Section L
ACTUARIAL CONSIDERATIONS

Preamble

Actuarial methods have for a long time been at the heart of life assurance, providing the essential discipline and long-term financial control. But in the last three decades, it has been increasingly realised in the UK that actuarial methods have an important part to play in general insurance as well. Although the time span is for the most part shorter, the business is likewise concerned with the measurement and financial control of risk. The problems of risk assessment and reserving, of solvency and the release of surplus are present in equal measure as with the life side.

The more sophisticated aspects of actuarial practice in claims reserving are to be found in Volume 2 of the Manual. The present section takes as its main subject the financial question of the discounting of reserves. There is a short discussion of some pros and cons of discounting, but the aim is to raise pertinent questions rather than provide conclusive answers. Some practical examples are given, showing how to put discounting into practice, if and when it is required.

The other actuarial topic dealt with at this stage is the monitoring of the claims estimates. Every method which is used for the estimating job should be regularly checked for the stability and reliability it shows in practice. Such procedure is a necessity if claims reserving is to be properly and professionally done.

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THE ACTUARIAL APPROACH

What is the contribution which actuaries are able to make to claims reserving? It is partly a question of the attitude of mind, of the determination to take as impartial and scientific a view as is permitted by the available data. But it is also the bringing into play of the techniques and principles which are required for a numerate and disciplined approach. From his or her training, such techniques and principles will be adopted almost as second nature by the actuary. Four of the most prominent will be mentioned here.

a) Variance of the claims estimate
b) Use of explicit mathematical models
c) Discounting of future cash flows
d) Tracking the performance of the estimates

a) Variance of the Claims Estimate

It is apparent, even from the simplest projection methods, that a variety of values for the claims estimate can easily be produced. In any case, since future events are involved, there can be no final certainty of what the exact figure should be. It may, however, be possible to give a best estimate, and a range (or variance) about that estimate within which the true value is likely to fall. Formal statistical techniques may throw some light on the confidence limits of the range of values.

b) Explicit Mathematical Models

The methods of §§E-K are set out in terms of strictly numerical development. This is the natural way to start in the work of claims reserving. But the methods can generally be restated in mathematical terms, introducing formal assumptions, equations and parameters of various kinds. The numerical work then resolves itself into: i) estimating the parameters, and ii) making the projection using the estimates. The advantage of the mathematical statement is that it brings into the open the mechanics of any particular method. The method's assumptions can then more easily be questioned, and the circumstances in which it is valid can be more precisely defined.

The use of statistical method and explicit mathematical models puts claims reserving on to a formal and fully reasoned basis. It is an area in which actuaries are particularly well fitted to contribute, and indeed provides the main thrust for Volume 2 of the Manual.

c) Discounting of Future Cash Flows

In life assurance work, it is customary for actuaries to discount the values of future cash flows of the business by some appropriate rate of interest. The main point of so doing is to take account of the fact that investment income is earned by the life office, and is a very material factor in the financial operation. In general insurance, investment income is not so dominant as on the life side, but it is still extremely important in contributing to profitability especially for insurers writing long-tail business. The implication at first sight would be that claims reserves, which relate very much to future cash flows, should allow for discounting. In the UK, however, that is not the practice, and almost all general insurance reserves are stated at the undiscounted value.

The actuarial view helps to clarify the issue of the possible discounting of claims reserves, so that advantages and disadvantages can be seen in the fullest light. Actuarial methods also provide the means for calculating discounted claims reserves, whenever and wherever these are required.

d) Tracking the Performance of the Estimates

How well do the claims reserving methods in common use perform? It is not always enough to make a claims estimate one year and then forget about it the next. One should ask, how good was the estimate in the light of subsequent events? If it was an accurate figure, that tends to show that the method used was sound in the circumstances, and may be expected to continue to give reasonable results, other things being equal. But if the estimate was off-beam, then the position needs to be re-evaluated. Perhaps a different method should be used, or the old one should be retained, but adjusted in a suitable way.

The aim should be to analyse the errors which occur in the past estimates, and make adjustments in future according to the experience gained. The process can be called "tracking the performance", and can be seen as a form of adaptive control.

