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A MODIFIED DEVELOPMENT METHOD FOR DERIVING HEALTH CLAIM RESERVES

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ABSTRACT

The development method described in John Bragg's paper [4] and illustrated in the *Record* [6] has long been one of the most accepted means of calculating claim reserves and liabilities for short-term health insurance benefits. Health actuaries use this method because it often provides a more accurate calculation of claim reserves than other methods. However, many of its advantages can be lost if pertinent influences are not properly recognized in the calculation. This paper identifies many of the influences on claim development and discusses various ways to recognize them.

INTRODUCTION

This paper describes a modified development method for analyzing claims experience and calculating claim reserves and liabilities on short-term health insurance benefits. "Short term" here refers to claims with a life or runout of 10 years or fewer. The paper is a "how to" presentation, not a discussion of appropriate reserving standards or principles, in contrast to recent committee reports [10] and papers [1], [8]. Hereafter, claim reserves and liabilities are referred to only as claim reserves.

The method used to establish claim reserves is as important as the principles applied, because improper use of a method may modify principles unintentionally or produce inaccurate estimates of actual experience or claim reserves. In fact, poor methodology in conjunction with a lack of understanding of principles probably is a major reason that companies have been unable to recognize poor or deteriorating experience and have subsequently suffered high losses.

Because of the necessary relationship between methodology and reserving principles, the motivations for this modified development method have been established as follows:

1. Identification of the reserving principles that will be employed.
2. Matching of incurred claims and earned premiums consistent with the principles delineated in objective 1.
3. Identification of the various influences that affect incurred claims and claim reserves.
4. Selection of a method consistent with the findings in objectives 1–3.

5. Estimation of claim reserves and resulting loss ratios.
6. Examination of the potential variations that may occur in loss ratio and claim reserve estimates.

Because development of claim experience and reserves by any method depends upon the assignment of incurral or loss dates to claim payments, the impact of various types of rules on the modified development method is also examined. The discussion of these rules is not intended to preclude the possibility of other reasonable rules that meet objectives as established. This paper does not discuss when a particular incurral dating rule should and should not be used.

The underpinnings for the modified development method are discussed in the following order:

- The basic development method (starting point)
- Adjustments to basic development method results
- The final result
- Summary.

The basic development method results and subsequent adjustments do not include recognition of a discount for interest. This item, however, can be recognized through an approximate method by discounting each payment from the payment date of the claim to the valuation date and summing results (see Bragg's paper for a discussion of possible methods [4]).

Numerous references discuss theoretical approaches to the development of claim reserves [9], [11]; note that the bibliography in [9] includes many others.

I. THE BASIC DEVELOPMENT METHOD (A STARTING POINT)

The minimum data necessary to utilize the modified development method are claim payments by period of incurral and by period of payment and earned premiums or exposed lives or some other unit of exposure for the same incurral periods. The period should preferably be small, such as monthly or quarterly, especially for products vulnerable to significant fluctuation in experience because of inflation or other influences. Other information, if available, can be used in making adjustments to the basic development method results, as discussed in Section II.

The underlying principle of the basic method is that all contingencies affecting the future development of a claim are inherently and properly dealt with through the assumed runout pattern; this includes probabilities of termination and continuance as estimated from past experience and adjusted to

properly reflect the current health care environment and the administrative practices of a company.

The minimum volume of claim payments normally needed to use this method may vary based on the type of plan, duration since plan inception, and the growth rate of the business; experience on major medical plans has generally indicated that at least $250,000 of claim payments is needed to obtain any credible results. Various plans or policy forms should be combined for analysis only if the runout pattern of the claims is expected to be similar or the relative distribution of plans included remains unchanged.

In the starting point calculation, all reserve factors, incurred claims and claim reserves are calculated without adjustment and considered credible. The determination of noncredible factors and amounts needing modification are discussed later.

The following summarizes the basic method step by step, assuming data are on a monthly basis.

