments of the market (e.g. by class of business or territories). The company would then consider a range of business strategies appropriate to the range of expected scenarios.

7.4.7 A detailed audit of the company's resources and capabilities will enable the company to identify any needs in terms of capital or resources to adopt a given strategy, and to be in a position to respond to changes in market conditions.

7.4.8 Thus, managing the underwriting cycle is about being in a state of preparedness to respond to a given change in market conditions within an expected range of scenarios. The extent of the analysis carried out internally and externally, and the flexibility of the organisation structure to respond to a given change, would differentiate between the companies which are able to survive and prosper in the current competitive climate of global reinsurance and the companies which are not.

8. The Role of Actuaries in Pricing

8.1 This paper has illustrated some aspects where the actuary could be involved with the underwriting process. The clear issue for this involvement is whether there is a potential benefit to the business. There are clearly mixed reactions to this type of involvement, particularly if the actuary is considered for the underwriting role. It is important to note that actuaries have progressed to underwriting different lines of business, both in the United States of America and in Continental Europe.

8.2 The skills of the actuary and underwriter are complementary. It is the opinion of the authors that the pricing actuary should be a member of the underwriting team which is led by the underwriter. The actuary has considerable technical skills. Appendix 1 deals with those skills by illustrating the calculation process for the technical rate for the risk. Having computed this rate, the underwriter inputs his skills, which take into account market conditions, handling negotiations with brokers, and so on. The skills required in the underwriting process include:

— risk selection and assessment;
— product design (coverage, terms and conditions);

— treaty wording and legal skills;
— contract negotiation with cedant or broker;
— questions of balance of portfolio; and
— longer-term strategy.

8.3 The crucial point is that underwriters must first have confidence in the actuary, so that he will utilise those skills. For this condition to hold, actuaries certainly need to understand the underlying business and have a working knowledge of the various contracts. This extends to the standard policy wording, the slip details and market conditions.

8.4 Of the factors affecting the future exposure change, the risk management features of the account need to be understood by the actuary in order to translate from the historic loss experience (and any collateral data employed in the rating) to the new exposure period being assessed. Experience in this process could be gained by the actuary spending a portion of his training period in the underwriting room, assisting in the day-to-day underwriting.

8.5 A by-product of this training strategy would be that the trainee would be in a position to add considerable value to the continuing reserving process of the account. The role of the chief executive of a London Market operation often doubles up as the chief underwriter, and if actuaries harbour aspirations to achieve such a status in the future, then it is essential that they have a sound grasp of the day-to-day operations in the underwriting room and the difficulties that underwriters have in pursuing their objective of writing profitable business. Actuaries cannot achieve this goal while pursuing a purely technical reserving role.

8.6 As actuaries become more involved in this role, there is potential for a conflict between the pricing and reserving roles, not least if the remuneration is contingent on the performance of a specific account. There is a clear need for professional guidance, with the possibility of divorcing the actuarial pricing and reserving roles. Such a separation between sales and control is very common in other financial service industries.

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APPENDIX 1

A SUMMARY OF RATING METHODOLOGIES

A substantial volume of literature is already available on the basic techniques. In this appendix, we shall only illustrate the techniques most commonly used in practice, and refer the reader to more detailed texts.

A.1.1. *Risk Excess of Loss Treaties (Risk X/L)*

A1.1.1 *Experience rating*

(1) *Introductory remarks*

Experience rating (or burning cost) is an intuitively appealing approach to pricing, taking into account, as it does, the cedant's past loss history in trying to estimate future losses to a layer. In theory, it can be used for any class of business where there is an adequate loss history, but it is, perhaps, most often used in practice to price commercial fire, motor and liability business. It is also frequently used to price medical malpractice business.

(2) *Basic recipe*

The following is an example of how a layer might be priced using experience rating. The FGU (full ground up) development of the cedant's large claims for a number of past years of account is obtained. 'Large' claims would typically mean claims which do, or are likely to, impact the layer to be priced; the reinsurer's reporting requirement might typically be for all losses, with an incurred equal to 50-75% of the deductible, after allowing for any indexation clause. (Note: development may not be available by individual claims, only on an aggregate basis). The development is adjusted for an appropriate measure of claims inflation to the period to be covered and for any changes to, for example, policy wordings, business profile, claim size and frequency; in market jargon, it is reworked on an 'as if' basis.

The ultimate for each loss in each year is then estimated using appropriate methods, for example, a traditional triangulation method might be used, with tail factors and market statistics applied where the development available is inadequate. Having adjusted the loss development for IBNR, it can be applied to the layer to be priced to produce an estimate of the ultimate losses to the layer for each year under consideration.

Next, the premium in each year of account is projected to ultimate and inflated to the period of cover, allowing for any changes in coverage, past rate inadequacy, appropriate sum insured inflation, etc. The estimated ultimate loss ratio, or perhaps, more frequently, the burning cost (equal to the loss cost to the layer, the burn, divided by the original cedant's premium) to the layer for each year can then be calculated, a suitable average selected, and loadings added for

the reinsurer's expenses, to get to the indicated rate, per unit of direct premium written.

(3) *Illustrative example*

Risk excess of loss
Casualty burning cost rating example
250,000 xs 250,000
Allocated loss adjustment expenses covered pro rata to loss.

For each accident year, each loss is adjusted on an 'as if' basis for both indemnity and expenses, for an appropriate measure of claims inflation, to the period to be covered; for example, consider 1991 accident year, 4 years after the start of the accident year.

Table A.1.1

Loss	Reported indemnity (1)	Reported expenses (2)	Inflation factor (3)	Adjusted indemnity (4)	Adjusted expenses (5)	Indemnity+ expenses (6)
1	500,000	50,000	1.464	732,000	73,200	805,200
2	450,000	45,000	1.464	658,800	65,880	724,680
3	325,000	24,000	1.464	475,800	35,136	510,936
4	300,000	7,000	1.464	439,200	10,248	449,448
5	240,000	11,000	1.464	351,360	16,104	367,464
Total	1,815,000	137,000		2,657,160	200,568	2,857,728

An appropriate method is used to estimate loss development factors to ultimate, and hence to estimate the ultimate value of each loss, for each accident year under consideration; for example, by using a triangulation of the adjusted losses from Table A.1.1.

Table A.1.2

Accident year	Development year				
	3	4	5	6	7
1990	2,277,920	2,961,295	3,858,565	4,784,620	5,980,775
1991	1,793,420	2,510,790	3,422,050	3,909,755	
1992	1,567,855	2,353,285	3,136,930		
1993	1,754,203	2,857,923			
1994	3,855,907				

For each accident year under consideration, the adjusted losses are increased by the appropriate factor to ultimate, and then each loss is put to the layer to be

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Table A.1.3

Accident year	Development year 3–4	4–5	5–6	6–7	7-ult
1990	1.300	1.303	1.240	1.250	
1991	1.400	1.363	1.143		
1992	1.501	1.333			
1993	1.629				
1994					
Average	1.458	1.333	1.191	1.250	
Selected	1.500	1.333	1.250	1.225	1.200
Cumulative	3.674	2.449	1.838	1.470	1.200

Table A.1.4

Loss	Adjusted indemnity (7)	Adjusted expenses (8)	Develop factor (9)	Est ult indemnity (10)	Est ult expenses (11)	Indemnity in layer (12)	Pro-rata expense (13)	Total in layer (14)
1	732,000	73,200	2.449	1,792,952	179,295	250,000	25,000	275,000
2	658,800	65,880	2.449	1,613,656	161,366	250,000	25,000	275,000
3	475,800	35,136	2.449	1,165,419	86,062	250,000	18,462	268,462
4	439,200	10,248	2.449	1,075,771	25,101	250,000	5,833	255,833
5	351,360	16,104	2.449	860,617	39,445	250,000	11,458	261,458
Total	2,657,160	200,568		6,508,414	491,269	1,250,000	85,753	1,335,753

Table A.1.5

Accident year	Adjusted subject premium (15)	Adjusted losses in layer (16)	Indicated loss rate (17)
1990	10,000,000	2,657,892	26.6%
1991	12,000,000	3,125,000	26.0%
1992	14,500,000	4,125,036	28.4%
1993	17,000,000	1,335,753	7.9%
1994	19,000,000	2,501,420	13.2%
Total	72,500,000	13,745,101	19.0%
Average			20.4%

(18) Indicated loss rate	20.4%
(19) Reinsurer loading (say)	100/80
(20) Exposure premium per unit of cedents direct premium	25.5%

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priced to calculate the loss in the layer; for example, the 1993 accident year is set out in Table A.1.4.

The subject premiums are then adjusted to current premium levels, for example, for changes in rate adequacy and changes in exposure, and then used to calculate the exposure premium.

(4) *Practical considerations*

In theory, experience rating requires a statistically significant historical loss development to be available for the cedant, and, as such, is much more suited to working layers of an X/L programme. In practice, there can be other sources of loss development, for example ISO development factors in the U.S.A., so full cedant FGU data might not be needed. ISO does a lot of work on development factors within layers, and, when pricing U.S. X/L, it may not be necessary to work with full FGU losses, but simply to work with losses to the layer. Consideration must be given to losses below the deductible, and how ISO and similar development factors cope with the losses, which are currently incurred below the deductible, that might still impact the layer in the future. Loss adjustment expenses must be allowed for appropriately, depending on whether they are included with the loss to be put to the layer, or are allocated on a pro-rata basis.

A.1.1.2 *Curve fitting*

(1) *Introductory remarks*

A method which is not dissimilar to experience rating, but, instead of using the FGU data directly, a curve, often Pareto, is fitted to the FGU data, and rates are derived by reference to the fitted curve. The data required are very similar to those required for experience rating, in particular, the cedant's FGU data for large claims are needed, where 'large' claims are defined as before. It is a method which can be used for both property and casualty business, and is often used for hospitals' medical malpractice in the U.S.A.

Much work has been carried out on the single parameter Pareto. This simplification arises if the FGU data are normalised, by dividing each loss by the observation point, the size below which losses are not included in the FGU data used. This paper does not repeat the derivation of the various formulae quoted, but the interested reader is referred to, in particular, Philbrick (1985) and the reading list included therein.

(2) *Basic recipe*

FGU data are obtained from the cedant for the past few years, perhaps five or six years, for losses which satisfy the reporting requirements for the layer to be priced (i.e. losses in excess of the observation point). These data are projected to ultimate to obtain an estimate of the IBNR. This can be done after fitting the curve. Although claims inflation has a more marked effect on frequency of losses in the layer, rather than the average claim size in the layer, it is generally better

to adjust the loss data to a common point in time. Philbrick (1985) argues that the Pareto described in his paper does not require that the original loss data be adjusted for claims inflation before fitting the curve, but this only holds if the Pareto fitted is a good fit for all claims above a lower observation point in earlier years, that point being the current observation point adjusted for inflation.

Next, the adjusted data are normalised by dividing each loss by the observation point, and then fitting a one-parameter Pareto by estimating the shape parameter. This can be done, for example, by maximum likelihood, and Philbrick (1985) gives the appropriate formula:

$$\alpha = n / \sum_1^n \ln X_i$$

for α fitted by maximum likelihood, where n is the number of losses in the observed FGU data and X_i is the size of the (normalised) ith loss. If α is the Pareto parameter, U is the upper limit (or censorship point), R is the retention of the layer to be priced and OP is the observation point, then the expected loss size in the layer is calculated as:

$$R(1-(U/R)^{1-\alpha})/(\alpha-1) \qquad \alpha \neq 1$$

$$R\ln(U/R) \qquad \alpha = 1.$$

Having fitted a curve for severity, one must then consider frequency. A distribution for frequency, typically Poisson, might be assumed, and the parameter(s) estimated from the data. The number of losses in excess of the observation point is estimated for each accident year under consideration, then divided by the exposure, for example the original cedant's premium adjusted to date on an 'as if' basis, to estimate the frequency above the observation point for each accident year. However, for frequencies, an increase in claims inflation and in claim sizes due to the development of a loss, both tend to increase the frequency of losses to the layer. Therefore, these frequencies must be adjusted by $(1+i)^{n\alpha}$, where i is an appropriate measure of claims inflation, α is the Pareto parameter and n is the number of years between each accident year and the year to which frequencies are being projected.

