A TECHNIQUE FOR ESTIMATING THE LIABILITY FOR INCURRED BUT UNPAID CLAIMS

MR. BENJAMIN H. MULKEY: I've been asked to speak on the subject of claim liabilities. Although the title of this open forum is Exhibit 9, I'm going to stray into Exhibit 11.

I'm preparing a paper on claim liabilities, primarily from the point of view of the group health actuary. This work pertains to incurred but unpaid claims liabilities. I expect to have this paper ready to submit for publication soon. Paul Fleischacker is aware of this work and has asked me to speak as a result.

My interest in claim liabilities has grown out of my dissatisfaction with the methods generally in use. In my experience, many of these methods cannot be relied on to produce reasonable results. Further, there is a multitude of methods in use in practice; there is no standard method. I hope that the work I have done will at least be a start toward a standard. In any case I am sure that the methods presented will be valuable to all practicing group actuaries, and to others who play a role in the estimation of claim liabilities.

The paper I am completing gives theoretical justification for the technique I am going to describe. My objective now is to explain the mechanics of the method so that you can try it with your spreadsheets when you return to your offices.

The technique I'm going to describe is not totally original. Some of you will have seen similar methods. I believe some of the details are original.

An Illustration of the Method

Let's start with a very simple example. I'll give a realistic example later. In Example 1, we are given paid claims by calendar quarter paid and by lag (see Table 1). By the way, in practice, I would use data by month rather than by quarter. I used quarters here to reduce the amount of data we need to display. By lag, I refer to the number of quarters a claim is paid after it is incurred. If a claim is paid in the same quarter in which it is incurred, its lag is zero. If it is paid in the quarter after it is incurred, its lag is one, and so on.

In the example we need to estimate the numbers that will replace the x's.

I think we would agree that the results in Table 2 are reasonable. We get a total claim liability of 52.

TABLE 1

CLAIM LIABILITY

Quarter Paid	Lag 0	1	2	3	Total
1	4	24	8	4	40
2	4	24	8	4	40
3	4	24	8	4	40
4	4	24	8	4	40
		x	x	x	
			x	x	
				x	

TABLE 2

CLAIM LIABILITY -- EXAMPLE 1

Quarter Paid	Lag 0	1	2	3	Total
5		24	8	4	36
6			8	4	12
7				4	4
					52

Before we turn to a more complicated example, let's make some observations about this table (Table 3). First, we calculate the average of each of the lag columns. Note that the sum of these averages is 40, which is equal to the average claims incurred in a quarter. We then display these averages as a distribution by lag. In the next row, we calculate the average lag for this distribution. The result happens to be 1.3. Observe that 1.3, the average lag, times 40, the average incurred claims, is 52, which is the claim liability.

The formula that the claim liability is equal to the average lag times the average incurred claims works generally in the case where the exposure remains constant over time. It is not valid when the exposure changes.

Now let's look at a somewhat different example in Table 4 - Example 2. This is intended to illustrate a method to handle changes in backlog in the claims department (Table 4).

Suppose that the block of business is the same as the one in the example we just looked at, but that all of a sudden in quarter 4, no claim payments are made. We assume that in the first three quarters, all claims were paid in the same quarter as they were reported, and that in quarter 4 the usual claims, totalling 40, were reported, but none of them were paid.

TABLE 3

CLAIM LIABILITY -- EXAMPLE 1

Quarter Paid	Lag 0	Lag 1	Lag 2	Lag 3	Total
1	4	24	8	4	40
2	4	24	8	4	40
3	4	24	8	4	40
4	4	24	8	4	40
Column Average	4	24	8	4	40
Lag Distribution	0.10	0.60	0.20	0.10	1.00
Lag x Distribution	0	0.60	0.40	0.30	1.30

1.30 is the Average Lag Time

1.30 x Average Quarter's Incurred Claims

= 1.30 x 40

= 52

TABLE 4
CLAIM LIABILITY -- EXAMPLE 2

Quarter Paid	Lag 0	Lag 1	Lag 2	Lag 3	Total
1	4	24	8	4	40
2	4	24	8	4	40
3	4	24	8	4	40
4	0	0	0	0	0
Column Average	3	18	6	3	30