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[L2]
THE DISCOUNTING OF CLAIMS RESERVES

In the insurance industry, premiums are normally collected in advance of the period of risk for which cover is given. In addition, it takes time for claims to be reported, processed and settled. It follows that an appreciable period is likely to pass between the receipt of premium and payment of the corresponding claims. During this time, the insurance office will make use of the moneys received by investing them in various securities. Investment income therefore enters the picture, and indeed plays an integral role in the overall balance of insurance accounts, affecting the office's solvency, profitability and competitiveness in the market.

This fact of commercial life raises interesting questions when it comes to the setting of claims reserves. Income will be produced in the time until the settlement of outstanding claims, and perhaps should be recognised in advance of its receipt. If this is to be done, the appropriate means is to discount the claims reserves by the principles of compound interest. The reserves will then appear at a lower figure in the balance sheet than they would otherwise have done on a flat, or undiscounted, basis. The practice is not an alien one, since it is followed almost universally in life assurance and pensions work.

However, against this, standard practice for general insurance in the UK is to publish undiscounted reserves. Discounting is rare in published and statutory accounts, and appears to have been largely limited to a few cases in the reinsurance market. There is the point that while life insurance and pensions have very long liabilities to consider, much business in general insurance is short tail, say of duration two years or less. For such business, investment income is not a large factor, and it may seem scarcely worthwhile to introduce it into the reserving equation.

Discounting for the purpose of the published accounts and the returns to the supervisory authority is constrained by legislation introduced in the UK to implement the provisions of the 1991 EC Council Directive on the accounts of insurance undertakings. It is not permitted except for categories of claim where the average expected period from the accounting date to final settlement, weighted on the basis of expected gross claims, is at least four years, and even for such categories there are other conditions that must be satisfied. Under the legislation, implicit discounting is prohibited.

Some additional disclosure is required in the accounts and supervisory returns where discounting has been applied. This disclosure should cover the effect of discounting on the overall provisions, the categories of claims to which discounting has been applied, the assumed mean term of the discounted claim payments (and the method used to assess the pattern of those claim payments) and the rate of interest used in the discounting.

Points of View on Discounting

When reserves are discounted, their values will almost always be reduced. The insurance office which consistently uses discounting will operate on a less conservative basis, and its emergence of profit will be accelerated. The desirability of this depends on the point of view being taken.

If solvency is in question, then discounting in effect removes one of the safety margins in the business. Although an explicit solvency margin is required by law, undiscounted reserves will provide a further cushion against adverse experience in the future. But at the other end of the scale, when premium rates are at issue, and we are not considering the reserves for the published accounts, discounting, implicit or explicit, is required if competitive rates are to result. For general management purposes, say in assessing the relative profitability of different lines, discounting will as a rule give the truer and fairer view.

The ultimate questions relate to the quantum of capital which is needed for underwriting new risks, and to how far profit should be held up in deference to the needs of solvency. There are no absolute answers to such questions — the application of sound professional judgment is the only practical way forward.

Three Stages in Discounting

For practical purposes, three main steps have to be taken in order to produce discounted reserves. These are as follows:

a) Assess the flat, or undiscounted, value for the outstanding liability.
b) Choose an appropriate payment pattern over the future years of settlement.
c) Select a suitable discounting rate, and apply it to the payment pattern.

We look at these three steps in turn.

a) Assess Undiscounted Value of the Liability

The first step is to determine the flat, or undiscounted value for the claims reserve. This may be found in many different ways, a fair number of which have been described in the earlier sections of the Manual. The undiscounted value is likely to include allowance for claims inflation, but the point should be checked. Questions may arise, for example, over case estimates. These can be valued to include future inflation, or alternatively for immediate settlement excluding inflation. In the latter event, an explicit allowance for inflation should be brought in during the course of the calculations.

b) Choose Payment Pattern over Future Years of Settlement

The payment pattern may often arise naturally from the derivation of the undiscounted estimate, but this is not always the case. Projections of paid claims or of paid loss ratio easily yield the payment pattern, but those of incurred claims do not. Case estimates are another example where information on the pattern is not normally provided. In such cases, the solution may be to use a standard pattern, perhaps gained from a study of industry data relating to the line of business in question. Alternatively, if data are available, a separate projection of paid claims may be made.