1. Develop paid claims by month of incurral and month of payment. Table 1 is an example using major medical claim payments for 1982–1984 with a December 31, 1984 valuation date.
2. Put paid claims in step 1 on a cumulative basis by month of incurral, denoted CP_t; see Table 2 for the cumulative claim payments from Table 1. The subscript t corresponds to the lag or difference in months between the month of incurral and accumulated month of payment. For instance, CP_2 for incurral month January 1982 = $1923 and CP_3 for incurral month January 1982 = $11,417.
3. Develop monthly completion ratios, CR_t, by month of incurral and accumulated month of payment. A monthly completion ratio is defined as the cumulative paid claims at the end of lag $t-1$ divided by the cumulative paid claims at the end of lag t, or

$$\frac{CP_{t-1}}{CP_t} = CR_t$$

where t ranges from 1 to infinity or the longest lag. Note that CP_0 represents those claims paid during the same month in which they were incurred and that CR_0 has no meaning since CR_1 represents the derived relationship of CP_0 and CP_1.

As an example, CR_3 for incurral month January 1982 equals $1923 ÷ $11,417, or 0.168433. Table 3 depicts this value and all other completion ratios relating to the cumulative paid claims of Table 2.

4. Develop completion ratio averages for n payment methods, denoted $(CR_t)^n$. The n months chosen are often the most recent months available, but variations in company practice and other considerations may alter the months selected.

TABLE 1

PAID CLAIMS BY MONTH OF INCURRAL AND MONTH OF PAYMENT FOR MAJOR MEDICAL THROUGH DECEMBER 1984

	Month Incurred											
Month Paid	12/82	11/82	10/82	9/82	8/82	7/82	6/82	5/82	4/82	3/82	2/82	1/82
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	358
3/82	0	0	0	0	0	0	0	0	0	141	1,992	1,565
4/82	0	0	0	0	0	0	0	0	32	159	21,411	9,494
5/82	0	0	0	0	0	0	0	0	10,060	9,266	3,419	4,823
6/82	0	0	0	0	0	0	68	280	11,224	10,904	1,049	1,936
7/82	0	0	0	0	0	0	3,573	4,490	14,014	4,974	3,061	930
8/82	0	0	0	0	0	8,241	26,299	4,122	6,869	6,452	6,873	0
9/82	0	0	0	0	7,725	8,911	15,504	6,151	5,780	7,370	288	88
10/82	0	0	0	9,933	25,313	12,852	17,343	3,346	6,761	3,109	88	6,365
11/82	0	0	2,244	15,486	26,018	4,598	9,026	21,567	0	2,776	1,678	282
12/82	0	5,339	24,935	8,878	18,276	6,278	4,280	3,223	1,513	0	66	686
1/83	1,875	19,304	24,903	11,749	3,191	2,072	2,281	5,266	0	109	0	212
2/83	15,928	22,459	18,519	6,187	4,321	5,985	11,382	69	892	1,514	42	127
3/83	24,216	43,074	21,052	1,561	2,411	5,567	327	428	110	645	8,568	48
4/83	31,265	16,100	4,684	9,362	5,831	244	784	246	201	4,221	242	0
5/83	13,892	4,770	8,463	1,932	2,098	2,152	0	−41	205	42	165	613
6/83	5,290	2,417	2,872	2,198	1,061	0	317	0	0	0	0	0
7/83	4,727	1,888	3,992	334	797	1,569	209	87	0	0	197	0
8/83	191	1,118	867	0	1,199	0	95	0	2,601	0	250	0
9/83	2,511	0	591	0	0	159	485	197	0	0	0	0
10/83	0	1,950	915	3,899	501	487	213	152	56	0	0	0
11/83	690	61	33	0	0	0	5,064	0	0	0	0	0
12/83	1,384	6,068	178	0	0	49	30	234	0	0	0	0
1/84	90	0	854	1,493	722	0	0	434	0	269	20	0
2/84	333	0	4,029	0	0	0	152	0	0	0	55	0
3/84	0	10,553	0	166	0	0	−43	240	0	0	3,832	0
4/84	0	216	−3,737	0	0	0	240	0	0	0	0	0
5/84	0	1,553	122	428	627	0	0	8,951	197	0	0	0
6/84	0	0	0	217	0	0	0	40	0	0	0	0
7/84	0	0	0	0	0	0	0	2,489	0	0	0	0
8/84	0	0	0	0	0	0	0	0	0	0	0	64
9/84	0	0	37,386	0	0	0	0	0	0	0	0	0
10/84	0	0	0	0	0	56	0	0	0	0	0	0
11/84	0	0	0	0	0	0	0	0	0	0	0	0
12/84	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 1—*Continued*