First Estimate: 1.3 x 30 = 39

Inventory Adjustment:

Ending Inventory by Lag

Lag	0	1	2	3	Total
Inventory	4	24	8	4	40

Formula

$$I_n - \frac{1}{n}\left(\sum_{k=0}^{n-1} I_k\right) + \frac{1}{n}\left(M_n I_n - M_o I_o\right)$$

n Number of months of paid claims data
lk Inventory at end of month k
mk Average lag of the inventory at the end of month k

In this case:

40 - ¼ (0) + ¼ (1.3(40)-0) = 53

TABLE 4 (continued)
CLAIM LIABILITY -- EXAMPLE 2

Total Liability 39 + 53 = 92

What is Reasonable:

40	In Inventory
52	Unreported, from Example 1
92	

In practice, ignore:

$$\frac{1}{n}\left(M_n I_n - M_o I_o\right)$$

Use:

$$I_n - \frac{1}{n}\sum_{k=0}^{n-1} I_k$$

The first step is to calculate the column averages, as before. The mean lag time is still 1.3. We multiply this by 30, the total of the column averages. The result is 39.

Now we adjust for the change in claims inventory. The formula for doing this can be derived theoretically. Here, I will show that it gives the correct result, so that you will have some confidence in its correctness. In words, the formula for the inventory adjustment is the ending inventory, minus the average beginning inventory, plus one over n times the difference between the ending inventory times its mean lag and the beginning inventory times its mean lag. The result in this case is 53. We add this inventory adjustment to the first estimate of 39. The result is 92.

Now, what is reasonable? The unreported liability is 52, which we calculated in the first example. The inventory is 40. Therefore the total liability is 92.

Unfortunately, the incurred dates, and therefore the mean lag, of the claims in inventory are not available in practice. Therefore, the third term in the formula cannot be calculated in practice, because we don't have information in enough detail. Fortunately, this term is small enough to be ignored in practice, except in the case of very wild swings in inventory. In group health insurance, the mean lag of the inventory is likely to be of a size similar to the mean lag in claim payment, or something like three months. Except in extreme cases, the inventory is less than one month. Therefore, if we assume, as in Example 2, that we use four quarters of paid claims data in the lag factor calculation, an upper bound on the size of this term is 1/4 of 1/3 of a quarter's claims, or about 1/12 of the typical total claim liability. Therefore, the error from ignoring this term is less than 10% of the total claim liability, except in case of extremely large backlog.

Now, let's turn to Example 3 where the exposure changes from quarter to quarter (Table 5). Exposure could be measured by number of covered members or perhaps by premium. The best measure is expected claims, but a precise calculation of this is usually not available. In practice, covered members, adjusted for trend seems to work well and is readily available.

If premium is used as the measure of exposure, it should be adjusted to current rate levels or to some other standard level. Actual charged premium is not always representative of the risk. For example, if there has not been a rate increase in some time, trend will result in increased expected claims while the premium remains constant.

In this example, we present paid claims data by quarter incurred. It was presented by quarter paid in the previous examples.

TABLE 5

CLAIM LIABILITY -- EXAMPLE 3

Quarter Incurred	Exposure	Lag 0	Lag 1	Lag 2	Lag 3
-2	10				4
-1	15			12	6
0	20		48	16	8
1	25	10	60	20	10
2	30	12	72	24	
3	35	14	84		
4	40	16			
Claim Total		52	264	72	28
Exposure Base		130	110	90	70
Average Claims Per Exposure Unit		0.4	2.4	0.8	0.4

Quarter Incurred	Exposure	Lag 0	Lag 1	Lag 2	Lag 3
2	30				12
3	35			28	14
4	40		100	32	16

As before, we want to get the averages of the lag columns. However, now we calculate the average claims per unit of exposure for each lag period. For example, for lag 1 we divide the total claims in the column, which is 264, by the corresponding exposure, which is 110(20+25+30+35). The result is 2.4. We now multiply these average claims per exposure unit by the appropriate exposures to fill in the triangle of incurred but unpaid claims. For example, 35 x .8 = 28. The total claim liability is 202. Observe that the resulting claim liability estimate is a perfectly reasonable progression from the paid claims. Now let's apply the mechanical methods just discussed to a real life example (Table 6).

