Report No. 2 - Outstanding Claims Reserves

Presented - GIRO seminar - YORK - September 1976

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Section I - Introduction

1.1 This paper is the second of a series of papers to be produced by the Technical Reserves working party (report No. 1 covered IBNR reserves). The main object of these papers is to describe methods which have been used to estimate technical reserves in General Insurance having made due allowance for the various circumstances experienced in practice. It is the intention to include explanatory comments to assist the user in applying the different methods described.

1.2 As mentioned in Report No. 1 the logical sequence of papers would probably have been different but at the request of the General Insurance Study Group the second paper has been restricted to reserves for reported outstanding claims.

1.2.1 Some of the methods described in this paper, however, could be used in certain circumstances to predict the total reserve required for outstanding reported claims plus IBNR and even plus unexpired risk reserves.

1.3 The comment made in Report 1 that it is not the intention to suggest ideal solutions to the problem is equally important in this report. For the sake of completeness we will repeat that the purpose is to highlight some of the considerations which must be taken into account by the statistical investigator in general insurance and to indicate possible practical approaches. Further work on the detailed statistical considerations needs to be carried out but unfortunately we had insufficient time to complete this.

1.4 It is vitally important to have close contact with both underwriting and claims staff so that the projected estimates of reserves will reflect changes in standards of underwriting or administration.

1.5 Insufficient experience is available as to the validity of the different methods for different classes but even if the method is the best available the adequacy of the method is very dependent on the quality of the data, the size of the portfolio and the assumption of future rates of inflation.

1.6 This paper is restricted to consideration of direct business because the major element in reinsurance business is the IBNR reserve. The outstanding claims reserve is as reported to the reinsurer by the direct insurer. (See Report No. 1 paragraph 1.2.1).

1.7 The main part of the paper has been subdivided into four parts:-

1.7.1 Section II Definitions

1.7.2 Section III A description of the data it is advisable to extract

1.7.3 Section IV A description of the statistical methods with practical comments on their use and interpretation of their results.

1.7.4 Section V Conclusion

1.8 We acknowledge that many comments in this report repeat those in the IBNR report, but we believe each report should stand on its own.

Section II - Definitions

Outstanding Claims Reserves - Direct Business

2.1 The compilation of a company's trading results will normally relate to a specified period ending on a defined date; and will include a statement of assets and liabilities as at that date.

We therefore refer to the 'accounting period' ending on the 'accounting date'; it is customary to publish results for an accounting period of 12 months ending on 31st December.

2.2 For practical convenience each company will have a set of rules which, having regard to its particular system of debiting and recording, determine the movements which are to be included in each accounting period. Such a set of rules will involve a date which we term the 'closing date' which effectively terminates the accounting period in question. In some cases the closing date will coincide with the accounting date; but more often that not the two dates will differ in order to allow 'pipe-line' movements to be processed.

2.3 With regard to claims the rules will customarily specify that all claims 'notified' before the closing date will be included in the known liabilities. In this context the meaning of 'notification' will vary according to company practice; for example; it may mean the reporting of the claim to a branch office; on the other hand it may be interpreted as the recording of the claim on the computer file.

2.4 Strictly speaking outstanding claims refer to claims which have been incurred and reported before the accounting date and remain outstanding at the accounting date (as defined in 2.1 above). However, in view of the convention of using a closing date which may differ from the accounting date it is convenient to define outstanding claims for the present purpose as those which are incurred before the accounting date and notified and remain outstanding by the closing date.

2.4.1 The subdivision of outstanding claims at the closing date by "year of claim" depends on the individual companies' definition of "year of claim". Depending on company practice and class of business this can mean 'year of occurrence', 'year of report' or 'policy year'.

2.4.2 Under direct business the incurment of a claim is generally determined by its occurrence, an event which is usually defined. There are, however, some exceptions which are exemplified below:-

(a) Industrial injuries or diseases may sometimes not become manifest as potential employers liability claims until a lapse of time after the incident, accident or situation which gives rise to the condition. Company practice may vary in regarding the claim as having been "incurred" at the time of the original incident or at the time when the resulting condition first becomes apparent. For the purpose of this paper if the claim is reported by the closing date and it is still outstanding then it is included in our definition of outstanding claims. The allocation of the outstanding claims between past years depends on the analysis procedure of the company i.e. year of occurrence, year of report or policy year (see 2.4.1).

(b) A similar problem arises in connection with claims under mortgage guarantee and professional indemnity types of policies. Company practice will determine to which "year of claim" an outstanding claim will be allocated.

2.5 As mentioned in 2.2.1 some methods can be used to predict outstanding claims reserves plus IBNR and sometimes plus the reserve for the unexpired risk period. It will be made clear in the report how the data should be analysed to produce the reserves for other than outstanding claims.

2.6 Any special reserve which might be required at the closing date against adverse movements in the estimated liabilities under claims already reported will be excluded from our definition of outstanding claims. We would consider any special reserves covering all outstanding claims irrespective of year of claim to be held as equalisation or contingency reserves.

2.7 Company practice varies as to the circumstances in which a claim may be regarded as "settled" (implying that the company has no further liability thereunder). Whatever the practice, it is to be expected that some proportion of such "settled" claims will subsequently be re-opened and further payments made. As a matter of prudence, it is customary to reserve against such additional liabilities, perhaps by means of specific reserves or implicitly by means of margins in the estimated liabilities under outstanding claims. However, many of the statistical methods described in this report automatically make allowance for re-opened claims.

2.8 We have assumed that the reserves are estimated on a Gross basis initially and allowance made for outward reinsurance, if appropriate, as a final adjustment determined by the type and nature of the reinsurance arrangements. In certain circumstances it is possible to estimate net reserves immediately.

2.9 Published company results may present outstanding claims reserves as including both the basic claims liabilities and the claims handling expenses. However, this paper is confined to a consideration of claims liabilities only and excludes claims handling expenses which it is assumed would be assessed as a separate provision. In this connection a distinction should be drawn between specific fees attributable to particular claims and general office administration costs; the former which would include such items as legal charges, medical fees and engineers' (consultative or employed) fees, would usually be regarded as part of the individual claims liabilities.