A 'suitable' averaged or trended value is selected from the adjusted observed frequencies, and an estimated number of losses in excess of the observation point is calculated, using (an estimate of) the exposure for the year to be priced. This frequency then needs to be adjusted to get to the frequency of losses in the layer to be priced, i.e. losses exceeding the retention. This is done by multiplying the projected frequency of losses in excess of the observation point (OP) by $(R/OP)^{-\alpha}$.

Having fitted a curve and calculated the expected claim cost to the layer and the expected claim frequency to the layer, the actuary should then consider both

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Table A.1.6

Accident year t	Loss	Amount (1)	Inflation adjustment (2)	Inflated amount (3)=(1)*(2)	IBNR factor (4)	Estimated ultimate (5)=(3)*(4)	Normalised (6)=(5)/25000	Log (7)=ln(6)
1992	1	37,775	1.469	55,504	1.00	55,504	2.220	0.798
1992	2	17,365	1.469	25,515	1.00	25,515	1.021	0.020
1992	3	27,121	1.469	39,850	1.00	39,850	1.594	0.466
1992	4	58,196	1.469	85,509	1.00	85,509	3.420	1.230
1992	5	20,328	1.469	29,869	1.00	29,869	1.195	0.178
1992	6	17,564	1.469	25,807	1.00	25,807	1.032	0.032
1993	7	392,477	1.360	533,961	1.30	694,149	27.766	3.324
1993	8	23,167	1.360	31,518	1.30	40,974	1.639	0.494
1993	9	19,918	1.360	27,098	1.30	35,228	1.409	0.343
1993	10	128,396	1.360	174,681	1.30	227,086	9.083	2.206
1993	11	19,123	1.360	26,017	1.30	33,822	1.353	0.302
1993	12	21,872	1.360	29,757	1.30	38,684	1.547	0.437
1994	13	19,870	1.260	25,030	1.80	45,055	1.802	0.589
1994	14	33,324	1.260	41,979	1.80	75,562	3.022	1.106
1994	15	25,293	1.260	31,862	1.80	57,351	2.294	0.830
1994	16	75,335	1.260	94,900	1.80	170,821	6.833	1.922
1994	17	80,735	1.260	101,703	1.80	183,065	7.323	1.991
1995	18	84,648	1.166	98,733	2.30	227,087	9.083	2.206
1995	19	32,556	1.166	37,973	2.30	87,339	3.494	1.251
1995	20	30,373	1.166	35,427	2.30	81,482	3.259	1.182
1995	21	408,062	1.166	475,964	2.30	1,094,716	43.789	3.779
1995	22	37,335	1.166	43,548	2.30	100,159	4.006	1.388
1996	23	60,388	1.080	65,219	2.90	189,135	7.565	2.024
1996	24	947,030	1.080	1,022,792	2.90	2,966,098	118.644	4.776
1996	25	422,180	1.080	455,954	2.90	1,322,268	52.891	3.968
								36.842

Pareto parameter = $(^{25}/_{36.842}) = 0.679$

of these estimates for reasonableness, and it will often be useful to get the view of the underwriter.

(3) *Illustrative example*

Risk excess of loss

Observation point	=	25,000	Claims inflation	=	8%
Excess	=	50,000	Upper limit	=	100,000.

(4) *Practical considerations*

Care must be taken, especially in extrapolating to layers beyond that for which data are available. As a general rule of thumb, this method should not really be used to extrapolate to losses in excess of three times the deductible of the layer for which data are available to fit the Pareto in the first place. The choice of α is especially crucial when extrapolating to a higher layer, and only a small change in α can have a very marked effect on the risk premium.

to adjust the loss data to a common point in time. Philbrick (1985) argues that the Pareto described in his paper does not require that the original loss data be adjusted for claims inflation before fitting the curve, but this only holds if the Pareto fitted is a good fit for all claims above a lower observation point in earlier years, that point being the current observation point adjusted for inflation.

Next, the adjusted data are normalised by dividing each loss by the observation point, and then fitting a one-parameter Pareto by estimating the shape parameter. This can be done, for example, by maximum likelihood, and Philbrick (1985) gives the appropriate formula:

$$\alpha = n / \sum_1^n \ln X_i$$

for α fitted by maximum likelihood, where n is the number of losses in the observed FGU data and X_i is the size of the (normalised) ith loss. If α is the Pareto parameter, U is the upper limit (or censorship point), R is the retention of the layer to be priced and OP is the observation point, then the expected loss size in the layer is calculated as:

$$R(1-(U/R)^{1-\alpha})/(\alpha-1) \qquad \alpha \neq 1$$

$$R\ln(U/R) \qquad \alpha = 1.$$

Having fitted a curve for severity, one must then consider frequency. A distribution for frequency, typically Poisson, might be assumed, and the parameter(s) estimated from the data. The number of losses in excess of the observation point is estimated for each accident year under consideration, then divided by the exposure, for example the original cedant's premium adjusted to date on an 'as if' basis, to estimate the frequency above the observation point for each accident year. However, for frequencies, an increase in claims inflation and in claim sizes due to the development of a loss, both tend to increase the frequency of losses to the layer. Therefore, these frequencies must be adjusted by $(1+i)^{n\alpha}$, where i is an appropriate measure of claims inflation, α is the Pareto parameter and n is the number of years between each accident year and the year to which frequencies are being projected.

A 'suitable' averaged or trended value is selected from the adjusted observed frequencies, and an estimated number of losses in excess of the observation point is calculated, using (an estimate of) the exposure for the year to be priced. This frequency then needs to be adjusted to get to the frequency of losses in the layer to be priced, i.e. losses exceeding the retention. This is done by multiplying the projected frequency of losses in excess of the observation point (OP) by $(R/OP)^{-\alpha}$.

Having fitted a curve and calculated the expected claim cost to the layer and the expected claim frequency to the layer, the actuary should then consider both

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cedant direct. The retention plus the limit for the layer are then expressed as a percentage of each of the direct limits in the same way. The former can be thought of as the proportion of each policy limit being retained by the cedant, and the latter less the former as the proportion of each policy limit which falls in the layer to be priced.

The next step is to choose appropriate values from Ludwig's table of cumulative loss amount distributions, depending on the class of business and type of coverage being priced, for each of the percentages already calculated. For each direct policy limit, the difference between the Ludwig values, multiplied by the direct premium for the limit, gives the expected value of the exposure premium for the limit falling into the layer being priced.

This exposure premium must then be adjusted for:

— the portion of the direct premium in respect of losses;
— the loss adjustment expenses to be allocated;
— any premium inadequacy;
— reinsurer's expenses; and
— the absolute amount of direct premium projected to be written by the cedant to get to a final exposure premium rate, per unit of direct premium written by the cedant.

For a casualty treaty, the method would be similar, but would use ILFs instead of Ludwig values.

(3) *Illustrative examples*

Example A

Property exposure rating example
Homeowners (non catastrophe) wind loss 150,000 xs 50,000
Allocated loss adjustment expenses covered pro rata to loss.

Table A.1.8

Policy limit	Subject premium	Retention as % of pol limit	(Retention + limit) as % of pol limit	Value from Ludwig curve for (3)	Value from Ludwig curve for (4)	Exposure premium ((6)-(5))x(2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
100,000	4,000,000	50.00%	200.00%	0.980	1.000	80,000
300,000	3,000,000	16.67%	66.67%	0.951	0.986	105,000
500,000	2,000,000	10.00%	40.00%	0.934	0.976	84,000
750,000	1,500,000	6.67%	26.67%	0.892	0.966	111,000
1,000,000	2,000,000	5.00%	20.00%	0.871	0.959	176,000
2,000,000	750,000	2.50%	10.00%	0.860	0.934	55,500
Total	13,250,000					611,500

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Table A.1.9

(12)	Exposure premium, prior to loadings	611,500
(13)	Times portion of subject premium for losses	0.6
(14)	Times allocated loss adjustment expense loading	1.05
(15)	Times adjustment for subject premium inadequacy	1.1
(16)	Times reinsurer loading	100/80
(17)	Indicated exposure premium	529,712
(18)	Divided by subject premium	13,250,000
(19)	Final indicated exposure per unit of cedant's direct premium	0.04

Example B

Casualty exposure rating example
700,000 xs 300,000
Homeowners (non catastrophe) wind loss
Allocated loss adjustment expenses covered pro rata to loss.

Table A.1.10

	Policy limit	Subject premium	Limited average severity	Increased limit factors	Excess factors	Exposure premium
	(1)	(2)	(3)	(4)	(5)	(6)=(2)*(5)
	300,000	2,000,000	63,962	1.563	0.000	0
	500,000	2,000,000	74,884	1.830	0.146	292,000
	750,000	1,000,000	83,417	2.039	0.233	233,000
	1,000,000	2,000,000	89,356	2.184	0.284	568,000
	2,000,000	500,000	103,173	2.522	0.246	123,000
Total		7,500,000			0.162	1,216,000

Table A.1.11

(7)	Exposure premium, prior to loadings	1,216,000
(8)	Times portion of subject premium for losses	0.75
(9)	Times allocated loss adjustment expense loading	1.15
(10)	Times adjustment for subject premium inadequacy	1.10
(11)	Times reinsurer loading	100/80
(12)	Indicated exposure premium	1,442,100
(13)	Divided by subject premium	7,500,000
(14)	Final indicated exposure per unit of cedant's direct premium	0.19228

(4) *Practical considerations*

Exposure rating can be a useful tool, in particular in circumstances where little or no historical loss information is available, so that an experience rating approach cannot be used. It can also be combined with experience rating into a credibility type approach to pricing a layer of X/L. Clearly care is needed in the

use of, for example, the Ludwig tables, or in the derivation of ILFs, to make sure that they are appropriate to the coverage being priced.

In an ideal world, excess of loss reinsurance rating should be a combination of both experience rating and exposure rating. The rates under the different approaches are unlikely to be the same, and the question remains of what weights are to attach to what methods. This issue is addressed in Patrik & Mashitz (1990).

If both exposure and experience rates have been successfully estimated and they differ, then there is a clear question of which to use. If the book has changed dramatically over a period of time, then experience rating will be meaningless. If the future exposure is likely to have changed, then the exposure rate is in doubt. In practice, the rate lies between the two.

A.1.2 *Catastrophe Excess of Loss Treaties*

A.1.2.1 *Introductory remarks*

The available methods depend crucially on the information available, which varies widely from territory to territory. Current best practice is that the cedant and/or broker will be able to supply the output from a computer simulation package, where engineering or meteorological estimates of the frequency and intensity of the underlying peril (e.g. earthquake, windstorm) have been applied on a simulation process to the details of the cedant's current exposed aggregate. These packages are readily available 'off the shelf' on a commercial basis for most U.S. earthquake and hurricane exposures, for United Kingdom wind and flood exposures, and for some Caribbean and European windstorm exposures. We are also aware that tailor-made studies have been commissioned on a private basis for many other natural peril exposures around the world.

It is of interest that the so-called developed territories are often worse at providing aggregates information on a regular basis than those territories which are less well developed. Some markets have a tariff rate for primary cover which may be used. The question as to its adequacy may arise. For example, the rates for earthquake cover in Turkey were set by the Government on the advice of a leading reinsurer, so may be felt to be reliable. Conversely, primary cover in Puerto Rico did not include any significant allowance for hurricane losses prior to Hurricane Hugo, because information from prior hurricanes had fallen out of the ISO data base, because they occurred more than 20 years previously.

A.1.2.2 *Aggregate-based methods*

(1) *Basic recipe*

The target perils and zones needs to be detemined. The cedant provides the aggregate exposure for the key zone, or zones, and perils. The return periods and damage degrees for natural perils of different severities and for different risk types are determined, using research undertaken by meteorological experts, construction engineers, and so on. The pure premium is then calculated for the excess layer as [damage degrees exposed] times [aggregate exposure]. Finally,

secondary perils are rated, e.g. fire following earthquake, tsunami, business interruption, workers compensation, and so on.

(2) *Points in practice*

Care must be exercised over the reliability of, and sensitivity to, the underlying return period and damage assumptions. The choice of key zone is also problematic, especially for windstorm exposures, but also for earthquake. For instance, the impact of an earthquake in Mexico is very difficult to model. This is because Mexico City is built on landfill, surrounded by mountains, which amplifies the earth's movements; a quake falling in this mountainous area will, therefore, cause a higher degree of damage to the city than at its epicentre. The 1985 earthquake had its epicentre in the Pacific. The premium is independent of market and cedant rates.

The need to understand original coverage, co-insurance and deductibles make the practical application very difficult.