Standard patterns are in fact prescribed in the USA for discounting purposes. But they are open to the objection that they encapsulate features of the past which may not be repeated in future. This is particularly the case with levels of inflation, which can have a strong secular variation. A further point is that standard patterns are the most difficult to derive for the longer tail lines, precisely those for which discounting has the greatest effect.

c) Select Interest Rate for Discounting and apply to Estimated Claims

The actual application of the interest rate for discounting to the payment pattern is straightforward, and need not detain us here — the method is shown in the example of the next section. However, the choice of the appropriate discounting rate raises some difficult questions.

The starting point should normally be the expected yield on investments over the term of the outstanding claims. Since a cautious view is likely to be taken, this yield will provide an upper limit for the discounting rate. By taking a lesser value, the reserver will build in an implicit margin of safety for the office.

The next point is on the identity of the investments themselves. The obvious choice would be the actual assets held by the insurance office, but these may not be suitable (it is a matter of debate how non-interest bearing assets should be treated). The foundation is to select such investments as would by their income and maturity values exactly match the claim liabilities both in amount and timing. The most likely choice is therefore a portfolio of gilts, with term chosen to match that of the outstanding claims. The yield on such a portfolio should be relatively easy to determine. It should be remembered, that, because exact matching is not possible, reinvestment problems with different yields will arise.

Finally, there is the matter of tax. We shall illustrate the discounting process by using an interest rate of 5% per annum. The main reason is that investment income used to meet claims or strengthen reserves is deductible for tax purposes. But the insurance office may lose tax benefits where it is in a loss-making position, and in this case a yield less than the full gross yield should be used for discounting.

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[L3]
PRACTICAL EXAMPLE OF DISCOUNTING

The preceding section gave the three main stages for obtaining discounted reserves. These were:

a) Assess the flat, or undiscounted, value for the outstanding liability.
b) Choose an apt payment pattern over the future years of settlement.
c) Choose a suitable interest rate for discounting, and apply it to the payment pattern.

We will now follow through these stages in a simple practical example.

a) Assess the Undiscounted Value for the Liability

We begin from the usual data on the paid claims, and carry out a link ratio projection (see §E5). The projection in this case must provide values for intermediate years as well as the ultimate position. The work therefore employs the one-step ratios r throughout rather than the final ones f.

					d			
		0	1	2	3	4	5	*ult*
	1	1001	1855	2423	2988	3335	3483	3705
	2	1113	2103	2774	3422	3844		
a	3	1265	2433	3233	3977			
	4	1490	2873	3880				
	5	1725	3261				**[*pC*]**	
	6	1889						

		0	1	2	3	4	5	*ult*
		1.853	1.306	1.233	1.116	1.044	1.064	
	1	1001	1855	2423	2988	3335	3483	3705
a		1.889	1.319	1.234	1.123			
	2	1113	2103	2774	3422	3844		
		1.923	1.329	1.230				
	3	1265	2433	3233	3977			
		1.928	1.351					
	4	1490	2873	3880				
		1.890					[*r*]	
	5	1725	3261				[*pC*]	
	6	1889						
	r	1.897	1.326	1.232	1.120	1.044	1.064	

The one-step ratios here are just the average of the values in the column above them. The ratios are now applied to generate the expected payments in future years, which appear in the table below. Explanation of the figures:

In the bottom row:

$3583 = 1889 \times 1.897$; $4751 = 3583 \times 1.326$; $5853 = 4751 \times 1.232$; etc.

In the next row up:

$4324 = 3261 \times 1.326$; $5327 = 4324 \times 1.232$; etc through the table.

						d		
		0	1	2	3	4	5	*ult*
	1							3705
	2		[*pC*]				4013	4270
a	3					4454	4650	4948
	4				4780	5354	5590	5948
	5			4324	5327	5966	6229	6628
	6		3583	4751	5853	6555	6843	7281

Addition of the last column gives the estimated final loss, which is £32,780.