Section III - A description of the data it is advisable to extract for case estimating and statistical reserving

3.1 Although the main aim of this paper is to provide guidance as to practical methods which can be used for estimating outstanding claims we will not be able to place them in perspective unless we initially discuss the way in which data can be displayed for analysis and the level of subdivision which is probably advisable.

3.2 It is right to question whether our aim is to provide adequate reserves for the company as a whole or to assess individual classes of business (product lines) separately. Suffice to say that it is up to the individual to decide the purpose for which the estimates of outstanding claims reserves are to be used. If it is to value the profitability of the company as a whole then the subdivision may be of a broader nature but if the aim is to consider the profitability of the individual classes of business then the subdivision must be at least to the level of individual classes of business.

3.3 In considering any subdivision we must always balance the requirement of homogeneity of data on the one hand the wish to minimise the statistical variance due to size of cell on the other. This fact is true whether we are considering valuing a company as a whole or a particular class of business on its own. For small companies, grouping similar classes of business may be necessary whereas for large companies it may be possible to divide the data for a particular class of business into risk groups. In practice, for liability classes of business, we aim for approx 2000 claims in a group so that the results produced are reasonably reliable. Of course the number will depend on the variance of the mean claim value. As a working party we do not have sufficient experience to advise effectively on this point for the individual classes of business.

3.4 On the question of homogeneity of data this can mean different things for different statistical methods. It is possible if we are using methods relating to the development pattern of claims payments that we may be able to group together data which for average cost per claim purposes could not be grouped. We may also find that for some classes of business the hetergeneity is due to different levels of frequency of claim rather than the different development pattern of the claims payments. The investigator must judge for himself or herself the relevance of the data he or she is investigating.

3.5 Most of the statistical methods and even the appraisal of case estimates require data to be presented and analysed in a particular way. For the purposes of this report we will assume that we have selected a particular class or classes of business to investigate and we will endeavour to describe how the data should be presented for analysis.

3.6 Claims can be analysed in a number of ways. For example the duration covered by a cohort can be specified by accident date, report date or even policy year date. Whilst for risk assessment accident date analysis is preferable the basis of subdivision depends on the individual circumstances of the individual companies.

3.7 As mentioned in discussing the subdivision of data in 3.1 to 3.4 we do require sufficient data in any particular cell for satisfactory analysis. This is important in considering the level of subdivision of data into the chosen group for analysis. Ideally to allow for changes in portfolio size and the effect of inflation we should aim to subdivide data into monthly cohorts with delay information in monthly periods of delay. It is likely however that in many cases this will provide cells of insignificant size and therefore we may require either quarterly cohorts with quarterly delay information or even yearly cohorts with yearly delay information.

3.8 Whether we are analysing cohorts of claims using case estimates or statistical estimates of outstanding claims it is preferable to provide a statement of the following kind.

No. of Claims	Cohort Period	Development Period					Estimated outstanding reserve	Total Liability
		1	2	3	4	t		

3.9 As mentioned in 3.7 the period of each cohort can be between 1 month and 1 year in duration. If the information is by yearly cohorts then the claims payment information is in respect of a cohort up to the "accounting date" of each year. If the information is by year of report rather than, say, year of accident, then the number of claim will be fixed and relate to the claims occurring before the "accounting date" but notified by the "closing date" - see 2.4 of the previous section.

3.10 Some statistical methods do require knowledge of exposure relating to the cohorts. Measurement of exposure in General Insurance can be difficult. Measures which have been used are policy years, vehicle years and sum insured. For some statistical methods even the amount of premium and number of claims have been used as a proxy for exposure. Whatever measure is used we should also collect the information on a consistent basis so that it can be combined with the claims data to provide a complete analysis of the class.

Section IV

A Description of the statistical methods with practical comments in their use and interpretation of their results

Individual case estimates for outstanding claims

4.1.1 Any report on reserving methods for outstanding claims would not be complete unless we include a description of the different ways of case reserving and monitoring their progress over time. For some classes of business the method could even be described as a semi-statistical method as it requires the individual claims assessor to draw on his experience in deciding on the most probable outcome of the claim to be reserved.

The value of case estimates

4.1.2 There are areas where case estimates are of particular value but there are many grey areas where the extra information they provide must be balanced with the cost of collecting and analysing it.

4.1.3 Systematic recording and analysis of numbers or amounts of notified outstanding claims is recommended if:-

(a) The value of outstanding claims constitutes a sizeable proportion of the notified liability for claims which arose in recent periods.

(b) The distribution of size of claim is such that the mean cost of outstanding claims cannot be accurately forecast (i.e. if the variance is large, or if there are outliers).

(c) The portfolio of risk is too small to allow accurate forecasts based only on paid amounts.

(d) The payment/settlement pattern is not sufficiently regular to enable good forecasts, or if a sufficient history of payments is not available.

(e) The incidence of claims is irregular as in the case of professional indemnity class of business.

Case estimates, perhaps on a simple basis, might also be of value in some other cases as a check on the answers produced by statistical methods.

4.1.4 A motor material damage account might satisfy none of the above conditions making systematic case estimates of little value but statistical methods of greater value. On the other hand a liability account might satisfy all conditions, making the analysis of case estimates of considerable importance, and statistical methods of lesser value.

The nature of case estimates

4.1.5 In a straightforward case a claims assessor can quantify the extent of liability under the policy and his only problem will then be to assess the probable delay to settlement of the claim and the appropriate rate of interest and/or inflation to arrive at a probable settlement cost. (For claims in a foreign currency there is also a problem in determining any future changes in the exchange rate).

4.1.6 However, this simple case will frequently be complicated by the receipt of further knowledge about the circumstances of the claim which will result in a revision of the outstanding reserve. In a sense, this case is parallel to that of a reopened claim.