A.1.2.3 *Loss-based methods*

(1) *Basic recipe*

Historic loss amounts are obtained in respect of specified events. These are revalued for inflation, and adjusted 'as if' for changes in the portfolio/exposure. Return periods are assigned to the specified catastrophic events, a curve is fitted (typically a version of the Pareto) to give specified relative frequencies to other losses, and 'ghost' events and return periods outside historical experience are added.

(2) *Illustrative examples*

'90A' for U.K. wind

Typhoon 19 Mireille for Japanese wind.

(3) *Points in practice*

A common problem can be rating for *one* event only. There is the need to recognise that two or more events are possible. Some lower layer catastrophe covers are effectively second loss policies.

A.1.2.4 *Simulation/modelling methods*

(1) *Basic recipe*

Cedant exposure split by postcode, prefecture, etc. is first obtained. A distribution of events is determined with data either from external consultancies or an internal R&D department. This will need frequency and severity components, together with an implied damage ratio for each severity. A 5,000 year simulation (say) is run. It is better to use stratified rather than random sampling to cope with the rare events. A good example is the Latin Hypercube sampling used by 'Crystal Ball'. Monte Carlo simulation does not have this feature, and could lead to underpricing. The average and standard deviation (and

possibly higher moments) of losses to the layer concern are determined.

(2) *Illustrative example*

These can be found, for example, in Christofides *et al.* (1992).

Very complex and subjective modelling is necessary. Packages can be bought in the marketplace.

(3) *Example*

Historically, in the U.S.A., the following procedure was used.

The total wind exposed premium was established. This was a percentage of total premium varying by line, e.g. 25 to 30% for homeowners or $7\frac{1}{2}$ to 10% for auto or property damage. A 20% PML was applied. This gave the attachment point for a reasonable catastrophe programme for which a rate on line of 20 to 25% would be charged. Higher layers were then priced at around two-thirds of the previous layer, and experience adjustments were made.

However, following the 1989 Hurricane Hugo loss, rates increased dramatically. This led to pressure from carriers who were less exposed to refined pricing methods.

Proprietary simulation packages are now widely used. This, at a standard level, runs off the income split by state, but enhanced versions use a county or even zip code breakdown. The results cover wind and earthquake exposure, but an additional load needs to be made for other perils, such as riot, flood and terrorism, or additional coverages, such as workers' compensation or business interruption.

A.1.3 *Proportional Treaties*

(1) *Introductory remarks*

Traditionally, the attitude of 'follow the fortunes' meant that the only pricing decision was how much over-rider commission to add to the cedant's original commission. In recent years, poor underlying performance and growing recognition of the unlimited nature of the cover and the extent of natural perils exposures have led reinsurers to make their own assessment of the total reinsurance commission affordable, independent of the original commission. This section will use a property proportional example to illustrate the ideas, then discuss the application to other lines of business.

(2) *Basic recipe*

(1) Split the exposure into three separate components:
   — basic loss cost (ordinary losses);
   — large individual fire losses (peak losses); and
   — catastrophe/event losses (natural perils losses).

(2) The basic loss cost may be priced using normal burning cost/experience rating methods, as follows:

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(a) Take the 100% cost of claims to the treaty for the last 5 or 10 years, and subtract peak and natural perils losses above a certain level, to obtain the experience of ordinary losses.
(b) Put the historic experience onto an 'as if' basis of the current exposures, e.g. adjusting for changes in primary underwriting terms and conditions, changes in portfolio mix and any other appropriate factor.
(c) Revalue the experience to reflect claims inflation and changes in primary rates.
(d) Take a suitable average or trend of historic experience, to arrive at an expected basic loss cost for the forthcoming treaty year.

(3) For peak losses, a suitable deductible is chosen. The cost of claims below this level falls into the basic loss cost. The cost of exposure to claims above this level should be priced using normal risk X/L methods, e.g.:
(a) Obtain a risk profile.
(b) Use a loss curve to apportion the original premium to exposures above and below the deductible.
(c) If a risk profile is not available, you may be able to use a Pareto curve extrapolation of the recent large loss history, but this is less satisfactory.
(d) The upper limit is equal to the treaty maximum sum insured.

(4) Catastrophe losses should be priced using a normal X/L method of rating, suitable to the risk and territory concerned:
(a) The choice of deductible will depend on the territory and peril. Sometimes the cedant will only report natural perils losses above a certain amount, e.g. minor snow/freeze losses in the U.K., minor typhoons in SE Asia. Sometimes the cedant will report all losses, and the peril should be rated from the ground up.
(b) The upper limit can be chosen as the event limit if the treaty is capped, otherwise treat as an unlimited treaty.
(c) If the cedant is using cession limits, the reinsurer needs to be very confident of the basis before using this as a pricing cap.
(d) Then use normal aggregate or loss-based methods, consistent with rating X/L exposure in the same territory.
(e) Often there will be a tariff in the territory for the natural peril concerned, e.g. earthquake in Turkey, and the primary premium will be split between natural peril and fire premium, with different commission scales. The reinsurer should obviously make himself aware of the source of the tariff, and in the spirit of proper pricing be prepared to take a different view.

(3) *Illustrative example*

The separate components of basic loss cost, peak loss cost and natural perils

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cost are all calculated using similar techniques to those shown in the excess of loss sections.

(4) *References for further reading*

LIRMA (1994) gives a clear exposition of the principles, and a long worked example. Munich Re (1990), covers other topics as well, but shows, in great detail, the degree of information reinsurers should ideally require from cedants.

(5) *Points in practice*

Underwriters now find that, given the information requirements and the variety of techniques involved, pricing a proportional treaty is often harder than pricing an X/L treaty.

Other issues include variable commission scales, loss participation clauses (LPC) and loss corridors, event limits (c.f. cession limits), and the cash flow mechanics of different types of commission scale.

A.1.4 *Use of Simulation Methods*

(1) *Introductory remarks*

This approach is used for calculations in the following circumstances:

- special treaty conditions depending on the aggregate amount of losses:
  - aggregate deductibles;
  - reinstatement premiums;
  - sliding scale commissions on pro-rata treaties;
  - sliding scale premiums on risk X/L treaties ('swing rates'); and
  - profit commission;

- treaties with special coverages depending on the aggregate amount of losses:
  - loss corridors;
  - loss participation clauses;
  - covers with aggregate annual limits; and
  - total loss only covers.

(2) *Basic recipe*

The loss cost is assessed for the ordinary cover without the special conditions, using the normal techniques. The ordinary loss cost is split into separate components of frequency and severity. Suitable distributions are assumed for each of these components, e.g. Poisson for frequency and Pareto or Log-normal for severity. Using this model of the loss cost, a simulation of the result of, say, 1,000 years of experience of the coverage with the special conditions included using, say, the @RISK add-on package. Care should be taken over the treatment of expense and profit loadings. Then the amount of loading on the original

premium is calculated. This should be a cash amount addition to special premium, not a percentage loading.

(3) *Illustrative example*

Suppose you have a cover £0.5m xs £0.5m, where the ordinary loss cost (before loadings) is 1.15% of GNPI of £100m, i.e. you expect about 4 to 5 losses to hit the layer, and the cedant asks you to quote for the cover with an annual aggregate deductible of £1m.

Assuming that the exposure is per risk only with no event exposure, then re-express the premium basis as:

(a) expected frequency of 5.0 losses p.a. to the layer, modelled as having a Poisson distribution; and
(b) severity is Pareto with alpha of 2.3.

Table A.1.12

		Treaty A Incurred loss ratio	Treaty B Incurred loss ratio
Year 1		82%	58%
Year 2		68%	72%
Year 3		80%	60%
Year 4		28%	112%
Year 5		92%	48%
Mean		70%	70%
Standard deviation		25%	25%
BC xs	70%	8.8%	8.8%
	80%	2.8%	6.4%
	90%	0.4%	4.4%
	100%	0.0%	2.4%

These parameters might come directly from the original rating calculation. If they are not available, for example, because an experience method was used, it is probably instructive to estimate them from the data as a first check of the result. Then it is very simple to model the cover with the deductible in @RISK, which shows the new loss cost is £0.34m, i.e. the credit for the deductible is £0.81m, i.e. 81%. If the original loadings for expenses and profit had been (100/75), i.e. 33%, the new premium should be loaded with £0.38m (33% of £1.15m), not £0.11m (33% of £0.34m). For simulating catastrophic events, alpha stable (Lévy) distributions are being considered as possibilities.

A.1.5 *Stop-Loss Treaties*

(1) *Introduction*

Burning cost techniques are not to be used, as illustrated by the example given by Table A.1.12.

The mean and standard deviation are the same, but the skewness is different.

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The historic burning cost may also equal zero. Each treaty needs special consideration, and it is hard to create standard approaches. It is vital to understand the FGU exposures and the structure of rest of reinsurance programme, i.e. which other covers inure to benefit of stop-loss cover being rated. It is also necessary to decide if the cover to be rated is being bought as a frequency or a severity cover.

(2) *Basic recipe*

A probability distribution is fitted to the aggregate of total claims amounts. This probability distribution is used to calculate the loss cost on a mathematical basis, i.e. integration of the probability of claim times amount of claim to the layer.

Ideally, distributions should be created separately for both frequency and severity of the underlying primary experience, but 'as if' historical loss-ratio experience is sometimes all that is available.

(3) *Illustrative example*

Consider a medium size specialist U.K. insurer seeking a stop loss on its household and small business property account. The natural perils losses were subtracted from the experience of the last 20 years. Once the residual experience was revalued, it was quite clear that there was an underlying cycle. Instead of taking the plain arithmetical standard deviation, the variability about a suitably modelled trend was assessed. This was used to model an expected trend loss ratio for underlying claims and variability around the trend.

The catastrophe exposure was modelled separately, using a loss-based method giving a distribution of return periods for events of different sizes,

The two separate distributions were combined using @RISK, which allowed the pricing any desired stop-loss cover.

(4) *References for further reading*

See Benktander (1974).

(5) *Points in practice*

Care must be taken over treatment of expense and profit loadings.

In excess of loss reinsurance rating, only 5 years of statistical information are normally used. In stop loss, a much longer period is needed, desirably 20 to 25 years. It is preferable to have covers where the fluctuation comes from the claims side and not the premium side, e.g. hail or windstorm.

APPENDIX 2

PROFIT TESTING

A.2.1 *The Profit Testing Table*

A.2.1.1 Set out in Table A.2.1 is an example of a profit test table. This is intended to establish the basic ideas for the discussion of individual items in Section A.2.2. It should be realised that there are many different ways of designing the table. In particular, in the example, Table A.2.1 shows cash flows as percentages of ultimate premiums, and a natural alternative would be to show them as amounts. Indeed, this may be more natural if the profit test is used for the business planning purposes.