Month Paid	Month Incurred											
	12/83	11/83	10/83	9/83	8/83	7/83	6/83	5/83	4/83	3/83	2/83	1/83
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	0
3/82	0	0	0	0	0	0	0	0	0	0	0	0
4/82	0	0	0	0	0	0	0	0	0	0	0	0
5/82	0	0	0	0	0	0	0	0	0	0	0	0
6/82	0	0	0	0	0	0	0	0	0	0	0	0
7/82	0	0	0	0	0	0	0	0	0	0	0	0
8/82	0	0	0	0	0	0	0	0	0	0	0	0
9/82	0	0	0	0	0	0	0	0	0	0	0	0
10/82	0	0	0	0	0	0	0	0	0	0	0	0
11/82	0	0	0	0	0	0	0	0	0	0	0	0
12/82	0	0	0	0	0	0	0	0	0	0	0	0
1/83	0	0	0	0	0	0	0	0	0	0	0	0
2/83	0	0	0	0	0	0	0	0	0	0	736	6,276
3/83	0	0	0	0	0	0	0	0	0	46	23,072	75,847
4/83	0	0	0	0	0	0	0	0	737	16,086	32,244	95,672
5/83	0	0	0	0	0	0	0	219	19,097	44,285	49,015	35,801
6/83	0	0	0	0	0	0	2,192	14,722	44,138	99,094	38,035	19,501
7/83	0	0	0	0	0	731	27,209	68,671	44,824	70,035	21,463	17,460
8/83	0	0	0	0	54	23,088	38,701	76,348	38,575	23,549	3,520	9,755
9/83	0	0	0	712	16,515	32,076	40,369	27,639	22,863	12,518	3,216	1,204
10/83	0	0	181	7,412	76,132	105,787	126,430	53,991	33,192	4,204	7,358	1,370
11/83	0	0	15,965	90,451	109,126	82,022	70,799	24,314	9,622	10,094	2,681	3,141
12/83	0	20,384	55,638	122,388	148,442	69,495	25,585	23,340	10,390	12,604	1,748	−167
1/84	94,953	222,290	223,045	174,235	116,066	54,747	24,944	9,357	4,637	2,281	1,294	6,181
2/84	123,245	145,780	240,216	99,086	39,028	19,220	14,542	6,241	3,979	6,100	537	18
3/84	87,493	82,742	106,907	43,873	22,150	13,179	8,365	2,901	4,354	711	4,752	429
4/84	159,948	106,771	64,540	−5,615	3,706	14,663	3,186	4,710	1,194	304	2,133	1,297
5/84	71,838	99,279	17,752	8,961	4,564	13,111	907	1,102	1,788	397	518	555
6/84	37,294	28,705	8,443	7,229	158,867	46,745	37	1,019	82	95	419	447
7/84	69,118	7,983	8,745	3,675	2,641	4,311	2,309	514	1,033	2,920	181	0
8/84	18,017	14,752	9,775	3,584	348	687	4,334	320	0	0	0	1,097
9/84	81,927	6,311	9,509	78,033	5,873	9,940	206	96	350	32	905	31
10/84	2,194	1,685	4,168	18,055	777	97	634	212	435	92	72	0
11/84	9,250	4,296	4,372	8,179	1,766	0	395	80	1,025	0	246	103
12/84	1,105	354	168	1,649	49	0	0	62	425	203	0	0