4.1.7 The more complicated case is where the claims assessor is conscious that he has not yet received complete information, but nevertheless has to state a reasonable reserve to be held until further information is received.

4.1.8 Practice regarding the allowance made for the expected delay to settlement and appropriate interest and/or inflation rates has varied from company to company. It might seem best to make no allowances on an individual claim basis, but to apply expected inflation rates and delay distributions to class totals whenever analysis is required. This method will have the advantage of allowing the most recent assessment of inflation and delay to be used and will allow some assessment of the technical accuracy of the claims staff. However, if inflation rates are applied on a block basis, care should be taken to identify any special features - e.g. significant deductibles on the claims.

(Block adjustments produces problems when individual estimates are needed for other purposes e.g. experience rating).

4.1.9 Some companies provide standard tables of factors to be applied depending on the expected delay to settlement. Others have relied on the experience of their claims staff to make adequate provision, so that estimates make an implicit allowance for delay and inflation.

4.1.10 However, except for very simple classes of risk, the greater part of any variation between outstanding reserves set up and eventual settlement costs will probably be due to additional information received, and where this is so it becomes very difficult to assess the technical performance of the claims assessor.

Analysis of case estimates

4.1.11 Once one starts considering the analysis of the accuracy of case estimates we move into the range of statistical valuation methods, but one worthwhile analysis which should be made is the following:-

Cohort Period	Outstanding Estimate B/F	Claim Payments during Period	Outstanding Estimate C/F	Movement since beginning of period (3) + (2) - (1)	Movement as a % of outstanding Estimate B/F
	(1)	(2)	(3)	(4)	(5)
x	19,960	1,960	9,070	-8,930	-44.7
x + 1	53,620	15,450	20,630	-17,540	-32.7
x + 2	182,000	40,419	166,710	25,129	13.8
x + 3	251,260	49,473	231,425	29,678	11.8
x + 4	425,730	55,368	457,210	86,848	20.4
Total	932,570	162,670	885,045	115,145	12.3

4.1.12 By reviewing the movement of the case estimates as indicated by Col (5) of the above table for different periods, some assessment of possible future movement could be made to adjust the current case estimates. It must be appreciated that the method is relatively crude especially as one of the factors which will influence the percentage movement will be the assessment in the past, by the claims staff, of future levels of inflation. It may be possible to make some adjustment for this incorrect assessment.

Average Cost Methods

4.2.1 With some classes of business, it is possible to project the estimate of the total claims cost, total cost of settlements by duration or the total cost of outstanding claims by duration. The main requirement for the projection of each of these items is that the fluctuations about the mean value is within acceptable limits.

4.2.2 All these methods require the historic values to be standardised to constant monetary values (prior to estimating the mean value); in other words the influence of inflation must be removed. Having estimated the mean value, the future values can be estimated by incorporating the effect of expected future inflation. The levels of inflation used in these exercises will be dependent on the class of business and the duration to settlement. In some cases the influence of inflation is purely dependent on when the claim occurs, not when it is settled, and the adjustments are then somewhat simpler.

4.2.3 In the remainder of sub-section 4.2 we will describe the three average cost methods, namely:-

(a) Average Cost per claim

(b) Average Cost per settled claim

(c) Average Cost per outstanding claim

The average cost per claim method probably has wider applicability than the other two methods especially as it can be used in forecasting as well as reserving.

Average Cost per Claim

4.2.4 In the first instance we must assess the impact of claims inflation compared with economic inflation so let us assume that for every £100 of claim occurring in 1970 the assumed payments are on average distributed as follows:-

	£
1970	15
1971	25
1972	30
1973	20
1974	10
Total	100

This £100 is the sum of the average payments in each year in terms of money in each payment year. The whole £100 is not in "1970" money. An important variant of this method is to express average payments in each year in say 1970 money, for each year of origin, then put back past inflation with allowance for future inflation. This is then effectively a payment run off method (a la Taylor) but with inflation taken from an index rather than derived from the payments pattern.

4.2.5 Let us assume that the levels of inflation applicable to the class of business from which this claim arises for the period 1970 to 1975 are:-

1971/70	11%
1972/71	12%
1973/72	14%
1974/73	17%
1975/74	26%

We also assume that inflation is related to date of settlement.

4.2.6 Based on the assumptions in 4.2.4 and 4.2.5 we can expect a claim occurring in 1971 to experience the following payments

1971	15 x 1.11	=	16.65
1972	25 x 1.12	=	28.00
1973	30 x 1.14	=	34.20
1974	20 x 1.17	=	23.40
1975	10 x 1.26	=	12.60
		Total	114.85

4.2.7 From section 4.2.6 above the expected average cost for a claim in 1971 is £114.85 which is 14.85% higher than the average cost for a 1970 claim and not 11%, the actual level of inflation between 1970 and 1971.

4.2.8 <u>The General Method</u>

Using the methods outlined in 4.2.4 to 4.2.7 above an estimate of the probable inflationary increase from one year to another is found by applying the standard "run-off" % 's for claim payments to the levels of inflation likely to be experienced over the "tail" of the claims.

4.2.9 Let us assume the standard run-off as referred to in 4.2.4 i.e.

YR 1	15%
YR 2	25%
YR 3	30%
YR 4	20%
YR 5	10%

4.2.10 Let us assume the same inflation rates in 4.2.5 together with projected rates to 1978 i.e.

1971/70	11%	1975/74	26%
1972/71	12%	1976/75	22.5%
1973/72	14%	1977/76	20.0%
1974/73	17%	1978/77	17.5%

4.2.11 Based on the assumptions of 4.2.9 and 4.2.10 the following working table can be produced:-

	1971		1972		1973		1974	
Run-off factors	Inflation	(1)x(2)	Inflation	(1)x(4)	Inflation	(1)x(6)	Inflation	(1)x(8)
(1)	(2) %	(3)	(4) %	(5)	(6) %	(7)	(8) %	(9)
.15	11	1.65	12	1.80	14	2.1	17	2.55
.25	12	3.0	14	3.50	17	4.25	26	6.5
.30	14	4.2	17	5.1	26	7.8	22.5	6.75
.20	17	3.4	26	5.2	22.5	4.5	20	4.0
.10	26	2.6	22.5	2.25	20	2.0	17.5	1.75
Total	-	14.85	-	17.85	-	20.65	-	21.55

4.2.12 A comparison of "adjusted" rates of inflation with the actual inflation rates is shown below:-

	actual	"adjusted"
1971/70	11%	14.85%
1972/71	12%	17.85%
1973/72	14%	20.65%
1974/73	17%	21.55%

4.2.13 By applying the "adjusted" rates and the actual rates of inflation to the 1970 average cost of a claim of £100 it is possible to obtain the following expected average cost per claim in each of the years 1971 to 1974.