Table A.2.1. Sample profit testing table

1. Development year	1	2	3	4	5	6	7
2. Gross premium	50.0%	25.0%	25.0%	0.0%	0.0%	0.0%	0.0%
3. External acquisition costs	–5.0%	–2.5%	–2.5%	0.0%	0.0%	0.0%	0.0%
4. Expenses	–5.0%	–2.5%	–2.5%	0.0%	0.0%	0.0%	0.0%
5. Net retro cost	–1.0%	–0.5%	–0.5%	0.0%	0.0%	0.0%	0.0%
6. Paid claims	–15.0%	–15.0%	–18.7%	–15.0%	–7.5%	–1.9%	–1.9%
7. Net U/W revenue	24.0%	4.5%	0.8%	–15.0%	–7.5%	–1.9%	–1.9%
8. PV at rsv disc net U/W rev	23.6%	4.3%	0.7%	–13.5%	–6.6%	–1.6%	–1.5%
9. PV at rsv disc end year liab	–18.2%	–22.5%	–23.2%	–9.7%	–3.1%	–1.5%	0.0%
10. End yr liab, valued at rsv disc each year	–18.8%	–23.9%	–25.4%	–10.9%	–3.6%	–1.8%	0.0%
11. Fund b/f	0.0%	24.7%	23.9%	25.4%	10.9%	3.6%	1.8%
12. Interest on net rev and fund	0.7%	1.6%	1.5%	1.1%	0.4%	0.2%	0.1%
13. End yr borrowing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
14. Interest on borrowing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15. Realised profit/loss, valued at 31/12 of year	0.0%	6.9%	0.7%	0.5%	0.2%	0.1%	0.0%
16. Fund c/f	24.7%	23.9%	25.4%	10.9%	3.6%	1.8%	0.0%
17. PV realised profit/loss	0.0%	5.2%	0.5%	0.3%	0.1%	0.0%	0.0%
18. Capital base (CB)	60.0%	2.4%	2.5%	1.1%	0.4%	0.2%	0.0%
19. CB injection/release 1/1 each yr	–60.0%	57.6%	–0.1%	1.4%	0.7%	0.2%	0.2%
20. Interest on CB	5.4%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%
21. Tot cash flow from CB	–54.6%	57.8%	0.1%	1.5%	0.8%	0.2%	0.2%
22. PV tot cash flow from CB	–47.5%	43.7%	0.1%	0.9%	0.4%	0.1%	0.1%
23. PV net U/W revenue	23.3%	4.1%	0.6%	–12.2%	–5.8%	–1.4%	–1.3%
24. PV end year liability	–15.9%	–20.0%	–20.6%	–8.4%	–2.6%	–1.3%	0.0%
25. End year liab, valued at 31/12 of each year	–16.8%	–22.5%	–24.6%	–10.6%	–3.5%	–1.8%	0.0%
26. Extra tech reserve (ETR) 31/12 each yr	1.9%	1.4%	0.8%	0.3%	0.1%	0.0%	0.0%
27. ETR injection/release 1/1 each yr	–1.9%	0.5%	0.6%	0.5%	0.2%	0.1%	0.0%
28. Total cash flow from UW & CB	–54.6%	64.7%	0.8%	2.1%	1.0%	0.3%	0.2%
29. PV total cash flow	–47.5%	49.0%	0.5%	1.2%	0.5%	0.1%	0.1%
30. Total PV of cash flow	3.9%						

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'PV' in the table stands for present value at 1/1 of development year 1, and a realised profit or loss is revalued at the return on investment required from the insurance operations. The return on investment used in the example is 15%.

A.2.1.2 The underwriting cash flow, resulting in a net underwriting revenue, cannot simply be revalued at the same rate of interest as profits, as premiums are not available for writing new business again until the corresponding claims have been paid. Instead, they are put in a technical reserve, which is typically invested at a lower, less risky, interest rate, often close to the long bond yield of the currency of the book considered.

A.2.1.3 In many cases, regulatory concerns or company policy decisions prevent the reinsurer from using even a risk-free rate for the discounting of the technical reserves, and a very conservative rate is used instead, or no discounting at all takes place. The discounting interest for the technical reserves in the example is 3% p.a.

A.2.1.4 There are several interesting issues arising from the choice of interest rate on technical reserves, most of which are beyond the scope of this paper. However, it deserves to be mentioned that many companies with technical reserves predominantly invested in equities would still choose to use a low-risk/risk-free, notional, discounting interest rate. It is unusual for London Market companies to invest technical reserves in equities, and such investment in other insurance companies is limited to free reserves or long-tailed liabilities as an hedge against inflation. A choice of low discount rate is logical, as long as the performance is measured against the risk-weighted capital allocated to the insurance operations, since the insurance result on capital should not gain from profits produced by taking investment risks. Indeed, such risks need to be backed up by a capital base of their own, and their viability/return assessed against such capital. For example, a company that would choose a higher interest based on equity investments would thus also have to increase the capital base and/or the return requirement. In the example profit test, a nominal interest rate on technical reserves of 6% p.a. was chosen. Investment expenses are assumed to have been taken into account in aiming at this choice of rate.

A.2.1.5 The final aspect of interest rates needed to be brought up is the case where the cash flow generated by the business does not generate enough funds to finance the technical reserves. This is often the case when undiscounted reserves are established for long-tailed business. The required funds can, in principle, be obtained by borrowing from shareholders' capital or from a third party. The appropriate borrowing yield to apply depends on the risk involved that the borrowed money may have to be used for paying claims. If money is borrowed for a short-tail business being funded for three years for accounting purposes only, this risk is very low. Conversely, while if the money is for long-tail business being discounted at a slightly conservative rate, the risk is obviously considerably higher. Furthermore, the borrowing yield should take into account whether the shareholders' capital is seen as an indivisible entity, and a risk-adjusted rate of return has been determined for this capital base, or if different

parts of the capital base are seen as being exposed to different levels of risk. In the example profit test in Table A.2.1, a borrowing yield of 9% p.a. has been used.

A.2.1.6 The calculation of the table is straightforward, but, in order to ensure a full understanding for the analysis of the underwriting cash flow items in the next section, and for clarity, the following observations are made:

— PV end year liability, is the sum of all future PV net U/W revenues;
— the end year liability, valued at 31/12 of each year, is the preceding PV end year liability revalued to 31/12 of each year by the technical reserve interest rate;
— total borrowing is the technical reserve minus the available fund; and
— the interest rate on net revenue and fund, is calculated as the interest for a full year on the fund brought forward and interest on 6 months on the net U/W revenue for each year.

A.2.2 *Underwriting Cash Flow Items*

A.2.2.1 The items in Table A.2.1 have, somewhat artificially, been grouped into underwriting items, lines 1 to 17, and capital base (CB) and extra technical reserve (ETR) items, lines 25 to 27. The present section will discuss the items normally directly connected to underwriting, while the details of the CB and ETRs are left for discussion in Section A.2.3. It is not unusual to see profit test tables in the London Market covering only the underwriting cash flow, and this can, to some extent, be motivated by the typically quite small effects of the other cash flow items. However, for a full understanding of the results of writing reinsurance business, these other items should not be omitted. An additional reason for including them would be, again, that the margins in reinsurance over time are not large enough to ignore even small effects if their effects are negative, which is often the case for the CB and ETR cash flows.

A.2.2.2 The premiums and claims paid distributions over time must be studied carefully in advance, to determine an underlying development pattern (accumulated proportion paid of ultimate by development year) for each one of them, and a forecasted ultimate claims ratio. The payment patterns can be calculated from classical triangulation schemes, with proper care taken to reflect expected future changes in payment speeds. These triangles, reflecting historic results, also give ideas for future expected loss ratios, which must be complemented with underwriting information.

A.2.2.3 For the Table A.2.1 profit test, the underlying development patterns are shown in Table A.2.2.

Table A.2.2. Payment patterns

Development year	1	2	3	4	5	6	7
Premium payment pattern	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Claims payment pattern	20.0%	40.0%	65.0%	85.0%	95.0%	97.5%	100.0%
Ultimate loss ratio	75.0%						

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A.2.2.4 Premiums and external acquisition costs are typically the most straightforward items. However, in reinsurance there are complicating features. Firstly, the net premium may be determined by a claims-dependent formula, such as a sliding commission, profit commission, a sliding scale premium or a reinstatement premium. Secondly, the reinsurance premium will always depend on the original gross net premium income, which is only estimated in advance by the cedant. These features will be reflected in triangulations for prior years only as long as the nature of the business is not expected to change much in the near future.

A.2.2.5 Retrocession costs, provided they are not negligible, have to be modelled carefully. As the profit table is concerned with expected cash flows, the net retrocession cost, after taking expected recoveries into account, should be given a payment pattern. This pattern will greatly depend on whether the cover bought is proportional or non-proportional. Again, triangulation of data may be valuable, although the losses to retrocession programmes may be typically rare, so triangles would often have to be coupled with sound judgement. A common simplification is to assume that, if very-high-level covers are bought, the recoveries are so remote they can be ignored, and then the retrocession payment premium is just a proportion of the incoming premium. This is the simplifying assumption in Table A.2.1, where retrocession costs have been set to 2% of the incoming premium.

A.2.2.6 It is also usual to start the profit test table with the premium net after retrocession, which is particularly suitable if the underlying triangulations are done on a net basis, or if the retrocession is proportional.

A.2.2.7 The expense ratio is determined by the allocation basis and the overall expense level of the company. A traditional approach would be to allocate expenses by premium income, maybe modified for proportional/non-proportional and/or facultative/treaty, depending on the reinsurer's organisation. A more detailed allocation can certainly be of value for strategic purposes, for instance a particular allocation may favour certain growth areas.

A.2.2.8 Paid claims is the item in the table which can be viewed in a stochastic manner. The shown values are expected values, but both the timing and the amounts are stochastic. Variability in the final loss ratio can often be calculated by modifying classical pricing formulae. Timing variability has not been studied significantly in the actuarial literature. If one is able to measure the variability, a stochastic model in a simulation package could be set up to give a better picture of the potential expected profits and timings.

A.2.2.9 Underwriting profits or losses in the profit test example are booked after two years, with additional profits appearing with the unwinding of the discount. Other common rules are realisation after one year, but with more conservative technical reserves, or realisation spread out over several years. Both rules (and indeed other variations) are easily implemented in the profit test table. The decreased risk of taking out the profits later is matched by the fact that their present value decreases with time, since the profits only earn a low return as long

as they reside in the technical reserves. They are eventually discounted at the return on investment requirement when released.

A.2.3 *Capital Base Cash Flow and Reserving Strain*

A.2.3.1 A capital base is allocated to the business when the business is actually written, and then released as the reserve is run off. Capital can be allocated by a number of methods, and the capital is usually released after one or two calendar years, as a simplification to the risk exposure. A tentative capital base, with a 60% capital to premium ratio for the first year, and then a 10% capital to liability ratio for the remaining years, has been used for the profit test of Table A.2.1.

A.2.3.2 The capital also produces investment income, and this interest needs to be included in the model. The investment policy for the capital base may differ substantially from the investment policy for technical reserves, as it is often less conservative and contains a higher proportion of equity shares. Care must be taken to reflect this feature. As already discussed in ¶A.2.1.4, one approach is to include only a nominal growth on the capital base, and consequently keep the risk-weighted target return free from investment risk, although this is by no means the only way to proceed.

A.2.3.3 One may think that adding the investment income from the capital base may automatically give a higher profit in the profit test, as more income, but no new losses, are added. However, the required return from underwriting and capital growth is naturally higher than that from underwriting alone. This is reflected in the risk-weighted target return at which the profits are revalued, which now is the company's full return on investment requirement and in the target profit, so it does not necessarily lead to easier targets. The present value profits at varying target returns are shown in Figure A.2.1 for the example profit test at a constant ratio.

A.2.3.4 Three lines are needed in the profit test to conveniently describe the effect of the capital base, one for the capital base itself, one for the necessary injection or release of capital to shareholders, and, finally, one for the nominal interest on the capital base.

A.2.3.5 The method by which reserves are determined needs to be able to run off the capital base against the technical reserve and to compute interest rates on reserves. This information could be in the form of an IBNR profile, a reserve discounting policy and a general reserving policy (degree of conservatism, '50/50' reserve, etc.). An IBNR profile giving more prudent reserves than the present value of future liabilities, a policy to discount technical reserves at a low interest rate, a general policy to carry 5% more reserves than the expected loss or reserves enough to meet liabilities with a high probability, are all different ways of specifying the extra reserve, which is really just an alternative way to increase the capital base allocated to the line.

A.2.3.6 In the example profit test, a conservative interest rate for technical reserves has been used, as this is the most common way of specifying an ETR.

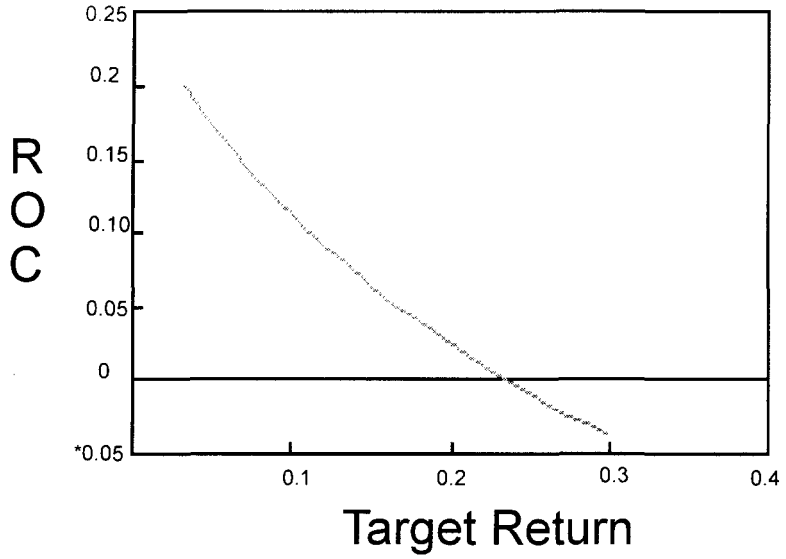

Figure A.2.1. PV return on capital as a function of the target return

It is also necessary to calculate the amount by which the reserve is prudent, as this information shows the increase in the actual capital base.