TABLE 1—*Continued*

Month Paid	Month Incurred											
	12/84	11/84	10/84	9/84	8/84	7/84	6/84	5/84	4/84	3/84	2/84	1/84
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	0
3/82	0	0	0	0	0	0	0	0	0	0	0	0
4/82	0	0	0	0	0	0	0	0		0	0	0
5/82	0	0	0	0	0	0	0	0	0	0	0	0
6/82	0	0	0	0	0	0	0	0	0	0	0	0
7/82	0	0	0	0	0	0	0	0	0	0	0	0
8/82	0	0	0	0	0	0	0	0	0	0	0	0
9/82	0	0	0	0	0	0	0	0	0	0	0	0
10/82	0	0	0	0	0	0	0	0	0	0	0	0
11/82	0	0	0	0	0	0	0	0	0	0	0	0
12/82	0	0	0	0	0	0	0	0	0	0	0	0
									0			
1/83	0	0	0	0	0	0	0	0	0	0	0	0
2/83	0	0	0	0	0	0	0	0	0	0	0	0
3/83	0	0	0	0	0	0	0	0	0	0	0	0
4/83	0	0	0	0	0	0	0	0	0	0	0	0
5/83	0	0	0	0	0	0	0	0	0	0	0	0
6/83	0	0	0	0	0	0	0	0	0	0	0	0
7/83	0	0	0	0	0	0	0	0	0	0	0	0
8/83	0	0	0	0	0	0	0	0	0	0	0	0
9/83	0	0	0	0	0	0	0	0	0	0	0	0
10/83	0	0	0	0	0	0	0	0	0	0	0	0
11/83	0	0	0	0	0	0	0	0	0	0	0	0
12/83	0	0	0	0	0	0	0	0	0	0	0	0
1/84	0	0	0	0	0	0	0	0	0	0	0	3,253
2/84	0	0	0	0	0	0	0	0	0	0	312	105,909
3/84	0	0	0	0	0	0	0	0	0	2,083	67,084	217,653
4/84	0	0	0	0	0	0	0	0	457	62,857	161,989	190,644
5/84	0	0	0	0	0	0	0	50	34,982	247,605	185,002	206,565
6/84	0	0	0	0	0	0	260	56,024	151,700	237,223	152,383	62,837
7/84	0	0	0	0	0	140	32,879	127,333	151,065	111,978	87,260	44,936
8/84	0	0	0	0	25	136,242	254,671	340,403	208,266	156,790	98,329	42,063
9/84	0	0	0	182	81,625	251,248	350,268	227,709	244,243	90,561	149,496	69,176
10/84	0	0	82	61,271	185,714	322,232	226,046	365,157	117,383	43,353	36,926	5,093
11/84	0	0	52,088	159,967	303,584	280,452	192,201	108,235	89,867	42,488	35,571	13,934
12/84	0	32,346	218,755	228,517	213,709	195,503	74,236	83,037	22,874	35,142	4,754	7,124