"adjusted" inflation				actual inflation			
1970			= £100	1970			= £100
1971	100	x 1.1485	= £114.85	1971	100	x 1.11	= £111
1972	114.85	x 1.1785	= £135.35	1972	111	x 1.12	= £124.32
1973	135.35	x 1.2065	= £163.30	1973	124.32	x 1.14	= £141.72
1974	163.30	x 1.2155	= £198.49	1974	141.72	x 1.17	= £165.82

The above figures indicate substantial differences can occur.

4.2.14 In practice we would probably apply the claims inflation factors to a number of past years to produce an estimate of more recent or immediate future year. For example, if the average cost per claim in each of the years 1970 to 1973 were as given below we can assess 1974 expected level using the claims inflation factors, as produced in 4.2.12.

	Cost per claim £	Inflation factors	Projected 1974 Cost £
1970	52	1.1485 x 1.1785 x 1.2065 x 1.2155	103.2
1971	60	1.1785 x 1.2065 x 1.2155	103.7
1972	68	1.2065 x 1.2155	99.7
1973	86	1.2155	104.5

Expected Average 1974 (the mean of the above) = £102.8

4.2.15 The estimate of the reserve for outstanding claims can be found for each "Claim Year" by multiplying the number of claims (which can include IBNR claims if applicable) by the average cost per claim obtained using "adjusted" inflation and then subtracting the payments to date.

4.2.16 With the past inflation factors incorporated in the method based substantially on the inflation experience of the portfolio, the method becomes closely akin to a claim payment run-off method in which past inflation has been eliminated and then past and estimated future inflation have been incorporated in the final projection.

4.2.17 The advantage of this method is that whilst it is relatively crude it is easy and quick to apply. It can be used, with a fair degree of confidence, where the portfolio being valued is relatively stable in its mixture of risks over a period of time and is of a reasonable size.

4.2.18 An alternative Average cost per claim method is one which subdivides the portfolio by risk groups and into the basic elements of a claim, e.g. Own Damage and Bodily Injury. The comments made in section III, especially paragraph 3.3, as to size of cell, should be kept in mind.

4.2.19 We will use a private car portfolio to illustrate the method but it can be extended with minor modifications to many classes of business.

4.2.20 To use the method the claims data is grouped by multiway classification. The rating factors which are considered important in assessing the claim cost e.g. cover, class of use; age of policyholder, car group are selected in advance. The rating factors can be denoted by:-

A, B, C etc. Each of these main rating factors are subdivided into levels e.g. Age 17-20, 21-24, 25-30 and 30-70. These can be denoted by a suffix to the main rating factor. Hence (ABC) ijk is the estimate for claims cost for rating factors A, B and C at levels i, j and k respectively.

4.2.21 In assessing the historic values of (ABC) ijk we require a considerable amount of data. Therefore it may be necessary to analyse a cohort of claims arising from a relatively long period of exposure. It is preferable that data are based on year of accident but it is not essential. The historic average claims costs should be divided into Accidental Damage, Third Party Property Damage, Third Party Bodily Injury (TPBI) and Other. Especially in the case of TPBI there could be an element of outstanding claims estimates.

4.2.22 The following information is also required:-

(a) Past inflation i.e. from period of accident to date at which claim reserving is to be estimated, and future inflation from date of claim reserving.

(b) The average period to payment for each type of claim.

(c) Proportion of zero claims.

(d) Run-off adjustments (if necessary).

This is the ratio of the claim payment paid to the date of the calculations as related to the expected total liability. For cohorts where all the claim payments have been made there is no adjustment necessary.

4.2.23 It can be shown that in practice we can estimate the average cost per intimated claim for Accidental Damage and Third Party property damage from the information above using the following formula.

Let $(X)_{i\ j\ k}$ be the average intimated claim cost for (ABC) ijk.

The average input value $(Y)_{ijk} = \frac{X\ (1 + e)^k}{R\ (1 + f)^m}$

where R is run off adjustment (if necessary)

f is inflation rate from date of accident to date of payment

m is average period to payment by amount

e is inflation rate from date of accident to date of claim reserving

k is period from date of accident to date of claim reserving

Then $(Y)_{ijk}$ is projected using future inflation, say g, and an average period to payment, say m':- hence value used is $(Y)_{ijk}\ (1 + g)^{m'}$

4.2.24 Experience suggests that for Accidental Damage multi-way averages are preferable but for Third Party property damage one way results are sufficient.

Third Party Bodily injury claims are a problem. It is possible to use the following method:-

(i) estimate one way relativities using a selected rating factor e.g. age

(ii) estimate the present average cost using settled data allowing for growth and inflation

(iii) apply (ii) to (i) and adjust for future inflation.

4.2.25 The following table indicates the suggested information which should be produced. The information required has already been stated and in addition we require the number of accidents for each cell. If the analysis is soon after the period under investigation an estimate of the unreported claims must be included in the number of accidents.