A.2.3.7 If the introduction of an ETR is for accounting or regulatory purposes, the pattern of emerging profits is more often than not affected. The 'unwinding of the discount' is probably the most common example of this effect. However, if the ETR is a provision against run-off deviations, one could just as well argue that the profits could be realised just as well without this extra reserve.

A.2.3.8 Taking the present value of the injections and releases of capital base amounts gives an amount to be added to the present value of the underwriting cash flow, thus giving the NPV of the business segment considered in the profit test. This value can then, for instance, be divided by the capital base of the first year, giving a return on capital measure. If this value meets the target one, then the studied segment of business is considered sufficiently profitable to take on the books, or to continue to write. Naturally, the target return may have been set to reflect a long-term commitment to a territory or class (it may even be negative!), and, therefore, meeting the target does not necessarily mean profitability.

A.2.3.9 In another approach one might set the investment return, return on equity parameters and also the target profit according to a set of assumptions and requirements, and subsequently solve for the highest loss ratio allowing us to meet the target. This approach has its value, in that it provides the underwriters with a parameter that is meaningful to their work, and can be discussed with cedants.

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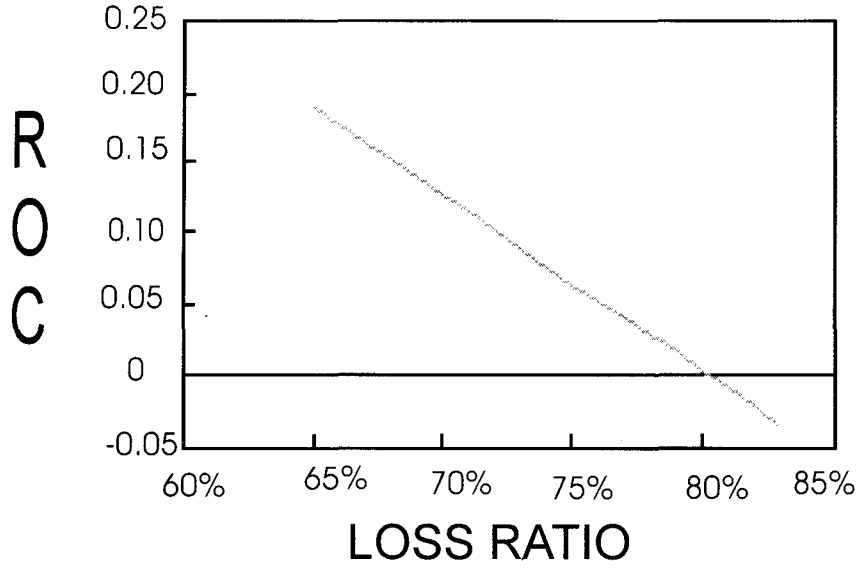

Figure A.2.2. PV ROC sensitivity to ultimate loss ratio

A.2.3.10 There are several other ways to use the results of the profit test. A common method from the life insurance industry would be to actually solve the entire table for the rate of return (the internal rate of return, IRR) giving a nil present value of the total cash flow, and compare this to the target rate of return. The return on capital (ROC) can be expressed as a function of the target rate of return (see Figure A.2.1, for example), the IRR can be looked up immediately from the graph. In general business, the total cash flow can, in fact, change sign more than once, giving rise to the well-known problem of multiple IRRs. (This problem may be solved by alternative assumptions as to the reinvestment of positive cash flows at specific rates, instead of the IRR rate.)

A.2.3.11 The sensitivity of profits to small changes in the ultimate loss ratio is typically quite high, and this is depicted in Figure A.2.2. A capital to premium ratio of 60% is assumed for this class. It is worth pointing out, though, that the effect often is roughly linear, as long as profits are realised within a few years.

A.2.4 *The Application of Profit Tests at Different Levels of Aggregation*

A.2.4.1 In the preceding sections a generic profit test has been considered, without reference to any difference in application depending on the aggregation level at which it is applied, or to the relative importance of different lines of business. In this section some guidance on these issues is given.

A.2.4.2 There are three obvious levels of application:

— the whole account level;

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— the business segment level; and
— the individual treaty level.

A.2.4.3 The most common application would be at the business segment level, where many of the parameters are already set, for example capital allocation, retrocession and management expenses, and the typical question is whether a certain book of business is profitable or not, or at what target loss ratio it could be written to be profitable. The business segment needs to be reasonably homogeneous for the profit test to be valid, as a mix of long and short-tailed business would certainly distort the effects of investment income.

A.2.4.4 In order to answer some of the strategic issues arising at whole account level, for example about optimal premium volumes and suitable expense and capital allocations, the profit test needs to be applied to the whole account. This does not mean just one profit test for all business, especially in view of what has just been said about homogeneity, but rather a number of simultaneous profit tests, run with different scenarios for the studied strategic parameters. In life insurance terminology, this would be a 'model office'. This is an integral part of the planning process. The practical problems of actually carrying out an optimisation in this environment are enormous, so one would typically have to confine oneself to look at a small number of scenarios.

A.2.4.5 Another issue to consider when using profit tests for strategic purposes, and in particular for multi-year planning, is the issue of tax. If the target ROC is set net of tax, one has to bear that in mind in the profit calculation. In particular, if the target ROC is considered a long-term average target, and if results are volatile, tax will only be paid on profitable years, and hence a simulation approach or scenario analysis are necessary, rather than just a straight percentage deduction.

A.2.4.6 Further examples may be found in Sanders *et al.* (1995).

ABSTRACT OF THE DISCUSSION

Mr D. E. A. Sanders, F.I.A. (introducing the paper): This paper concentrates on the communication aspects of pricing in the London Market. We have centred the paper on reinsurance business, although the London Market contains many more lines, in particular marine, aviation and direct insurance. The techniques we have described are not, however, limited to reinsurance, and can be generalised to all these classes. We concentrate on the issue of converting a given strategy into a meaningful plan which is controlled at the operating (i.e. the underwriting) level. Thus, a strategy which asks for profitable growth giving a return on capital employed of, say, 15% is translated into, again say, an underwriting result for a specific line of 5% of premium net of commission as that line's contribution to meet the overall objective. The tools that we use in this translation are profit testing tables and the process of setting target underwriting ratios. These processes may be set in a stochastic framework.

The methods that we put forward have been used in practice in major London Market companies. There may be different ways of setting out the profit test table and underwriting targets; what is of importance are the underlying principles. Of particular interest in this approach is that a standard life actuarial technique, established some 25 years ago for uniform mass risks, can be readily used in an environment where risks are often dissimilar and are rated individually. The paper does not concentrate on basic pricing. This has been covered, in part, by working parties at GISG and by other authors. We do, however, give some examples in the Appendix.

Until recently, actuarial involvement in the London Market has concentrated on the reserving aspects of the business. Any actuary wishing to consider a pricing role needs to be aware of the many pitfalls that surround the task. Unlike the traditional life actuary's role in pricing, there are many contingencies to consider, some of them remote, but extremely expensive if they should occur. I recall, for example, discussing the price of a catastrophe risk in the Caribbean, where the manager was pleased that the risks had not been hit by hurricanes, but was completely unaware of the continuing consequential possible potential losses from other natural catastrophes in the area, which included earthquake and volcanic activity, and building codes based on standards which would not have been acceptable in California some 60 years ago.

The authors believe that actuaries have considerable value that they can bring to pricing. This has been recognised some time ago in the United States of America. The introduction of corporate capital in the Lloyd's market, and the new disciplines that this entails, will create new opportunities for actuarial involvement in the field. With additional responsibilities come potential conflicts, particularly if the pricing actuary is also the reserving actuary, and when the remuneration package is contingent on the performance of the syndicate or company. Specific guidance from the Institute may be required in this respect.

The increased involvement of actuarial skills in London Market pricing will, in themselves, lead to new innovative techniques being used to solve the complex problems. These techniques will rely heavily on computers and good data. The more complex the technique, the harder it will be to communicate back and translate as meaningful targets to the underwriter. The tools that we set out in this paper are a starting point for this communication process, which will doubtless be improved as we all gain more experience of the complex issues which surround the London Market.

Mr D. C. B. Ibeson, F.I.A. (opening the discussion): I believe that this paper will be a useful document for actuaries in the London Market, not so much in its introduction of revolutionary ideas, but in terms of the practical aspects discussed.

In the introduction there were two areas that attracted my attention. These were the comments on 'the subscription market' and on 'communication'. The implication of a subscription market was stated as being that a price needs to be set such that the following market will sign up. In addition to this, I believe that the subscription market leads to small lines being taken on many contracts. The result of this is that the size of individual contracts often does not warrant a 'full actuarial exercise'. However, whilst this currently holds true, I believe that, especially in Lloyd's, with the evolution of the Mega Syndicate, we are likely to see increased line sizes in the future. This will mean that more focus is likely to be placed on fewer contracts, leading to the further use of actuaries in the area of pricing.

In connection with communication, I do not believe that its importance can be undersold. In this environment the underwriter is 'king', because of his wealth of experience and ability as a businessman. If the actuary is to add value to the team, it is not sufficient for his numerical calculations just to be presented in the decision-making process. It is imperative that the decision maker understands both the results and the sensitivity of the results to any changes in assumptions. Good communication is a process of education. How can an underwriter assess the implication of whether a log-normal or a gamma distribution is appropriate if the actuary has not taken time to explain the differences? What use is a model that can estimate the price of a contract and illustrate the variability of outcomes, if the underwriter cannot understand the main determinants of the results?

In connection with pricing, the actuary can fulfil two roles. In particular, he can:

(1) verify that the underwriter has charged a sufficient mathematical price; or

(2) he can be part of the team that arrives at the price.

In order to add value, the actuary should aspire to be part of the team.

If not fully understood, the actuaries' models will become black boxes. That will be fine when the numbers produced agree with those produced by the underwriter, but when they are different, the risk is that the underwriter will merely discard the results and resort to judgement. This would be a lost opportunity, and, with proper communication, it should be avoided.

In the section on basic pricing, the authors state, in ¶2.3: "The major problem is, therefore, assessing the distributions of claim numbers and claim amounts, and hence their expected values. This, in itself, can be very problematic." Where only judgement is used, it can be turned to guesswork when only limited information is available. Unless experienced in such areas, actuaries should be careful when making such guesses, as it does not take long for a guess to be translated into 'complex actuarial methodology'. Unfortunately, in the current environment, the ability to push for more information appears severely hindered by some insurers' willingness to price and write risks on less than adequate information.

In the section on risk and reward, the authors refer to running an asset/liability model. They say, in ¶3.1: "Using its pre-set riskwillingness criteria, the company can compute the marginal extra capital required to support the new contract, and the marginal contribution to profit that the contract should make." I have always been impressed with the ease with which such statements can be made, although, unfortunately, I have not found their application as easy in practice.

In connection with allocating profit targets to individual contracts, I was not sure whether the authors propose that this should be carried out when each contract is offered for writing or whether they propose to do it as a one-off exercise on the contracts that are expected to be offered. Also, in terms of carrying out such an allocation, does anyone attempt to deal with issues such as correlation, or does the market tend to think that the clarity of a simplistic approach is beneficial over the potentially spurious results arrived at by introducing unnecessary complexity?

With regard to using a profit test as a means of explaining information to underwriters, I would be interested to know whether the allocation of capital to individual underwriting sections improves understanding and motivation or whether it tends to put pressure on the underwriter to service the capital, even if, for the group, the application of capital elsewhere would be more productive. My concern is that, in allocating capital, we are encouraging the underwriter to write for income.

The authors' comment, in Appendix 2, that the inclusion of income on the capital base does not necessarily lead to easier targets. I think that, if the correct required rates of return were being used, then surely the targets should be the same.

In Section 5, I fully support the sentiment of communicating with the underwriter in language with which he is familiar. Unfortunately, I have found that, whilst most underwriters use a similar language, there is no guarantee that they will look at things in the same way, and I suggest that the appropriate approach will vary by individual.

In Section 6, I agree with the concept that the development of the 'feedback loop' is essential if we are to maximise the use of available information, and that analysis of the reserving process in terms of expected numbers of claims and their amounts is useful in this respect. However, I would go

further, and I believe that analyses of this type not only improve insight in terms of feedback, but can be considerably useful:

— in the analysis of outwards reinsurance that may have been purchased;
— in aiding discussion with the underwriter and generally; and
— in improving the actuary's familiarity with the account.