Paid claims to date are (as usual) £20,334. If these are deducted from the loss, we arrive at the undiscounted liability of £12,446.

b) Choose a Payment Pattern over Future Years of Settlement

In the present case, the step is simple, since the link ratio method on paid claims produces its own payment pattern. The figures in the table above are the cumulative values for paid claims as the years progress. Subtraction along the rows gives the year-by-year figures:

		d						
		0	1	2	3	4	5	*ult*
	1							222
	2		[ΔpC]				169	257
a	3					477	196	298
	4				900	574	236	358
	5			1063	1003	639	263	399
	6		1694	1168	1102	702	288	438

The payment pattern as a whole can now be obtained by adding the values along the diagonals. The sum of the top diagonal gives the amount to be paid in the year following the accounting date, the diagonal below that gives the year next following, and so on. We designate these years as t=1, t=2 ... ... The pattern is then:

t	1	2	3	4	5	6	7
$\hat{}pC(t)$	4525	3198	2275	1323	687	438	0
%	36.4	25.7	18.3	10.6	5.5	3.5	0.0

Overall Values: $\sum \hat{}pC(t)$ 12446

There is a point of detail in that the payments in the *ult* column do not quite follow the main pattern, since they represent the tail of the run-off. We will suppose as before (in §J2) that these payments occur on average 18 months later than those for year d=5. The practical effect is that, for example, the first *ult* payment of 222 can be seen as divided equally between the years t=l and t=2. The second *ult* payment of 257 can be divided between the years t=2 and t=3, and so on. This requires only a simple adjustment to the figures, effected in the next table:

t	1	2	3	4	5	6	7
$\hat{}pC(t)$	4414	3180	2255	1293	667	418	219
%	35.4	25.5	18.1	10.4	5.4	3.4	1.8

Overall Value: $\sum \hat{}pC(t)$ 12446

c) Choose Interest Rate for Discounting, and Apply to Payment Pattern

The third step can now be taken. We shall illustrate the discounting process by using an interest rate of 5% per annum. As seen in the preceding section, however, the choice of the rate is not an easy one, and should never be taken for granted. The reserver must weigh up the factors which bear on the situation, not least of which will be the purpose for which the reserve estimations are required.

To calculate the discounting factors themselves, and apply them, is a straightforward matter. An assumption has first to be made on how the claim payments will fall in each future year. Usually, it is adequate to assume an even spread, so that payments can be taken on average as falling at the midpoint of each year. With a 5% rate, the discounting factor for year t=1 will then be 1.025, since only half the year's earnings will be received by the time the average payment is due. Further payment points then follow at yearly intervals, so that succeeding factors are given by multiplying 1.025 by 1.05 the requisite number of times:

t	1	2	3	4	5	6	7
$\pi(1+h)$	1.025	1.076	1.130	1.187	1.246	1.308	1.373

The factors are labelled as $\pi(1+h)$. Here, π is used to denote a product, while h stands for the hypothetical rate of earnings on the fund.

The main discounting calculation can now follow. For each future year, the estimated payment $pC(t)$ is divided by the discounting factor $\pi(1+h)$. The resulting values are the amounts which should be set by as discounted reserves. According to the assumptions, if these reserves are invested at the accounting date and if they yield the required investment income, then estimated claims can be met exactly on their due dates.

t	1	2	3	4	5	6	7
$\hat{}pC(t)$	4414	3180	2255	1293	667	418	219
$\pi(1+h)$	1.025	1.076	1.130	1.187	1.246	1.308	1.373
Disct$^d V$	4306	2955	1996	1089	535	320	160

Overall Values:	Outstanding Claims	12,446
	Discounted Reserve	11,361

The 5% rate has here produced an appreciable reduction in the reserve required. It is useful to look at the sensitivity of the result, by evaluating it for a number of different rates of discount. This is done below:

Discount Rate	0%	2.5%	5%	7.5%	10%
Reserve	12,446	11.873	11,361	10,880	10,455

In selecting an appropriate rate for discounting the starting-point or benchmark could be a position where assets in risk-free investments are exactly matched to the run-off of liabilities. Gilts could be regarded as a first approximation but they do not cover currency and/or inflation risks; and in practice it is unlikely that they would match exactly by the term of run-off. Any deviation from that position leads to the consideration of a margin in the expected yield and capital growth; and a margin for mismatching of the timing. Whether such margins are introduced will depend upon the purpose of the discounting. The important point is that discounting has little meaning without reference to the actual or hypothecated assets. In §L4 the link between claims inflation and the discount rate (or investment return) is considered.