		Average claims cost taking into account inflation and average period to payment				Total cost
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cell $(ABC)_{ijk}$	No. of Claims	AD	TPPD	TPBI	Other	(2)((3) + (4) + (5) + (6))

By summing column (7), we obtain total expected cost. By subtracting total payments paid to date from this total (if the reserves are to be taken after the date of accident), we obtain the outstanding figure. This result will include the IBNR reserve. If produced by year of report then the reserve would exclude the IBNR reserve.

4.2.26 The main disadvantage of the method is that there is a significant amount of work in designing and writing the complex system for collecting and applying the data. However, once written it can be easily applied and it is not necessary to obtain a great deal of data output since summary tables can be obtained as indicated above.

4.2.27 The main advantage of the method is that it is possible to take into account different inflation rates, period to payment, growth and changes in mix of risk groups. Also the assumptions used can be validated at a later date by actual experience and by taking into account types of payment etc. If the actual experience gives different results then, because of the detail, attempts can be made to find where the assumptions have gone astray. (An additional benefit of the method is that the information can be used to estimate premiums, hence valuation of reserves and premiums are directly related).

Average cost per settled claim

4.2.28 In the following paragraphs we will describe the method, but it should be emphasised that it can sometimes be a rather dubious process to base the estimate of outstanding claims solely on average settled claims.

Consider as an example two branches:-

Branch	Average settled claim	Average O/S claim
A	£60	£140
B	£67	£150

We might be tempted to conclude that Branch A must have a lower overall claim average than B, since both the settled and outstanding averages are lower.

4.2.29 This is not so if the situation is as follows:-

First 50% of claims settled for £60 each:	total	£3000K	) where there
Next 10% of claims settled for £100 each:	total	1000K	) are 100K
Final 40% of claims settled for £150 each:	total	6000K	) claims in all
		10000K	

and if Branch B has settled 60% of its claims, 10% more than Branch A.

4.2.30 It is quite common, at least in motor, for this sort of apparent anomaly to arise, sometimes in a more pronounced form than in the above example. We need to tread warily when considering average settlements.

4.2.31 The first step in applying the method is to tabulate historic averages of settled claims having adjusted for inflation. For the purposes of the example the retail price index was used, although users must satisfy themselves of the suitability of any index used in standardising the values.

4.2.32 The table below is an example of the results obtained.

Average cost of claims settled in year (£)
(Adjusted by the RPI to 1975 values)

	Claim year						
	1969	1970	1971	1972	1973	1974	1975
Settlement year							
1969	84.1						
1970	124	84.4					
1971	251	120	81.3				
1972	1054	370	128	82.2			
1973	1593	844	407	131	84.5		
1974	1319	2222	916	394	130	84.9	
1975	2769	1918	2015	1042	348	117	82.7

4.2.33 The above values assume that claims once settled are never reopened - a reasonable assumption since the amount paid on reopened claims in this example are small. If circumstances are different then a reopened allowance may have to be made.

4.2.34 Looking along each successive diagonal, it will be seen that the average becomes more variable as the settlement duration increases. This is partly because the long duration averages are based on a small number of settlements.

4.2.35 From the above table the future settlement pattern can be projected as follows:-

(a) The average of each diagonal is taken (i.e. in 1975 money terms) However, some values appeared abnormally low, e.g. the 251 on the third diagonal and the 1593 on the fifth diagonal, and for the sake of prudence such values were omitted from the averaging. If it were known that the future experience for long duration settlement were likely to differ from that in the past, an allowance of some kind could be made.

(b) Each cohort is considered separately and the averages from (a) are multiplied by the expected settlements in each future year. The results must be adjusted for future inflation.

4.2.36 The standard settlement pattern used should be derived from past experience. An example of a settlement pattern is:-

Development year	1	2	3	4	5	6	7	8
% age settled by number	60.5	35.5	2.5	0.8	0.4	0.15	0.08	0.07

assuming all remaining claims are settled in year 8.

This can be alternatively expressed as:-

Development year	1	2	3	4	5	6	7	8
% age of claims o/s (or not yet arisen) at start of year which are settled during the year	60.5	90	62.5	53	57	50	53	100

The expected number of settlements in a year can be estimated by applying the latter table to the number of outstanding claims for each claim year.

4.2.37 An example will make the method clearer:-

Let us take claim year 1974, and let us suppose there were 100,000 claims of which 94% had been settled by the end of 1975. On the assumption of 20% inflation between 1975 and 1976, and 25% thereafter, we then have:-

(1) Future year	(2) No. O/S at start	(3) % age of (1) settled in year	(4) No. settled in year = (1) x (2)	(5) Average settlement (1975 money)	(6) Inflation factor	(£000) Cost of settlement = (3) x (4) x (5)
1	6000	62.5	3750	380	1.2	1710
2	2250	53	1193	964	1.5	1725
3	1057	57	602	2000 (say)	1.875	2258
4	455	50	227	2000 (say)	2.344	1064
5	228	53	121	2800 (say)	2.930	993
6	107	100	107	2800 (say)	3.966	1188
TOTAL			6000			8938

Since the last future year includes all remaining settlements, 1⅓ years' inflation is allowed for between future years 5 and 6.

4.2.38 It will be seen that a large contribution to the final column is made by the last few lines, which are dependent on both the inflation assumptions and the assumption as to average settlement cost for the later settlement durations.

Average cost per outstanding claim

4.2.39 A method based on average cost per outstanding claim will be in many ways similar to the average settlement method above. An average outstanding claim method suffers from the same main drawbacks as the average settlement method; that is, the possible distortion of the results when the proportion of claims outstanding is liable to vary, and the need for a large volume of claims to reduce the variability in the averages to a manageable level.

4.2.40 Again, the claims will have to be subdivided into cohorts, say by year of reporting or occurrence. For the earlier cohorts, for which little will remain to be paid, the final liability can be estimated using any reasonable method - possibly involving case estimates. Knowing the number of claims outstanding and the cumulative amount paid at the end of each earlier year, the average estimate at the end of each year can be calculated based on the latest estimate of the ultimate cost. The object is then to use this information from earlier cohorts to estimate the outstanding claims for the more recent cohorts.