Unfortunately these data are not always readily available.

In Sections 7 and 8 the authors, in my opinion, make three important comments:

(1) that underwriting involves considerably more skills than mere mathematical calculation;
(2) that managing the underwriting cycle is about being in a state of preparedness to respond to a given change in market conditions; and
(3) that actuaries need to have a working knowledge of many aspects of the business in order to have the confidence of the underwriter.

In these final sections I would have liked to have seen a section discussing the issue of the 'year 2000'. However, I hope that this issue might be covered later.

The authors also touch on the potential conflict between pricing and reserving roles. Whilst I agree that there is a potential for conflict, I do not believe that the solution is simple. The involvement of actuaries in both reserving and pricing increases their ability to add value. To divorce the two would be removing an important link. Also, I am not convinced that there are sufficient actuarial resources for separate roles to be implemented everywhere.

In summary, I believe that the actuary is faced with three main problems:

(1) trying to get the relevant data;
(2) having the technical skills and applying the most appropriate method of analyses; and
(3) the communication of the results to underwriters and users.

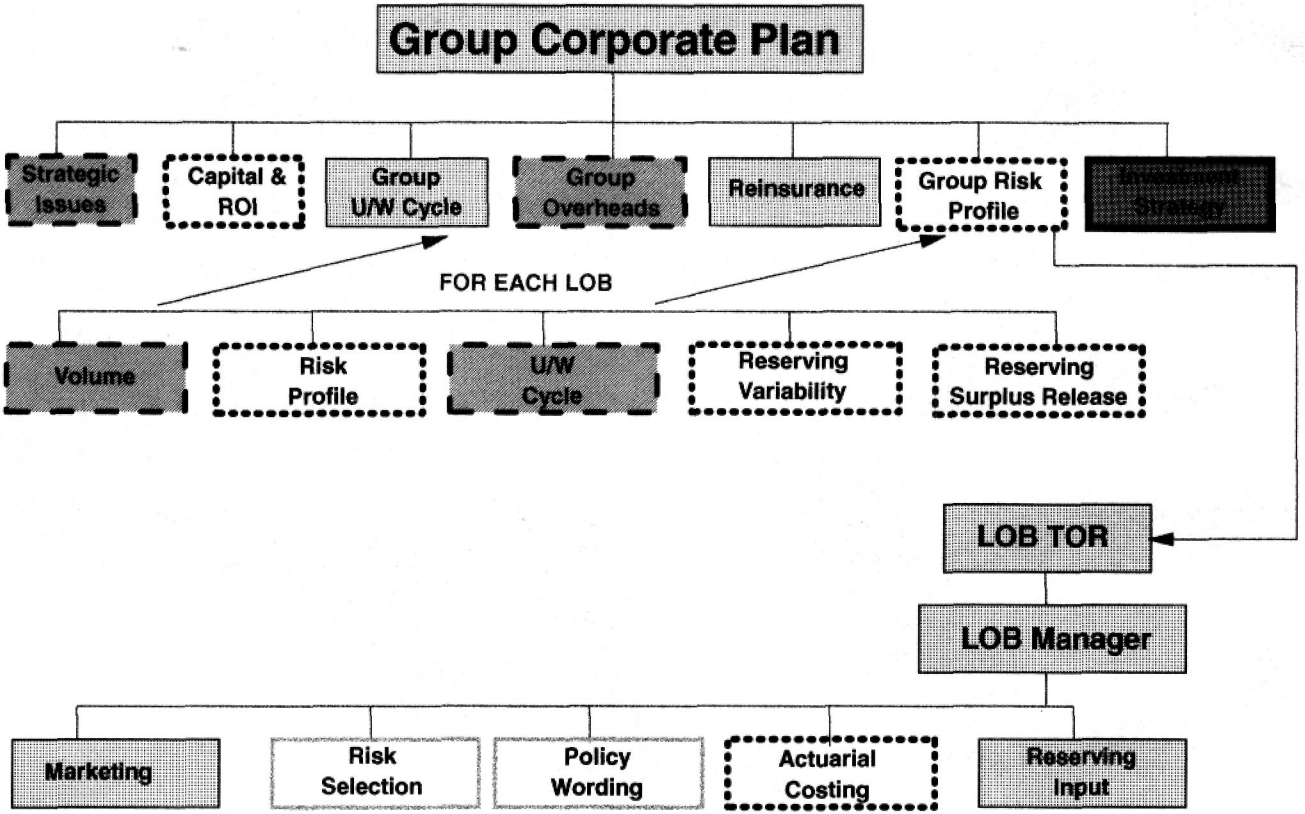
Mr J. P. Ryan, F.I.A.: There is a large amount of material in this paper. However, an unfortunate side effect of the wealth of points made by the authors is that an outsider may not fully recognise the complete contribution that an actuary can make in London Market pricing. Thus, the figure on page 473, showing the various relationships in the pricing process, may be helpful in this respect.

The figure is necessarily somewhat complex, because of the very different aspects and important inter-relationships and skill sets that are required in pricing in the London Market. It is best understood by first considering the line of business (LOB) analysis in the middle and towards the left side. In doing an initial analysis for each line of business, one needs to analyse a range of issues in order to price. This then needs to be incorporated into the top line, which pulls it together into some form of corporate plan. This is then translated down to set the local target operating ratios (TORs) that the authors refer to, and then down to the bottom line, which shows the inputs into the individual pricing at the individual risk levels.

The boxes in the top line are, from the left: strategic issues; capital and return on investments; the group underwriting cycle; group overheads; reinsurance; group risk profile; and investment strategy. The boxes in the next line below are: the volume for each line of business; the risk profile at the line of business level; the underwriting cycle at the line of business level; reserving variability; and reserving surplus releases. Under this last is the line of business target operating ratio, with the line of business manager below that. The bottom line gives: marketing; risk selection; policy wording; actuarial costing; and reserving input.

The important point to realise is that the line of business analysis needs to be done first in considerable detail. That then needs to incorporate capital and risk analyses and target setting. They are not a function of the actual pricing process. All are key inputs into the overall plan, as are other factors affecting reserving. The reserving aspect, from that point of view, is as much the way in which that surplus emerges and also the variability of those potential reserves rather than the actual setting of reserves at the year end. It consists of two points: the actual way in which the surplus gets released; and, equally important, the variability.

All these analyses need to done separately for each line of business, and then combined at the



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group level. It is important to realise that, for a London Market company, these LOB analyses are not additive, and need to be combined in a more complex way; hence the role of the actuary. This is alluded to by the authors in Sections 3 and 7.2. This is a fundamental difference between a London Market company and a life company or a monoline non-life company, e.g. a motor insurer.

Combining these at the group level also requires a number of other items, including strategic issues, knowledge of the group reinsurance programme, as well as investment strategy. Relating this to the group capital and return on investment considerations then provides the basis for setting TORs. This is inevitably an iterative process, as it is important to realise that the TOR for any given LOB is not only a function of the volume of business written within that LOB, but also of the volumes and mix and returns of other LOBs. This is a function of the non-additivity of the LOB analysis shown on the left side of the figure. Since, for practical purposes, this is not an issue in a life company, the process there is very much more straightforward.

It is important to realise that writing more than the target volume of business could well require the LOB manager to increase his unit margins rather than to decrease them, in order to meet the overall targets. This is one reason why it is better to set TORs than to allocate capital, as the opener referred to. This phenomenon is a function of a reduced element of diversification if you write a large amount of any one particular line of business. This is directly at variance with life office experience, where usually the reverse phenomenon applies because of the increased impact of overhead recovery. While overhead recovery would also be a benefit on the PC side, the diversification element is usually much the more significant. The volumes, TOR and their relationship are all that the LOB manager needs to know, and he does not need to get involved in other corporate variables. Given the overall TORs, it is necessary to obtain, in the market place, the volume of business required to achieve those targets. Failure to do so will mean not meeting the plan.

This is effectively shown in the lower portion of the figure, under the heading of 'LOB manager'; a term that I have taken to allocate responsibility for this task, and underneath are the various skill sets required to undertake that task. The following boxes: strategic issues; group overheads; volume; and underwriting cycle refer to skill sets rather than to particular functions, and, in many cases, the same individual will actually fulfil the roles outlined in a number of boxes.

The issues which are the responsibility of the LOB manager include: marketing; risk selection; and policy wording and related issues; as well as the tasks of a more conventional actuarial nature, such as the actuarial costing techniques which are described in Appendix 1, and also, possibly, some subsequent input into the reserving process.

As is common in the London Market, the authors have used the term 'underwriter' in two senses, as the opener did also. I have specifically used the word LOB manager to differentiate that from the skill set that I consider to be important in a narrow underwriting sense. It is important to recognise, for the purposes of evaluating actuarial input into the London Market, that these are two distinct functions. The concept of a LOB manager is not, in fact, that of an underwriter in the narrow sense, an underwriter whose skill set is the risk selection and policy wording process. However, many successful underwriters and many people who call themselves underwriters in the London Market are really functioning as LOB managers rather than underwriters. They are making sure that either they, or their colleagues — possibly including actuaries — provide the other necessary inputs to make sure that all the functions are carried out effectively in the pricing of individual risks. Currently, it is unusual for an actuary to function as a LOB manager, although there are some exceptions to this.

In most cases, and this is the implication given by the paper, actuaries function only in providing input in respect of actuarial costing and also some of the reserving input. However, a good actuarial training in the London Market would mean that many actuaries in the future will be very strong candidates for the position of LOB manager, as, indeed, will people arising from other disciplines, such as pure underwriters, i.e. specialists in risk selection and policy wording.

I have emphasised this distinction, because I believe that it is fundamental to our developing a proper role for the actuary in the London Market that we understand the different functions and that we perform and behave appropriately. Getting this right, and the developments that follow, can form an important growth area for the profession, over and above the actuarial costing aspects.

The boxes in the figure with the same shading and edging lines are related:

(1) Those in white, edged with heavy dots, are the ones where a significant amount of actuarial input would be required to do the job properly for the majority of London Market companies, i.e. they normally require an actuary.

(2) Those with light shading edged with normal black lines indicate areas where the actuary might be a reasonable candidate for the job, but where he or she is by no means the only candidate, as the role requires several different skills, including some quantitative ones that would normally be associated with an actuary, but there are other issues as well.

(3) Those with heavier shading, edged with heavy dashes, are the areas where the actuary would not normally be expected to make a direct input by virtue of his actuarial training, although individuals might possibly be in a position to make strong contributions by virtue of their own experience, e.g. in the analysis of strategic issues.

(4) That with even heavier shading, edged with a heavy line, is the area where actuaries would be well suited to fulfil the role, but where other disciplines might also have a reasonable claim to participate. This is an area where we, as a profession, need to make an effort to market ourselves.

In terms of the ongoing future of the profession, it is imperative that the profession must sell its role in the areas described in (1). If we fail to do that, then we are failing to deal with our basic opportunities. The areas described in (2) will depend as much on individual actuaries selling themselves and their own capabilities rather than the profession as a whole. However, as a profession, we should be putting more effort into the area described in (4). Although the figure does not make this clear, it is the actuary who is the only one who has the skill to combine the assets and the liabilities. The investment strategy may come from somebody else, but it is very much in the actuarial area to combine the two.

It is important to realise that completing the circle between the LOB manager and the LOB analysis does not conform to the actuarial control cycle as it is usually formulated. It would be tempting to draw a line from the bottom end of it up to the other side and say "That provides a complete circle that is analagous to the actuarial control cycle", but that is, in fact, not the case. The control cycle is actually a series of sub-sets of these analyses, especially the risk analyses and risk selection and actuarial costing processes. Thus, there will be an actuarial control cycle that goes on in various aspects, but it complicates the issue when thinking about a London Market type process. It is important to emphasise the whole diagram. What I have put together is very much an iterative process, and that starting at the left middle side and proceeding to the bottom right side is unlikely to be carried out in one particular run, and does require 'buy in' of many different individuals at many different stages of the process. The authors cover this in different parts of their paper.

Dr S. M. Coutts, F.I.A.: This paper is extremely important, because there are young actuaries who are entering the London Market, and they do not really appreciate some of the issues and some of the problems that they are facing or will face. I would like the Institute to play a more active role in looking after these young actuaries and their advice to the London Market. A recent advertisement in *The Actuary*, suggesting that a life or a pensions actuary can be taught to become a general insurance actuary within three months, is unbelievable. After 25 years in this profession, 99% of it in general insurance, I feel that I know less now than I did 25 years ago. That may reflect on me, but I believe that it reflects on the difficulty of the issues surrounding general insurance.