[L4]
DISCOUNTING COMBINED WITH INFLATION

When using discounted reserves, it is prudent to check the relationship between the discounting and any claims inflation in the projection. As seen in §J inflation will often be implicit in the data, and projected forward at its past rate. Alternatively, the reserver may have put in an explicit inflation assumption. In either case, the assumptions should be examined for their consistency, since times of high inflation often coincide with those of high earnings on invested funds, and vice versa. It is difficult to generalise over this point, however, and the reserver should keep aware of the prevailing influences on both claims inflation and investment yields.

The remainder of this section deals with the mechanics of combining discounting and inflation allowances in the same projection, by means of a practical example. The data used are the usual paid claims data with inflation adjustment built in, and are taken directly from §J2.4.

		d						
		0	1	2	3	4	5	*ult*
	1	1540	2789	3555	4233	4608	4756	4949
	2	1628	2963	3768	4468	4890		
a	3	1705	3107	3972	4716			
	4	1788	3283	4290		**[Adj.*pC*]**		
	5	1865	3401					
	6	1889						

These data are first projected using the link ratio method, averaging the factors down the columns:

d

		0	1	2	3	4	5	*ult*
		1.811	1.275	1.191	1.089	1.032	1.041	
	1	1540	2789	3555	4233	4608	4756	4949
		1.820	1.272	1.186	1.094			
	2	1628	2963	3768	4468	4890		
		1.822	1.278	1.187				
	3	1705	3107	3972	4716			
		1.836	1.307					
	4	1788	3283	4290				
a		1.824					**[*r*]**	
	5	1865	3401				**[Adj.*pC*]**	
	6	1889						
	r	1.823	1.283	1.188	1.092	1.032	1.041	

The ratios are used to project the claims for the various accident years, working along each row in turn:

d

		0	1	2	3	4	5	*ult*
	1							4949
	2		[Adj.*pC*]				5046	5253
a	3					5150	5315	5533
	4				5097	5566	5744	5980
	5			4363	5183	5660	5841	6080
	6		3444	4419	5250	5733	5916	6159

Addition of the *ult* column gives the estimate of the final loss, adjusted to the value of the present year's currency. This loss is £33,954. The paid claims to date, again in the same currency, are £23,942. (This value comes from adding the figures on the leading diagonal of the first data triangle above.) Subtraction of paid claims to date from the final loss gives the required reserve, which is £10,012.

This is the value which we now wish to adjust for i) inflation and ii) discounting of investment income. The first step in the adjustment is to find the year-by-year values for the future paid claims. As usual, this is done by subtracting along the rows of the above table:

		d						
		0	1	2	3	4	5	*ult*
	1							193
	2	**[Adj.Δ*pC*]**					156	207
a	3					434	165	218
	4				807	469	178	236
	5			962	820	477	181	239
	6		1555	975	831	483	183	243

Labelling future years beyond the accounting point as *t*=1, *t*=2, ...we can now build up the claim payments pattern. This is by adding the values along the diagonals in the above table (*t*=1 is the top diagonal, *t*=2 the second one, and so on):

t	1	2	3	4	5	6	7
^Adj.*pC(t)*	4107	2636	1704	900	422	243	0
%	41.1	26.3	17.0	9.0	4.2	2.4	0.0

Overall Value: ∑^Adj.*pC*(*t*) 10,012
(100%)

As in §L3, there is an adjustment to make for the payments estimated in the *ult* column. These payments are taken to occur 18 months later than those for year *d*=5. As a result, they need to be divided, for example so that half of the amount 193 falls in *t*=l and half in *t*=2. When this is done, the adjusted pattern is:

t	1	2	3	4	5	6	7
^Adj.*pC(t)*	4011	2629	1698	891	420	241	122
%	40.0	26.3	17.0	8.9	4.2	2.4	1.2

Overall Value: ∑^Adj.*pC(t)* 10,012
(100%)

Now we are ready to put inflation back into the payments. The future rate assumed will be 10%. This generates the following set of inflation multipliers:

t	1	2	3	4	5	6	7
$\pi(1+f)$	1.100	1.210	1.331	1.464	1.610	1.771	1.948

The multipliers, when applied to the payments pattern, give:

t	1	2	3	4	5	6	7
^Adj.$pC(t)$	4011	2629	1698	891	420	241	122
$\pi(1+j)$	1.100	1.210	1.331	1.464	1.610	1.771	1.948
^$pC(t)$	4412	3181	2260	1304	676	427	238