4.2.41 The average outstanding estimates obtain for the earlier cohorts at each development period must be adjusted by inflation factors so that they relate to values at the current valuation date. For this purpose an inflation index will be required, and the index value at each date must take into account the spread of future payments, and the expected cost level in the future years in which the payments will be made, for the claims outstanding at that date.

Methods employing the aggregate of claim payments

4.3.1 The methods described in this section can be used to provide alternative estimates to be compared with those produced by other methods of estimating and in certain cases could be considered suitable for the definitive calculations for the reserves for outstanding claims.

4.3.2 All the methods are based on the underlying assumption that for a cohort of claims or a period of exposure the "run-off" of claim payments by duration is relatively stable. As with many statistical methods the data are required to be sub-divided into broadly homogeneous risk groups. The choice of an appropriate time period for analysis of the data depends upon the volume of data and the effect of seasonal fluctations. All the methods automatically allow for reopened claims and also allow for I.B.N.R. claims if analysed by year of accident.

4.3.3 The data required for all the methods described would be all or part of the information displayed in para 4.3.8. For illustrative purposes we will use the following actual data so that we can provide practical examples for most of the methods.

Year	Earned Premium	No. of Claims	Cumulative payments to development year 1	2	3	4	5	Outstanding Reserve	Total Liability
1970	2304000	62725	753535	1402469	1714158	1887666	1958980	219464	2178444
1971	2274000	56403	642252	1290684	1540330	1746833		E_{71}	
1972	2735000	53837	715761	1376898	1686306			E_{72}	
1973	2642000	54122	841599	1704180				E_{73}	
1974	4129000	50994	968835					E_{74}	

The assumed past inflation rates will be:-

1971/70	11.3%
1972/71	12.4%
1973/72	14.0%
1974/73	17.3%

The assumed future inflation rate will be a constant 20% p.a.

4.3.4 The methods which will be described are:-

(a) chain ladder without inflation adjustment

(b) chain ladder with inflation adjustment

(c) chain ladder with separation technique

(d) geometrical progression

(e) delay table related to premiums

These methods are very similar to each other and there are many others which have not been described which are based on the underlying assumption mentioned in para 4.3.2.

Chain ladder without inflation adjustment

4.3.5 This method is based on the relationships of the cumulative claim payments for successive years of development for each cohort of claim. It can be used for classes of business which have a relatively short "run-off", say five or six years. However, care should be taken with some classes (e.g Consequential Loss) which have a short run-off but have low payments in the first year or two making the method unreliable. Longer periods of "run-off" can be used but the prediction for the more recent years where the amount of claim payment is small in relation to the total liability can be suspect. This method, as with some of the others, lend themselves to be applied to the data from Schedule 3 part 3 of the returns supplied to the Department of Trade.

4.3.6 The method is best described by using the values as produced in para 4.3.3.

$E_{71} = 1746833 \times (M_1 - 1)$ where $M_1 = \frac{2178444}{1887666} = 1.154$

$E_{72} = 1686306 \times (M_1 \times M_2 - 1)$ where $M_2 = \frac{1887666 + 1746833}{1714158 + 1540330} = 1.117$

$E_{73} = 1704180 \times (M_1 \times M_2 \times M_3 - 1)$ where $M_3 = \frac{1714158 + 1540330 + 1686306}{1402469 + 1290684 + 1376898} = 1.214$

$E_{74} = 968835 \times (M_1 \times M_2 \times M_3 \times M_4 - 1)$ where $M_4 = \frac{1402469 + 1290684 + 1376848 + 1704180}{733535 + 642252 + 715761 + 841599} = 1.95$

Therefore the outstanding claims reserve is:-

1971	269,000
1972	487,000
1973	962,000
1974	1,995,000
Total	3,713,000

4.3.7 The advantages of the method are that it is simple to apply and the data consist entirely of information (i.e. payments) which is subject to audit although it is possible to allocate claim payments incorrectly between years of claim. The method should also reflect trends in payment patterns to some extent.

4.3.9 The disadvantages in the method are more numerous. An important disadvantage is that the value of the multiplier M_1 is dependent on a single year's information which could be abnormal. This will affect estimates for every years outstanding claims. If we overcome this by using some historic data, then we may not reflect more recent trends. For property and personal accident classes, the size of this multiplier could be negligible but for motor and liability classes, it could be substantial.

4.3.10 Similarly the year 1 payments which are multiplied by successive smooth values of M_i are prone to large fluctuations especially for the longer tail classes. These fluctuations in the first year payments can arise due to the effect of weather for Motor, epidemics for P.A., internal administration and even the day on which Christmas falls.

4.3.11 An important disadvantage especially for those classes where claim payments are influenced by inflation at the time of payment is that inflation is not realistically allowed for.

4.3.12 The method also does not cope adequately with changes in mix of business, especially where the mix of business affects the run-off pattern.

4.3.13 Finally, the method does not adequately allow for expansion or contraction within the period of a cohort especially if the duration of each cohort is for an annual period.

4.3.14 Experience would suggest that the method produces better results for groups of years, i.e. the outstanding claims for the years 1971 to 1974 in total rather than the individual years. Also, the shorter the tail the more acceptable the results.

Chain ladder with inflation adjustment

4.3.15 As mentioned in 4.3.10 one of the more important disadvantages of the unadjusted chain ladder method is that it makes no specific allowance for inflation. One can overcome, to an extent, this disadvantage by standardisation of the "run-off" to pounds of a constant value, for instance - in our example - to 1970 values. It is then possible to carry out the same procedure in estimating standardised future payments as described in para 3.6. The standardised values would then be adjusted to expected money values using assumptions as to future inflation rates.