We are given data as shown. These are actual data for a block of association group business. "Members" refers to members of the association -- we use it as the measure of exposure. We begin by calculating lag factors, which we called claims per unit of exposure in the immediately preceding example. We use only the most recent four quarters of paid claims in the calculation of these factors. More or fewer quarters of paid claims can be used. We then apply these lag factors to the corresponding exposures to complete the liability triangle. We get a total of 1,855.

We next adjust for the change in inventory (Table 7). In fact, the information we got was the number of days of inventory at the end of each month. We converted this number of days to dollars on an estimated basis.

TABLE 6

CLAIM LIABILITY -- FIRST ESTIMATE

Members	Incurred Quarter	0	1	2	3	Total
3,512	3/88	119	405	78	43	645
4,386	4/88	103	508	170	55	836
5,047	1/89	133	693	152	61	1,039
5,725	2/89	355	670	140	50	1,215
6,360	3/89	433	906	132	37	1,508
6,790	4/89	706	1,049	135	127	2,017
7,107	1/90	656	1,388	130		2,174
7,519	2/90	772	1,042			1,814
8,060	3/90	754				754
Last 4 Qtrs. Claims		2,888	4,385	537	275	
Exposure Base*		29.476	27.776	25.982	23.922	
Lag		0	1	2	3+	
Lag Factor *1,000		97.978	157.870	20.668	11.496	288.012

*Corresponding 4 Qtrs. Exposure, Divided by 1,000

Claim Reserve Estimate, Before Inventory Adjustment

Incurred	Lag			
Quarter	1	2	3+	Total
1/90			82	82
2/90		155	86	241
3/90	1,272	167	93	1,532
				1,855

TABLE 7
ADJUSTMENT FOR INVENTORY

Claim Reserve Estimate, Before Inventory Adjustment

Incurred Quarter	Lag 1	Lag 2	Lag 3+	Total
1/90			82	82
2/90		155	86	242
3/90	1,272	167	93	1,532
				1,855

Quarter	Ending Inventory ($000)
3/89	273
4/89	288
1/90	471
2/90	392
3/90	594

Average, 3rd Qtr. 89 - 2nd Qtr. 90	356	
3rd Qtr. 90	594	
Inventory Adjustment	238	12.83%

Claim Reserve Estimate, After Inventory Adjustment

Incurred Quarter	Lag 1	Lag 2	Lag 3+	Total
1/90			92	92
2/90		175	98	273
3/90	1,436	188	105	1,728
				2,093

The mechanics of the inventory adjustment are those described in Table 4. It is ending inventory minus the average beginning inventory. We use the most recent four quarters of beginning inventory to correspond to the four quarters used in the lag factor calculation.

The total adjustment is 238, which is 12.83% of the initial estimate. We increase each entry in the initial liability triangle by 12.83%. This gives a total claim liability estimate of 2,093.

I should point out that this proportional allocation of the inventory adjustment is somewhat arbitrary. The allocation of the adjustment is done in order to give a basis for reasonableness tests and for experience analysis. (The total inventory adjustment is not arbitrary).

Now let's display the results (Table 8). The entries marked with an asterisk are the estimates we just calculated. In practice we used these data to calculate the trend -- that is the rate of increase in incurred claims per member. This turned out to be a rate of 31%.

We then adjusted the members by this trend rate of 31% annually and went through the same process again (Tables 9-11). The only difference is the exposure measurement, which

TABLE 8

EXPERIENCE ANALYSIS

		Lag					Incurred
	Incurred						Claims Per
Members	Quarter	0	1	2	3+	Total	Member
		Claims by Lag ($000)					
3,512	3/88	119	405	78	43	645	184
4,386	4/88	103	508	170	55	836	191
5,047	1/89	133	693	152	61	1,039	206
5,725	2/89	355	670	140	50	1,215	212
6,360	3/89	433	906	132	37	1,508	237
6,790	4/89	706	1,049	135	127	2,017	297
7,107	1/90	656	1,388	130	92*	2,266	319
7,519	2/90	772	1,042	175*	98*	2,087	278
8,060	3/90	754	1,436*	188*	105*	2,483	308