TABLE 2

CUMULATIVE CLAIMS, OR CP_t VALUES, BY MONTH OF INCURRAL AND MONTH OF PAYMENT FOR MAJOR MEDICAL THROUGH DECEMBER 1984

	Month Incurred											
Month Paid	12/82	11/82	10/82	9/82	8/82	7/82	6/82	5/82	4/82	3/82	2/82	1/82
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	358
3/82	0	0	0	0	0	0	0	0	0	141	1,992	1,923
4/82	0	0	0	0	0	0	0	0	32	300	23,403	11,417
5/82	0	0	0	0	0	0	0	0	10,092	9,566	26,822	16,240
6/82	0	0	0	0	0	0	68	280	21,316	20,470	27,871	18,176
7/82	0	0	0	0	0	0	3,641	4,770	35,330	25,444	30,932	19,106
8/82	0	0	0	0	0	8,241	29,940	8,892	42,199	31,896	37,805	19,106
9/82	0	0	0	0	7,725	17,152	45,444	15,043	47,979	39,266	38,093	19,194
10/82	0	0	0	9,933	33,038	30,004	62,787	18,389	54,740	42,375	38,181	25,559
11/82	0	0	2,244	25,419	59,056	34,602	71,813	39,956	54,740	45,151	39,859	25,841
12/82	0	5,339	27,179	34,297	77,332	40,880	76,093	43,179	56,253	45,151	39,925	26,527
1/83	1,875	24,643	52,082	46,046	80,523	42,952	78,374	48,445	56,253	45,260	39,925	26,739
2/83	17,803	47,102	70,601	52,233	84,844	48,937	89,756	48,514	57,145	46,774	39,967	26,866
3/83	42,019	90,176	91,653	53,794	87,255	54,504	90,083	48,942	57,255	47,419	48,535	26,914
4/83	73,284	106,276	96,337	63,156	93,086	54,748	90,867	49,188	57,456	51,640	48,777	26,914
5/83	87,266	111,046	104,800	65,088	95,184	56,900	90,867	49,147	57,661	51,682	48,942	27,527
6/83	92,556	113,463	107,672	67,286	96,245	56,900	91,184	49,147	57,661	51,682	48,942	27,527
7/83	97,283	115,351	111,664	67,720	97,042	58,469	91,393	49,234	57,661	51,682	49,139	27,527
8/83	97,474	116,469	112,531	67,620	98,241	58,469	91,488	49,234	60,262	51,682	49,389	27,527
9/83	99,985	116,469	113,122	67,620	98,241	58,628	91,973	49,431	60,262	51,682	49,389	27,527
10/83	99,985	118,419	114,037	71,519	98,742	59,115	92,186	49,583	60,318	51,682	49,389	27,527
11/83	100,684	118,480	114,070	71,519	98,742	59,115	97,250	49,583	60,318	51,682	49,389	27,527
12/83	102,068	124,548	114,248	71,519	98,742	59,164	97,280	49,817	60,318	51,682	49,389	27,527
1/84	102,158	124,548	115,102	73,012	99,464	59,164	97,280	50,251	60,318	51,951	49,409	27,527
2/84	102,491	124,548	119,131	73,012	99,464	59,164	97,432	50,251	60,318	51,951	49,464	27,527
3/84	102,491	135,101	119,131	73,178	99,464	59,164	97,389	50,491	60,318	51,951	53,296	27,527
4/84	102,491	135,317	115,394	73,178	99,464	59,164	97,629	50,491	60,318	51,951	53,296	27,527
5/84	102,491	136,870	115,516	73,606	100,091	59,164	97,629	59,442	60,515	51,951	53,296	27,527
6/84	102,491	136,870	115,516	73,823	100,091	59,164	97,629	59,482	60,515	51,951	53,296	27,527
7/84	102,491	136,870	115,516	73,823	100,091	59,164	97,629	61,971	60,515	51,951	53,296	27,527
8/84	102,491	136,870	115,516	73,823	100,091	59,164	97,629	61,971	60,515	51,951	53,296	27,591
9/84	102,491	136,870	152,902	73,823	100,091	59,164	97,629	69,971	60,515	51,951	53,296	27,591
10/84	102,491	136,870	152,902	73,823	100,091	59,220	97,629	61,971	60,515	51,951	53,296	27,591
11/84	102,491	136,870	152,902	73,823	100,091	59,220	97,629	61,971	60,515	51,951	53,296	27,591
12/84	102,491	136,870	152,902	73,823	100,091	59,220	97,629	61,971	60,515	51,951	53,296	27,591