Many years ago, when I was losing weight, I was listening to a diet programme on the radio. There came this very interesting question: "How long does it take the stomach to send to the brain a message that it has eaten too much?" My first reaction was 'a matter of seconds', but I got it completely wrong. The answer is 'about 20-25 minutes', depending on how long the short intestine is. So, how long does it take a Lloyd's syndicate to receive a message from the stomach of the Lloyd's syndicate that it has a problem? My answer is very simple: "It depends how long the intestine is between the actuarial advice and the lead or live underwriter in that syndicate".

I would like to think that a version of this paper is passed through all the Lloyd's syndicates, through the professional market, even into the fringe market, so that the people who run those

companies can really begin to appreciate that actuaries can offer very useful advice in this area. The concept of business planning; pricing; the control cycle, as described in this paper; give a complete solution in a theoretical way of how to do things. It is then up to the actuary to do it. However, we should only offer advice where we know that we are competent.

Mr G. G. Wells, F.I.A.: One of the key themes of this paper is the use of profit-testing techniques to set underwriting targets and as a monitoring tool. Now, a profit test is essentially a cash-flow projection made against the background of the reserves established and the capital employed. It also needs to recognise where we are in the underwriting cycle.

I now consider briefly the following three non-cash-flow items and their impact on the emerging profits at the level of analysis chosen:

(1) Reserving for London Market business, particularly long-tail United States casualty business, is one of the more challenging exercises facing an actuary in this arena. The need to exercise caution cannot be overstated, and the underwriter involved should have sympathy with this approach, although he may feel a little hard done by. However, if a 'strong' reserving policy is adopted, this will defer the emergence of profit, which, on a risk-discounted basis, will reduce the present value of future profits projected on the business being valued.

(2) The move to a risk-based capital or some other capital allocation method will, in all likelihood, result in a greater capital allocation to more risky business. For example, for long-tail U.S. casualty business one needs to consider whether the overall capital employed, i.e. including the reserve margin (if any), is high, medium or low on an organisation's prudency scale, subject, of course, to statutory requirements. The need to service that capital and its impact on the emergence of profit are fundamental to profit testing.

(3) The profitability of the business being valued cannot be estimated in a vacuum without regard to market conditions, i.e. the current stage of the underwriting cycle. This is particularly important for business planning over (say) the next 3 to 5 years. The value added by business written at the top of the cycle will, other things being equal, be greater (and potentially much greater) than at other stages of the cycle, as rates descend to the trough of the cycle, before again moving up to reflect the then market and capital realities.

Mr P. A. C. Seymour, F.I.A.: Mr Ryan spoke about the distinction between pure underwriters, as it were, and underwriters as we know them in Lloyd's. That point has been of some concern to me in Lloyd's, because I see underwriters combining the roles of selling and also underwriting the business. There is a risk, in my view, that, in pursuit of premium, they could actually sacrifice the purity of the pricing that is discussed in this paper. This probably happens in other sectors, but not so much in the life insurance sector, where salesmen and underwriters are quite clearly separated.

We can be as scientific as we like about capital, but, in the Lloyd's market, capital is rather like stocks and shares. Capital tends to pursue the people who are currently 'flavour of the month', and they finish up with too much capital, and then they themselves go chasing premium. So the annual renewal cycle may, itself, cause some problems.

A point was made by the opener, who asked whether there was a conflict between reserving and pricing. Again I have to fall back on my basic origins, which are in life insurance, and it seems to me, if I understood the control cycle that Mr Goford propounded a few years ago, that the feedback loop is the very essence of what *should* be happening; namely, that you look at what emerges as experience, and then plug that back into the loop to make it part of the pricing. Thus, I cannot support, in any way, the idea that we should separate these two functions.

I support the idea that we should try and regain the actuarial position in the investment field. However, the one-year accounting used in Lloyd's is detrimental to our developing a proper investment strategy. If we have long-tail liabilities, then we ought to be investing long or we ought to be investing in equities. The response is that when you have a reinsurance to close one year out, you are actually taking a view of less than a year. The whole Lloyd's system is not very well set up to facilitate the proper asset/liability matching that we regard as normal behaviour.

Working without data, as happens a lot in health insurance, is difficult. At our first health-care

conference, held in May 1997, one of the issues was about how we can actually get data that will be useful for the profession to build proper pricing models. In the health-care area, there are only a few players of any significance, and they do not want to share their data. If they do not want to share the data, how can the market — or indeed actuaries — obtain data that are actually sufficiently broadly-based to be meaningful?

When you come to the very esoteric (low frequency, high claim value) types of issue that we are discussing in this paper, that problem must be of major magnitude. Somebody said that actuaries have to avoid the temptation to guess. I support that. I have discussions within my own board about whether actuaries can genuinely add any value if the statistical data with which we can work are not there. My answer to that question is 'yes', because the disciplines with which we are accustomed to work, the understanding of the control cycle and the feed back loops, make us, potentially, very valuable partners in the team.

Mr A. J. Newman, F.I.A.: The profit test is the major contribution that this paper makes to those people who would be familiar, primarily, with reserving techniques. I mention three issues on the profit test:

(1) There is a danger in all intricate models, because some people think that, because of all the detail, the models cannot be wrong. This is an issue in this case. The profit testing rather skates over asset allocation, and generally the paper does tend to simplify the actuarial issues in an attempt to gain a wider audience. The danger is that the inexperienced pricing actuary might concentrate less on valuing the liabilities, which is an essential aspect of what actuaries do, in his attempt to better contribute to the overall underwriting management.

(2) As Mr Wells mentioned, the profit test depends on predicting the underwriting cycle. Paragraph 7.4.8 deals with managing the underwriting cycle rather than predicting it. That is an inconsistency; it is a conflict of the way the world in which we live works. I am not suggesting any resolution to that, but I just point out that there is an inherent contradiction there.

(3) There is the issue of reserving against pricing. Section 6 points the way to a grand unified system for pricing, planning and reserving. Again, as Mr Wells pointed out, the profit test has, as one of its inputs, the reserving basis used. There is this central conflict that, if you do not separate the reserving from the underwriting, then the underwriter, the actuary who is devising the profit test, will have a lower reserving basis, and it will then be very difficult for him, if he is the same person, to strengthen his reserves later, because that meant that all his early calculations were wrong. This is the problem that you have with any underwriter setting reserves. It is exactly the problem for which the DTI issued its prudential guidance, that said that the claims and reserving function and the underwriting function really had to be substantially independent from one another, and, although the profit testing and the control cycle do bring in all the data and incorporate feedback, there is a danger, which I think has been under-stated by many contributors to the discussion.

Mr C. J. W. Czapiewski, F.I.A.: I first consider the question of potential conflict. Some years ago I was in a situation of reserving for a London Market company, and I was also in the position of underwriting and pricing. At the time I was quite lucky, because the book I wrote was in a profitable area. However, I used to wonder what would happen if my area got particularly tricky? How would I approach the reserving? It was a very short-tail class of business, and the problem did not arise. The problem was not so much about the actual professionalism, but probably more about the perception by others. Clearly, there is a need for very strict discipline in this area.

Pricing and underwriting are very different from reserving. Whereas reserving affects the timing of the emergence of profit or loss, pricing and underwriting affect the quantum of that profit or loss, and that means that they are more important. The implication is that the emphasis that we give, as a profession, in our training and in our guidance must be reassessed. At present we very much focus on the area of reserving. Our guidance, our tuition, much of our research have been in the area of reserving. Only recently have we been getting involved in the pricing area.

Any research and development in general insurance always highlights the complexity of Lloyd's

and the London Market. Dr Coutts commented that the longer he has been in the market the harder he finds it, because the more he understands what he does not know. That is the same for all of us. The question is of pricing, reserving, capital, reinsurance; all these things are intertwined.

What else does an actuary do in the role of pricing? Underwriters have always been very much involved in calculating their best estimate for the risk being assumed. The actuary in this field, as in all fields, thinks far more about the potential for the degree of variability about that best estimate, and this is crucial added value. This involves sensitivity and profit testing. The more research that we do in this area, the more that it can be seen that we add value to pricing.

Mr R. C. Wilkinson, F.I.A.: When I worked for a life reinsurer, many years ago, we were asked to quote for a group life scheme. In the previous three years the numbers of deaths had been seven, five and three. The very aggressive underwriter suggested that we quote on a very low mortality assumption, which would give just two deaths, because we would get the business and it might be worthwhile. We considered what more scientific techniques could be used, and so we took 70% of the rates given in the latest mortality tables. This gave the answer of 12 expected deaths, and we strongly advised that the company did not quote further for the business. The next year another company quoted for the business on the basis of two expected deaths, but 15 people died. Thus, on the life side it is easy; you can relate to actual exposures and come up with a sensible answer. On the non-life side it is much more difficult.

That brings me on to the point of actuaries being involved in pricing on the non-life side, especially in the London Market. Some of the risks in the London Market are just impossible to price. They are almost not insurable. If we take the underwriting market for aviation business, premium income in the market is the equivalent to paying for about two and a half jumbo jets going down in any one year. However, in the next year five may go down or one may go down. I would still say, basically, that that is not really assessable by actuaries. A small risk can be taken on, and they can make sure that they stay off if it goes bad, but it is almost uninsurable. What the actuary can do is to give a very good guide to the underwriter as to what will happen in different circumstances. Then it is up to the underwriter to make a decision whether he wants to take on the business or not.

There are many very useful techniques which can be learnt from our U.S. colleagues. One of these relates to the insurance cycle in particular. They do what we call an underwriting audit, taking a dozen risks which are very similar, and which have been renewed year on year. They look at the fatness of the premium, and say: "Last year the premium rate was so much. It is a very similar risk this year, and the premium has come down by 5% or may have gone up by 5%." This is a very good tool to measure how fat the premium is relative to the last three years. In the current position, with the cycle going down, it is a very good measure to start with.

Lloyd's, in particular, has always been in a very difficult position. Many professional reinsurers in the London Market and throughout the world have always been lucky and have not had accountants imposing what we call true and fair view accounting. What they have done in the past was always to put away an amount each year, because the market is very up and down. It is almost impossible to come up with a reasonable result in any one year, because you really do need to put some money away for the bad years. Many good Lloyd's syndicates survived, adopting similar techniques. Unfortunately, you end up with criticisms when you have to do a reinsurance to close and have to achieve equity between Names. We know that this is the way that actuaries can work. We are very much at conflict with our accounting colleagues, who do want a true and fair view account, and want it all cut on one year. I think that that is very difficult.

So my plea to the actuarial profession is that we must communicate to the underwriters, not always get too involved in the underwriting side, but give the underwriters some evidence so that they can then come to a more reasoned judgement in terms of whether they should or should not take on or renew a risk.

Mr R. W. Davies, F.I.A.: A number of speakers have said that actuaries have much to contribute to this business. The paper demonstrates that we do, and I agree. However, Mr Ryan said that few actuaries are line of business managers currently, but perhaps they may be in the future. There is also

the case of two young budding actuaries, who stopped taking the examinations because they were doing so well in underwriting. Why have we allowed this to happen, and what are we going to do about it? I do not have an answer; but if actuaries really can add such value to this business — and I think that they can — then we need to find a way of putting young actuaries to work as underwriters, but keeping them as actuaries. If we are right, then a few years after we succeed in doing that, it will be apparent; their syndicates will be better managed and more profitable than those which are not run by actuaries.

Mr J. C. T. Leigh, F.I.A.: I like the distinction that several speakers have drawn between the underwriter and the line of business manager. In a previous employment, that was about as far as one could get from the London Market and yet stay within general insurance, I acted, in effect, as the underwriter of a company. I was not involved in selling, and the salesmen of the company, in effect, acted as brokers, broking the business into their own company. They would bring it to me; I would quote a rate; and if they liked it, they would take it back to the prospective buyer. If the prospective buyer liked it, we would do the business.

The strength of the arrangement was that I could see the risks, and I could underwrite the risks, without there being any pressure on me to generate business. The salesmen knew that if they did not like what they saw, then, although there might be an appeal to the chief executive, he would be most unlikely to uphold it. The system worked well, and we wrote very little business that was not profitable.