TABLE 9

TREND ADJUSTMENT

Annual Trend Rate	0.31
Quarterly Trend Factor	1.0698375

Quarter	Members	Trend Factor	Trended Members
3/88	3,512	1.0000	3,512
4/88	4,386	1.0698	4,692
1/89	5,047	1.1446	5,777
2/89	5,725	1.2245	7,010
3/89	6,360	1.3100	8,332
4/89	6,790	1.4015	9,516
1/90	7,107	1.4994	10,656
2/90	7,519	1.6041	12,061
3/90	8,060	1.7161	13,832

TABLE 10

SECOND ESTIMATE (TRENDED)

Trended Members	Incurred Quarter	Lag 0	1	2	3+	Total
		Claims by Lag ($000)				
3,512	3/88	119	405	78	43	645
4,692	4/88	103	508	170	55	836
5,777	1/89	133	693	152	61	1,039
7,010	2/89	355	670	140	50	1,215
8,332	3/89	433	906	132	37	1,508
9,516	4/89	706	1,049	135	127	2,017
10,656	1/90	656	1,388	130		2,174
12,061	2/90	772	1,042			1,814
13,832	3/90	754				754
Last 4 Qtrs. Claims		2,888	4,385	537	275	
Exposure Base*		46.065	40.565	35.514	30.634	
Lag		0	1	2	3+	Total
Lag Factor*	1,000	62.694	108.099	15.121	8.977	194.891

* Corresponding 4 Qtrs. Exposure, Divided by 1,000

TABLE 11

SECOND ESTIMATE (TRENDED)

Claim Reserve Estimate, Before Inventory Adjustment

Incurred Quarter	Lag 1	Lag 2	Lag 3+	Total
1/90			96	96
2/90		182	108	291
3/89	1,495	209	124	1,829
				2,215

Quarter	Ending Inventory ($000)
3/89	273
4/89	288
1/90	471
2/90	392
3/90	594

Average, 3rd Qtr. 89 - 2nd Qtr. 90	356	
3rd Qtr. 90	594	
Inventory Adjustment	238	10.75%

Claim Reserve Estimate, After Inventory Adjustment

Incurred Quarter	Lag 1	Lag 2	Lag 3+	Total
1/90			108	108
2/90		206	122	328
3/90	1,687	236	140	2,063
				2,499

is now trended members instead of unadjusted members. The result is a claim liability of 2,499. In real life, we got 2,455. There were several differences, related to using monthly data instead of the quarterly data.

Ideally, if there were no random fluctuations, and if the 31% trend rate were a perfect fit, the incurred claims per trended member in the right-hand column of Table 12 would all be equal.

Following are some advantages of the method just described, when comparing it to some of the other methods in use:

- Automatically reflects changes in exposure
- Can be used to adjust for trend or other changes in claim levels
- Produces reasonable results with relatively little ad hoc intervention
- Mechanically very simple
- Sound theoretical basis
- Reflects changes in claim inventory

As with any method, some caution is necessary, and professional judgement should be exercised. The method will not remove the inherent randomness from the claim liability. In addition, systematic changes in claim payments patterns may occur. No matter what

TABLE 12

EXPERIENCE ANALYSIS

Members	Incurred Quarter	Lag 0	Lag 1	Lag 2	Lag 3+	Total	Incurred Claims Per Trended Member
		Claims by Lag ($000)					
3,512	3/88	119	405	78	43	645	184
4,692	4/88	103	508	170	55	836	178
5,777	1/89	133	693	152	61	1,039	180
7,010	2/89	355	670	140	50	1,215	173
8,332	3/89	433	906	132	37	1,508	181
9,516	4/89	706	1,049	135	127	2,017	212
10,656	1/90	656	1,388	130	108*	2,282	214
12,061	2/90	772	1,042	206*	122*	2,142	178
13,832	3/90	754	1,687*	236*	140*	2,817	204

estimation process is used, there will occasionally be a substantial difference between the initial claim liability estimate and the ultimate run-off.

Conclusion

I believe that the method I've described is better than different methods. It is relatively very simple to use and to explain to others, and I believe it is more likely to be accurate than other methods. This belief is founded on theory and on a variety of practical experience. If you aren't already using a similar method, I would encourage you to try it. I think you will find that it is helpful.