Overall Value: $\sum$^$pC(t)$ 12,498

The inflated payments now have to be discounted back by an appropriate rate, to allow for investment income. If 5% is chosen, as in §L3, the same set of discounting factors can be used. The result of the operation is:

t	1	2	3	4	5	6	7
^$pC(t)$	4412	3181	2260	1304	676	427	238
$\pi(1+h)$	1.025	1.076	1.130	1.187	1.246	1.308	1.373
Disct$^d V$	4304	2956	2000	1099	543	326	173

Overall Values: Outstanding Claims 12,498
Discounted Reserve 11,401

The result of discounting, as is often the case, is a substantial reduction in the required reserve. The assumptions in the projection are conservative, nonetheless, and inflation has been allowed a more powerful influence than the investment yield. At times, however, the reserver may wish to allow for a positive return on investments, net of any inflation of claims. If, for example, the above figures were reworked with inflation at 5% and investment yield at 7.5%, the reserve estimate would be reduced to £9,845.

It is well worth repeating the calculations for a number of different inflation and investment assumptions, and this has been done below.

		Discounting Rate (=Hypothetical Investment Yield)				
		0%	2.5%	5%	7.5%	10%
	0%	10,012	9,569	9,220	8,867	8,550
Inflation	5%	11,192	10,700	10,258	9,845	9,476
	10%	12,498	11,920	11,401	10,915	10,487
	15%	13,959	13,280	12,672	12,107	11,603

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[L5]
TRACKING THE PERFORMANCE

This section is a brief introduction to a large subject. The fact is that a claims estimate, once made, cannot be regarded as in any way sacrosanct. Future events are more than likely to prove it lacking in some respect. But that does not mean that the past estimates made in previous years should be forgotten. It is all too easy to consign them to insignificance in the archives when it comes to making the new set of reserves for the ending of the current accounting period. But much can be learned from the errors and inconsistencies in past estimates when compared with the latest set of data available to the reserver. In particular, the analysis of such errors can tell us more about the data in hand, and about the relative reliability of the different reserving methods under different conditions. In brief, the aim should be to track the performance of the past estimates, and take account of the information gained in setting the current reserves.

What follows in this section is a simple numerical example by way of a first illustration. The interpretation of the results, however, will not always be as straightforward as in the case shown here. It is an aspect of reserving which greatly needs a more formal, mathematical approach, although comparatively little seems to have been done on this to date.

Worked Example

The example uses figures from §L3, where paid claims were projected by the link ratio method. (The aim in §L3 was to illustrate the effects of discounting the claims estimates, but that aspect is not relevant here.) The result of the projection, discounting apart, was to produce the following figures for the ultimate losses (see §L3.2):

a	6	5	4	3	2	1
^L-ult	7281	6628	5948	4948	4270	3705

Overall Values:	$\sum$*^L-ult*	32,780
	$\sum$*pC**	20,334
	Reserve	12,446

A further result was to provide year-by-year figures for the projected paid claims, as in the table overleaf:

		d						
		0	1	2	3	4	5	*ult*
	1							222
	2		[ΔpC]				169	257
a	3					477	196	298
	4				900	574	236	358
	5			1063	1003	639	263	399
	6		1694	1168	1102	702	288	438

Now let us examine the position a year later. We suppose that the following paid claims are actually recorded during the year, the breakdown being given by accident year as usual:

a	7	6	5	4	3	2	1
ΔpC	2023	1850	1146	810	428	163	105

These values enable the new totals of paid claims to date to be found (time 0 in $pC^*(0)$ denotes the original position, time 1 the new, current postion):

a	7	6	5	4	3	2	1
$pC^*(0)$	-	1889	3261	3880	3977	3844	3483
ΔpC	2023	1850	1146	810	428	163	105
$pC^*(1)$	2023	3739	4407	4690	4405	4007	3588

Also, we may compare the estimates that were made under the link ratio method with the actual, emerging figures:

a	7	6	5	4	3	2	1
Estimate	-	1694	1063	900	477	169	111
ΔpC	2023	1850	1146	810	428	163	105
Deviation	-	+9.2%	+7.8%	-10.0%	-10.3%	-3.6%	-5.4%

Sum for years a=1 to 6:	Estimate	4304
	ΔpC	4397
	Deviation	+2.2%

(Note: 111 appears as the estimate for year a=1, since only half the tail of 222 is expected to be realised during the year in question. The deviation figures show the % increase or decrease of the actual figures over the estimates).