4.3.16 Using the table in paragraph 4.3.3 an example will assist the reader.

The standardised values of the claims payments are:-

	development year						
Year	1	2	3	4	5	Outstanding Reserve	Total Liability
1970	753535	1336584	1585733	1707395	1750025	109325	1859350
1971	577046	1095373	1270421	1393863			
1972	572146	1035726	1220681				
1973	590118	1105745					
1974	579143						

where 1971 development 3:- $1270421 = \frac{1540330 - 1290684}{1.113 \times 1.124 \times 1.14} + 1095373$

4.3.17 The values of M_i calculated by similar methods to para 4.3.6 are:-

$$M_1 = 1.089$$

$$M_2 = 1.086$$

$$M_3 = 1.176$$

$$M_4 = 1.835$$

4.3.18 The expected outstanding reserves allowing for 20% future inflation will be

1971	285,000
1972	535,000
1973	1,074,000
1974	2,209,000
Total	4,103,000

If we had used 20% inflation in 1975 and 15% thereafter the total outstanding reduces to £3,899,000

4.3.19 As can be seen from the previous paragraph the figures can be very sensitive to the assumptions as to future inflation rates. This highlights the difficulty one has in forecasting the future especially for liability claims, or even more so premiums. The past inflation rates used to standardised the claim payments should be those considered to correlate closely with reality, probably earnings for the liability classes and prices for property classes.

4.3.20 This method overcomes only the disadvantages of not adjusting for inflation. All the other advantages and disadvantages remain as for the unadjusted method.

Chain ladder with seperation technique

4.3.21 Since the unadjusted chain ladder is unable to cope satisfactorily with inflation and other exogeneous influences which are liable to produce substantial distortions in the multiplier and also since in the adjusted chain ladder we have to assess subjectively how much inflation is affecting claim payments, G. C. Taylor has developed a separation technique to allow for these effects.

4.3.22 The data required are as for the other methods but with the addition of the number of claims so that payments in each period of development can be converted into average payments per claim.

4.3.23 The data triangle can be set out in the form below where each average payment per development period is assumed to be the product of two factors:-

(a) r_k , dependent upon the year of development, which is intended to represent the basic distribution of claim payments unaffected by inflation and other influences.

(b) λ_t intended to represent the exogeneous influences which are assumed to be dependent upon the calendar year of payment.

4.3.24

Year of Origin	Payments in each year of run-off				
	First	Second	Third	Fourth	Fifth
t	$r_0 \lambda_0$	$r_1 \lambda_1$	$r_2 \lambda_2$	$r_3 \lambda_3$	$r_4 \lambda_4$
t_1	$r_0 \lambda_1$	$r_1 \lambda_2$	$r_2 \lambda_3$	$r_3 \lambda_4$	
t_2	$r_0 \lambda_2$	$r_1 \lambda_3$	$r_2 \lambda_4$		
t_3	$r_0 \lambda_3$	$r_1 \lambda_4$			
t_4	$r_0 \lambda_4$				

The 5th payment for t_0 does not include any reserve for later payments which is dealt with separately when it exists.

4.3.25 Assuming that the payments are completed in the (k+1)th development year the definition of r requires that $\sum_{i=0}^{k} r_i = 1$. If we sum along the bottom diagonal (every term of which involves λ_k) we obtain:-

$$d_k = \lambda_k (r_0 + r_1 + r_2 \; \cdots \; r_k) = \lambda_k$$

Thus d_k (the sum along this diagonal) is an estimate ($\hat{\lambda}_k$) for λ_k. Summing the next diagonal we obtain:-

$$d_{k-1} = \lambda_{k-1}(r_0 + r_1 + r_2 \; \cdots \; r_{k-1}) = \lambda_{k-1}(1 - r_k)$$

so that we could obtain an estimate for λ_{k-1} if we knew r_k . We can estimate r_k from:-

$$\hat{r}_k = v_k / \hat{\lambda}_k$$ (where v_k is the sum of the vertical involving r_k)

Hence we estimate $\hat{\lambda}_{k-1} = d_{k-1} / (1 - \hat{r}_k)$

By repeating this procedure we obtain the general solution:-

$$\hat{\lambda}_k = d_k / (1 - \hat{r}_k - \hat{r}_{k-1} - \ldots - \hat{r}_{k-i+1})$$

$$\hat{r}_j = v_j / (\hat{\lambda}_k + \hat{\lambda}_{k-1} \ldots \lambda_j)$$

where d_i is the sum along the (h+1)th diagonal and v_j is the sum down the (j+1)th vertical.

4.3.26 Using these estimators we can calculate smoothed values to replace all the actual known payments but cannot yet add the future payments to uncompleted years as the appropriate values of λ are not available. These are estimated by adding the forecast rate of inflation to the last calculated value of λ .

There remains the problem of payments still to be made after the 5th year. The average reserve estimated by the insurer for the earliest year of origin (which will be the only figure available when the data are restricted to a 5 year run-off for the last 5 years) is uplifted at the forecast rate of inflation to provide a reserve for each of the later years.

Finally all figures have to be multiplied by the appropriate numbers of claims to obtain the total liability.

4.3.27 Using the same data as set out in paragraph 4.3.3 we obtain the following values for

$r_0 = 0.4140$	$\lambda_0 = 29.0$
$r_1 = 0.3499$	$\lambda_1 = 28.4$
$r_2 = 0.1321$	$\lambda_2 = 33.2$
$r_3 = 0.0790$	$\lambda_3 = 35.9$
$r_4 = 0.0250$	$\lambda_4 = 45.5$

for additional values of λ_i increase by assumed future rate of inflation.

4.3.28 The expected outstanding claims value at 20% future inflation is:-

1971	314,000
1972	591,000
1973	1,104,000
1974	2,222,000
Total	4,231,000

Again if inflation was assumed to be 20% in 1975 and 15% thereafter the figure would have reduced to £4,018,000.

4.3.29 This method has been shown to produce similar results to the adjusted chain ladder method except where the average cost per claim is changing due to the mix of business. In these cases, it can produce substantially worse results.

4.3.30 As with the adjusted chain ladder method the method does allow for future inflation but is dependant on the accuracy of its projection. The method is also dependant on the reliability of the λ_t and ξ_t factors.