TABLE 2—*Continued*

Month Paid	Month Incurred											
	12/83	11/83	10/83	9/83	8/83	7/83	6/83	5/83	4/83	3/83	2/83	1/83
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	0
3/82	0	0	0	0	0	0	0	0	0	0	0	0
4/82	0	0	0	0	0	0	0	0	0	0	0	0
5/82	0	0	0	0	0	0	0	0	0	0	0	0
6/82	0	0	0	0	0	0	0	0	0	0	0	0
7/82	0	0	0	0	0	0	0	0	0	0	0	0
8/82	0	0	0	0	0	0	0	0	0	0	0	0
9/82	0	0	0	0	0	0	0	0	0	0	0	0
10/82	0	0	0	0	0	0	0	0	0	0	0	0
11/82	0	0	0	0	0	0	0	0	0	0	0	0
12/82	0	0	0	0	0	0	0	0	0	0	0	0
1/83	0	0	0	0	0	0	0	0	0	0	0	0
2/83	0	0	0	0	0	0	0	0	0	0	736	6,276
3/83	0	0	0	0	0	0	0	0	0	46	23,808	82,123
4/83	0	0	0	0	0	0	0	0	737	16,132	56,052	177,795
5/83	0	0	0	0	0	0	0	219	19,834	60,417	105,067	213,596
6/83	0	0	0	0	0	0	2,192	14,941	63,972	159,511	143,102	233,097
7/83	0	0	0	0	0	731	29,401	83,612	108,796	229,546	164,565	250,557
8/83	0	0	0	0	54	23,819	68,102	159,960	147,371	253,095	168,085	260,312
9/83	0	0	0	712	16,569	55,895	108,471	187,599	170,234	265,613	171,301	261,516
10/83	0	0	181	8,124	92,701	161,682	234,901	241,950	203,426	269,817	178,659	262,886
11/83	0	0	16,146	98,575	201,827	243,704	305,700	265,904	213,048	279,911	181,340	266,027
12/83	0	20,384	71,784	220,963	350,269	313,199	331,285	289,244	223,438	292,515	183,088	265,860
1/84	94,953	242,674	294,829	395,198	466,335	367,946	356,229	298,601	228,075	294,796	184,382	272,041
2/84	218,198	388,454	535,045	494,284	505,363	387,166	370,771	304,842	232,054	300,896	184,919	272,059
3/84	305,691	471,196	641,952	538,157	527,513	400,345	379,136	307,743	236,408	301,607	189,671	272,488
4/84	465,639	577,967	706,492	532,542	531,219	415,008	382,322	312,453	237,602	301,911	191,804	273,785
5/84	537,477	677,246	724,244	541,503	535,783	428,119	383,229	313,555	239,390	302,308	192,323	274,340
6/84	574,771	705,951	732,687	548,732	694,650	474,864	383,266	314,574	239,472	302,403	192,742	274,787
7/84	643,889	713,934	741,432	552,407	697,291	479,175	385,575	315,088	240,505	305,323	192,923	274,787
8/84	661,906	728,686	751,207	555,991	697,639	479,862	389,909	315,408	240,505	305,323	192,923	275,884
9/84	743,833	734,997	760,716	634,024	703,512	489,802	390,115	315,504	240,855	305,355	193,828	275,915
10/84	746,027	736,682	764,884	652,079	704,289	489,899	390,749	315,716	241,290	305,447	193,900	275,915
11/84	755,277	740,978	769,256	660,258	706,055	489,899	391,144	315,796	242,315	205,447	194,146	276,018
12/84	756,382	741,332	769,424	661,907	706,104	489,899	391,144	315,858	242,740	305,650	194,146	276,018