What the table shows is very clear: the method of projection has underestimated the payments for the two recent accident years, a=5,6; and it has overestimated payments for the earlier years a=1,2,3,4. The evidence is that a change in the claim development pattern is taking place, with a particular shift between years a=4 and 5. However, the evidence is not conclusive, since there are still comparatively few items of data on the years from a=5 onwards. Fortunately, for the projection as a whole, the deviations tend to be self-cancelling. But the warning sign is there, and must be heeded by the reserver — it suggests that an adjustment to the projection may be needed.

To develop the analysis further, it is useful to recast the whole projection for the current date. The new projection will be made for the years a=2 to 7, ignoring any small variation which may be indicated in the tail values for a=1. First, we shall set up the paid claims triangle, by reference to the original one (given on § L3.1). The new values required appear in the table on the previous page as the $pC^*(1)$ row. They provide the new leading diagonal for the triangle, whose updated version is:

					d			
		0	1	2	3	4	5	*ult*
	2	1113	2103	2774	3422	3844	4007	4263
	3	1265	2433	3233	3977	4405		
a	4	1490	2873	3880	4690		[pC]	
	5	1725	3261	4407				
	6	1889	3739					
	7	2023						

Here, the value 4263 in the *ult* column has been estimated as bearing the same proportion to the d=5 value as 3705 did in the earlier triangle. We now apply the link ratio method to the triangle in the usual way:

					d			
		0	1	2	3	4	5	*ult*
		1.889	1.319	1.234	1.123	1.042	1.064	
	1	1113	2103	2774	3422	3844	4007	4263
		1.923	1.329	1.230	1.108			
	2	1265	2433	3233	3977	4405		4885
		1.928	1.351	1.209				
a	3	1490	2873	3880	4690			5806
		1.890	1.351					
	4	1725	3261	4407				6677
		1.979				[*r*]		
	5	1889	3739			[*pC*]		7579
	6	2023						7882
	r	1.922	1.338	1.224	1.116	1.042	1.064	
	f	3.896	2.027	1.515	1.238	1.109	1.064	

Overall Values:	$\sum L\text{-}ult$	37,092
	$\sum pC^*$	23,271
	Reserve	13,821

We can now compare the results of the original and the new projections of the ultimate loss, on an accident year basis:

a	7	6	5	4	3	2	1
^L-ult(0)	-	7281	6628	5948	4948	4270	3705
^L-ult(1)	7882	7579	6677	5806	4885	4263	-
Shift %	-	+4.1	+0.7	-2.4	-1.3	-0.2%	-

The figures confirm the earlier picture, of an underestimation for the later accident years, and an overestimation for the others. But the information becomes even more useful when the loss ratios for the two projections are calculated. This is done below, using the earned premium figures, *aP*.

Original Projection:

a	7	6	5	4	3	2	1
^L-ult(0)	-	7281	6628	5948	4948	4270	3705
aP	-	8502	7482	6590	5680	5024	4486
^λ	-	85.6	88.6	90.3	87.1	85.0	82.6%

New Projection:

a	7	6	5	4	3	2	1
^L-ult(1)	7882	7579	6677	5806	4885	4263	-
aP	9211	8502	7482	6590	5680	5024	-
^λ	85.6	89.1	89.2	88.1	86.0	84.9%	-

Comparison:

a	7	6	5	4	3	2	1
^λ*(0)*	-	85.6	8.6	90.3	87.1	85.0	82.6%
^λ*(1)*	85.6	89.1	89.2	88.1	86.0	84.9%	-
Shift	-	+3.5	+0.6	-2.2	-1.1	-0.1%	-

The message coming through in these figures is clear: for the older accident years, there is a slight but welcome reduction in the estimated loss ratio. But for the latest accident year, the method is appreciably undervaluing the liability, owing to a change in the claim settlement pattern. It will be prudent to increase the estimate for this year (a=7), to reflect an anticipated loss ratio of at least 89%.

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