Geometric Progression

4.3.31 The long tail business quoted as not amenable to chain ladder methods has been observed to exhibit the feature that after an initial period claim payments tend to form, though subject to considerable fluctuations, a proportion of payments of the previous year, i.e. they run into geometrical progression. The initial period is usually three years, so for the year of origin and the following two years special measures are adopted, normally the reserve being taken as the whole fund represented by the excess income over outgoings to date. Calculation of the reserve based on the geometrical progression is then applied for claims outstanding at the end of the third year of development and the claims from all early years of origin in one aggregate amount.

4.3.32 The data required again came from the claims settlement analysis and are similar to those in paragraph 4.3.3 consisting of the claim payments made in the current year and two previous years for all years of origin which have reached development year 3 or later.

4.3.33 The data are tabulated in a form convenient for the calculation as below. The payments are for the year only (not accumulative)

Year of origin	Payments made in year of account		
Y_0 & earlier	$\frac{Y_3}{d_0}$	$\frac{Y_4}{e_0}$	$\frac{Y_5}{f_0}$
Y_1	c_1	d_1	e_1
Y_2	b_2	c_2	d_2
Y_3	a_3	b_3	c_3
Y_4	-	a_4	b_4
Y_5	-	-	a_5

The payments for years or origin Y4 and Y5 are dealt with in the special procedures for the initial period. If the ratio of the geometrical progression is "r" then the reserve required for the early years is

$\frac{r}{1-r}(c_3 + d_2 + e_1 + f_0)$ One estimate of r would be $\frac{d_2 + e_1 + f_0}{c_2 + d_1 + e_0}$ but by bringing in the year of account Y_3 it is possible to introduce some smoothing by using the recommended estimate $\frac{(d_2 + e_1 + f_0) + (d_1 + e_0)}{(c_2 + d_1 + e_0) + (c_1 + d_0)}$

4.3.34 The method has the following disadvantages:-

(a) Statistical fluctuations can be large enough to produce serious distortions in the calculation of "r." It could, for example, exceed 1; it is normally intended to put upper limits such as .95 on "r" but in such circumstances the reserve of 19 times the latest years payments is likely to be excessive. It is not impossible for r to be negative. Variations in the speed of settlements due to internal office action or administrative difficulties could produce similar distortions.

(b) There will be problems if there have been any breaks in the development of the business; these could arise from changes in the composition of the portfolio, changes in the rate of inflation, changes in the law etc. Anticipated changes in the rate of inflation, or of other factors, cannot easily be provided for.

(c) The basic assumption that claim payments form a geometrical progression is doubtful. Some data suggest that r reduces with increasing duration.

(d) It is always possible that higher reserves then the excess of income over outgo are needed in the first two years but any indications that this is so would have to be obtained from independent sources.

4.3.35 The initial period of special treatment described for the geometrical progression can be for other than three years; the changes are obvious. The initial period with the same kind of special treatment could also be applied in conjunction with the chain ladder methods. When more than the minimum number of years of data are available, it becomes possible to use the early years to apply additional smoothing or supply alternatives to data dependent upon only one or two years data figures; tests applied to actual data show that this is often advisable.

Delay table related to premiums

4.3.36 A further development of the chain ladder technique is to relate claim payments for a cohort to the earned premium for that cohort, thus the values of r can be expressed as the amount of claim payments paid in year 't' of development for cohort S per unit of earned premium for cohort S. Thus the sum of $r_1 + r_2 + r_3 + \cdots + r_k$ provides the indicator of the claims ratio for the cohort.

4.3.37 As can be seen the method does rely on the stability of the underwriting results and of the premium basis. The method does allow as with all the other methods the possibility of monitoring the expected future cash flow of claim payments with the actual cash flow. Adjustments can be made if the emergence is seen to be different.

4.3.38 One can improve the method by building in inflation factors, but as with other methods these must be subjective.

4.3.39 An advantage of the method is that values of r can be obtained if the only data available are earned premiums for each of several durations in the past and merely the current claim payments paid during the period subdivided by cohorts. The claim payments are divided by their respective earned premiums to obtain values of r_t .

4.3.40 An example will make this clearer. Using the data in 4.3.3 we have

$$r_1 = \frac{2178444 - 1887666}{2304000} = 0.1262$$

$$r_2 = \frac{1746833 - 1540330}{2274000} = 0.0908$$

$$r_3 = \frac{1686306 - 1376898}{2735000} = 0.1131$$

$$r_4 = \frac{1704180 - 841599}{2642000} = 0.3265$$

4.3.41 The estimate of the outstanding claims reserve will thus be:-

1971	= 2274000 x 0.1262	=	287,000
1972	= 2735000 (.1262 + .0908)	=	593,000
1973	= 2642000 (.1262 + .0908 + .1131)	=	872,000
1974	= 4129000 (.1262 + .0908 + .1131 + .3265)	=	2,711,000
		Total	£4,463,000

Section V

Conclusion

5.1 This paper has brought together a number of statistical methods for reserving for outstanding claims. As a working party we can between us suggest further lines of development which may provide a lead to further methods. One such suggestion is that there may be value in using information on claim size distribution but as yet insufficient practical experience is available to the members to propose the method as a practical proposition.

5.2 As a working party we are conscious that statistical methods can be dangerous if used with lack of understanding of the limitations both of the data and method in which they are applied. The examples given indicate how critical many of the methods are to the assumption as to future rates of inflation and this, of course, must be equally true with case estimates. In some areas of general insurance statistical methods are of evident value but there are nonetheless some circumstances in which only time will tell whether they have the advantage over case estimates.

5.3 Finally, we would add that there has not been complete agreement by all the members of the working party on the contents of this report. Time has not allowed sufficient discussions between us and we are conscious of the fact that we have not achieved all that we would have liked. We would recommend that the Study group allows a working party to continue to investigate the methods for estimating outstanding claims reserves and hopefully provide more detailed advices on how Actuaries should approach the problem.

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