This leads to the question of guidance being needed when an underwriter's remuneration is based on the business that he does. It is a fundamental principle that remuneration, if it is based on performance, should be based on rewarding what the person is meant to do. This may seem obvious, but it has not always happened in the past. For example, underwriters may have been rewarded on volumes of business written, which leads to its own corruptions.

The Sessional Meeting held on 30 June 1997 (*B.A.J.* **3**, 1059-1075) concerned the ethics of actuarial work. I think that this question ought to be related to that. If an actuary's remuneration is actually directed at the performance of the company, then he should not be responsible for setting the reserves that measure that performance. Rather, it would be better if his remuneration were measured against the accuracy of the reserves that he sets. A similar point might be made about the underwriter, as we have called him, as opposed to the line of business manager, who should be remunerated for getting his underwriting right rather than for writing volumes of business.

If remuneration patterns are set so that we are remunerated for doing what we are supposed to be doing well, rather than what other people are supposed to be doing, then the professional issues will evaporate and be seen not to be important.

Mr J. P. Ryan, F.I.A.: Risk selection and policy wording are areas where actuaries would normally have nothing to contribute.

There is part of the paper which is quite subtle in terms of changing volumes. As volumes change, so underwriting targets change, in terms of the relationship to the capital required. Thus, you need to change the target rates of return as the volumes change.

The implication of this, and this is analogous to investment theory, is that a high risk line cannot command, in the long run, a higher rate of return than a low risk line, because you will find that one of your competitors, somewhere, will be able to diversify in order to be able to reduce the rates and write the business at a lower rate. That is something that the authors allude to. It is something that the market does not operate on, and I do not think that there is general agreement among actuaries that this is, in fact, the case. The one exception is where there is a shortage of capacity, and, therefore, companies can charge a premium price for a high risk line, because buyers cannot go anywhere else, or there will not be enough companies to diversify because of the capital aspects of it.

It is just the simple aspect of portfolio theory, not merely actuarial aspects of it, where you diversify the risks away, and that any one particular share, in the long run, is not going to be able to earn an above-average rate of return because of the diversification effect. Exactly the same thing arises in reinsurance, and the authors make that point quite clearly.

Mr C. D. Daykin, C.B., F.I.A.: I want to emphasise the importance of the role of the actuary in the pricing and underwriting function, whereas historically, perhaps, we have tended to emphasise the reserving aspect more. Certainly, to come in only at the reserving end of the process is, in many ways, to shut the stable door after the horse has bolted. You only really control the profitability of the business and the strength of the industry through contributing to the pricing and the underwriting process, where the business is taken on.

Perhaps the most important contribution of this paper is the emphasis that it places on the use of the profit-testing technique in general insurance. This is something which some of us were advocating 10 years or so ago, and tried to get into the new syllabus. It was intended to present profit testing in a variety of ways, from both the life and the non-life perspective. The current syllabus still places far more emphasis on the life aspects of it than the non-life. I hope that the new syllabus, which is currently under development, will go further in restoring the balance.

Profit testing is an important technique to be used in all areas of the business. The difficulty which has been perceived in introducing it more in the general business area is partly to do with the volatility of the business, and hence the difficulty of getting stable results from a profit test. It is also because the distinction between the pricing basis and the reserving basis, which has become deep rooted on the life side, certainly in the U.K., although not necessarily world-wide yet, is not well understood on the general business side, because the models that are used for pricing and for reserving are not integrated to the same extent.

There is also a distinction in that life business places strong emphasis on reserves being established on a prudent basis, so as to be somewhere high up the distribution of possibilities in terms of ensuring adequacy. That philosophy is not as strong in general insurance. There is much more of a feeling that the provision should be a best estimate, apart from the fact that it is not generally discounted, although there has even been a tendency, in recent years, to move more towards a discounting approach.

This may be accelerated by the coming international accounting standard for insurance enterprises, where the IASC are pushing heavily in the direction of fair value accounting, both on the assets and the liabilities sides. As actuaries, we are going to have to work hard to get them to understand the need for provision for adverse deviation in respect of the property-casualty business, when they will be arguing: "No, it should be discounted to present value on a best estimate basis".

One other area on which we need to work further, in terms of developing the actuarial contribution to the pricing of general insurance business, is how to get the underwriter fully to understand the extent of the uncertainty. The actuarial input should provide a broad understanding of what is going on. To do that we may need to use the stochastic approach to the profit test, which is alluded to in the paper, but which presents challenges of its own in terms of presenting the results in a comprehensible way. That is something which needs to be tackled.

One of the important emphases of this paper is the need for good communication between the actuary and the underwriter. Unless that is at a level that the underwriter can understand, then we are wasting our time.

Mr M. G. White, F.I.A. (closing the discussion)**:** The role of actuaries in general insurance is slightly different to that in other parts of the profession. In general insurance, the underlying risks are so complex and varied that the actuary has to be part of a team. This aspect of teamwork runs strongly through the paper, together with the related theme of communications. The most important example in the paper comes from setting targets, the underwriting target table, Table 1. This set of targets and the concepts underlying them are linked to the profit test in Appendix 2. The profit test is one of the many debts which the general insurance actuary owes to the life insurance actuary. The profit test appears as the basis behind communications with the rest of the team. The paper is written for an actuarial audience. However, its contents should also be of interest to other members of the team in an insurance company. It demonstrates that actuaries can show value by helping companies make profits; and, most important, that actuaries are interested, as a profession, in so doing.

The underwriting cycle was mentioned a number of times. Nobody disagrees with the authors that the secret is to be prepared. One extremely important issue, that of exposure, was excluded from the

paper, and almost entirely from the discussion. On this point, it is good to see that Lloyd's is now requiring syndicates to consider realistic disaster scenarios. The examples of pricing techniques included in Appendix 1 are particularly valuable to actuaries not currently involved in the area. A relatively quick read gives a feel of the subject. I would emphasise that these are not sufficient in themselves, in practice much effort being needed to understand the situation in each case.

Mr Ryan's term 'line of business manager' was coined to denote the wider skill set needed, in practice, by the underwriter as an entrepreneur, a job that may suit some actuaries, but not others. Mr Seymour commented on the business conflicts between underwriters in their pricing and selling roles. Mr Ryan's line of business manager concept may be a solution to this.

On the conflict between reserving and pricing, reserving is, or can be, highly subjective, and there is a danger that under-reserving sends entirely the wrong message.

Mr Czapiewski made the point that it is the price charged which determines the profit. Mr Daykin also expanded on this point, together with the value of profit testing. Pricing very high layers is important, and this is an area where capital exposure, as well as frequency, has to be considered.

Mention was made of the developments in the U.S.A. We should remember that actuaries have been involved in pricing there for many years, and much of the U.S. literature is relevant to London Market pricing. Mention was also made of the conflict between smoothing and equity between Names at Lloyd's. Reinsurance to close is a commercial contract requiring a willing-buyer and a willing-seller price. This implies that there has to be a margin of safety for the Names who accept the liabilities. This is an issue which the Inland Revenue should be sensitive to in their test of aiming for neither profit nor loss. Mr Davies emphasised that we need to encourage actuaries who become underwriters to continue to see themselves as actuaries. I think that they will continue, first and foremost, to see themselves as businessmen, however, and we should accept that, and be proud of it.

The pricing role is not just a technical one. This is a paper about management as well as about technical issues. In such a difficult area it is not easy to communicate management issues clearly, and some of the points made reflect that.

What should the focus be for future papers in this area? I think that further work on the link with the capital base will help. The link with the capital base requires the answer to a number of almost philosophical questions, such as: "How much are you really exposing your capital by each extra risk?" "How should the various targets be determined?" These questions delve further into the areas of risk and reward, mentioned briefly in Section 3, and into asset/liability modelling.

Then, all these issues should be communicated to the shareholders from a business, as opposed to an actuarial, perspective.

Mr A. N. Hitchcox, F.I.A. (replying)**:** Pricing in the London Market is an interesting and complex subject. In my experience, if you have 20 or 30 data points when pricing a risk, that can sometimes be regarded as a large sample. This means that the more complicated mathematical and statistical techniques are often not applicable. However, the actuary can still be of assistance to the underwriter by focusing on some core skills coming out of his normal training. I mention three of these:

(1) making sure that estimates are unbiased;
(2) trying to quantify the basic concepts of risk and reward; and
(3) ensuring the consistency of model building.

This last skill is, to me, one of the most important contributions I feel that I make to my own managers and underwriters.

Mr Ryan's contribution was useful, because it helped set the topics in our paper in the context of the problems of managing a London reinsurance company. His distinction between narrow underwriting skills and the so-called line of business manager is well made, and reflects the discussions we frequently have within my own company when we discuss the skills required by our managers for the future. If actuaries want to be managers for the future in London reinsurance companies, then they do need to have a good grasp of the skills demonstrated by Mr Ryan.

The President (Mr D. G. R. Ferguson, F.I.A.): This is a developing area for actuaries, and is one where we can make financial sense of the future, where we can make a contribution in a number of ways, some of which have been illustrated in the discussion. It has been, and still is, an area of employment growth for actuaries, and as those younger members of the profession who are working in the area will know, it is one with a very bright future and with a significant remuneration premium attached to it.

We also know from the experience in North America that this is an area of considerable growth for actuaries the other side of the Atlantic Ocean. There is a great deal that we can learn from our American colleagues. However, experience in this country also goes back some way.

This has been a good discussion. I give my thanks to the authors for an excellent and extremely readable paper, and a very useful addition to actuarial literature. I hope that you have all enjoyed it as much as I have, and we now show our appreciation to the authors.

WRITTEN CONTRIBUTION

The authors subsequently wrote: There were various recurring themes in the discussion on the paper. We address some of these below.

Firstly, we comment on the potential conflict between the pricing actuary and the reserving actuary. Some speakers felt that the link between the pricing and the reserving functions was essential, since it added value to both functions and effectively completed the feedback loop within the control cycle. Other speakers commented on remunerations related to performance, requiring different perspectives and measurement criteria for the two functions.

The solution may reside in recognising the differences in pricing basis and reserving basis, and effectively communicating these to the management. For pricing it may be appropriate to take a realistic view, whereas for reserving for statutory purposes it would be more appropriate to take a prudent view. Provided that the differences in the two bases are understood and appreciated by the management, the interaction between the two functions can only help to improve the effectiveness of both the functions. Furthermore, the reserving function would act as a control and peer review of the pricing function.

The extent to which the planning, pricing and reserving models can be integrated and feedback loops established will determine the effectiveness of this communication process. This may also call for yet another actuarial role in the form of a corporate or planning actuary to facilitate communication with management. For a small company with limited actuarial resource, it is likely that a single actuary may be required to fill all three roles.

Secondly, on the effect of underwriting cycles on profit testing, we would refer to our comments in the paper on the difficulty of predicting underwriting cycles, and thus allowing for them in profit testing. Our approach advocates use of profit testing, not to arrive at a single estimate of return on equity or target underwriting ratio, but to arrive at a range of estimates within which the actual experience may fall. Thus, taking a longer-term view of, say, five years, covering a potentially complete underwriting cycle, the range of scenarios may give results at both top and bottom of the underwriting cycle. The actual pricing would depend on current market conditions, and should, it is to be hoped, fall within the projected range. The underwriting management would then be a question of managing the company's free reserves. In good years the free reserves would be added to, and in bad years they would be drawn upon, to meet the required financial results. To a large extent, this approach advocates the need for equalisation reserves for all classes of business.

Given the uncertainty in any pricing or reserving processes, scope exists to carry a provision for adverse deviation. The extent of this provision would depend on the expected profits available within the current pricing levels and the size of the free reserves. We agree that it would be difficult to apply such longer-term perspectives to Lloyd's syndicates on the current annual structures. However, this approach may well be appropriate for dedicated corporate capital vehicles.

Thirdly, on allocating capital to individual lines of business and then chasing premium volumes, we would agree that setting target underwriting ratios would be a better alternative. The capital

allocations to different lines of business and the required return on capital from each line of business may be considered at a corporate level, with final allocations based on the expected market conditions, and with a view to optimising the required return on equity at the corporate level. At a line of business level, the underwriter may well be given a premium target (rather than a capital allocation) and a target underwriting ratio on that premium level.

Finally, on the training and the development of actuaries, needs exist in both specialised pricing and reserving roles. However, ultimately the chief actuary will need to be fully conversant at these specialised levels and also to have other skills in areas such as business planning, investment management and general management.