TABLE 2—*Continued*

	Month Incurred											
Month Paid	12/84	11/84	10/84	9/84	8/84	7/84	6/84	5/84	4/84	3/84	2/84	1/84
1/82	0	0	0	0	0	0	0	0	0	0	0	0
2/82	0	0	0	0	0	0	0	0	0	0	0	0
3/82	0	0	0	0	0	0	0	0	0	0	0	0
4/82	0	0	0	0	0	0	0	0	0	0	0	0
5/82	0	0	0	0	0	0	0	0	0	0	0	0
6/82	0	0	0	0	0	0	0	0	0	0	0	0
7/82	0	0	0	0	0	0	0	0	0	0	0	0
8/82	0	0	0	0	0	0	0	0	0	0	0	0
9/82	0	0	0	0	0	0	0	0	0	0	0	0
10/82	0	0	0	0	0	0	0	0	0	0	0	0
11/82	0	0	0	0	0	0	0	0	0	0	0	0
12/82	0	0	0	0	0	0	0	0	0	0	0	0
1/83	0	0	0	0	0	0	0	0	0	0	0	0
2/83	0	0	0	0	0	0	0	0	0	0	0	0
3/83	0	0	0	0	0	0	0	0	0	0	0	0
4/83	0	0	0	0	0	0	0	0	0	0	0	0
5/83	0	0	0	0	0	0	0	0	0	0	0	0
6/83	0	0	0	0	0	0	0	0	0	0	0	0
7/83	0	0	0	0	0	0	0	0	0	0	0	0
8/83	0	0	0	0	0	0	0	0	0	0	0	0
9/83	0	0	0	0	0	0	0	0	0	0	0	0
10/83	0	0	0	0	0	0	0	0	0	0	0	0
11/83	0	0	0	0	0	0	0	0	0	0	0	0
12/83	0	0	0	0	0	0	0	0	0	0	0	0
1/84	0	0	0	0	0	0	0	0	0	0	0	3,253
2/84	0	0	0	0	0	0	0	0	0	0	312	109,162
3/84	0	0	0	0	0	0	0	0	0	2,083	67,396	326,815
4/84	0	0	0	0	0	0	0	0	457	64,940	229,385	517,459
5/84	0	0	0	0	0	0	0	50	35,439	312,545	414,387	724,024
6/84	0	0	0	0	0	0	260	56,074	187,139	549,768	566,770	786,861
7/84	0	0	0	0	0	140	33,139	183,407	338,204	661,746	654,030	831,797
8/84	0	0	0	0	25	136,382	287,810	523,810	546,470	818,536	752,359	873,860
9/84	0	0	0	182	81,650	387,630	638,078	751,519	790,713	909,097	901,855	943,036
10/84	0	0	82	61,453	267,364	709,862	864,124	1,116,676	908,096	952,450	938,781	948,129
11/84	0	0	52,170	221,420	570,948	990,314	1,056,325	1,224,911	997,963	994,938	974,352	962,063
12/84	0	32,346	270,925	449,937	784,657	1,185,817	1,130,561	1,307,948	1,020,837	1,030,080	979,106	969,187

TABLE 3

COMPLETION RATIOS, CR_t, BY LAG PERIOD AND MONTH OF INCURRAL FOR MAJOR MEDICAL THROUGH DECEMBER 1984

	Month Incurred											
Lag t	12/82	11/82	10/82	9/82	8/82	7/82	6/82	5/82	4/82	3/82	2/82	1/82
0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018676	0.000000	0.003171	0.470000	0.000000	0.000000
2	0.105319	0.216654	0.082564	0.390771	0.233822	0.480469	0.121610	0.058700	0.473447	0.031361	0.085117	0.186167
3	0.423689	0.523184	0.521850	0.741144	0.559435	0.571657	0.658833	0.536437	0.603340	0.467318	0.872530	0.168433
4	0.573372	0.522334	0.737695	0.744842	0.763668	0.867118	0.723780	0.591105	0.837224	0.804512	0.962362	0.703017
5	0.839777	0.848508	0.770308	0.881550	0.960372	0.846429	0.874312	0.818043	0.879531	0.797718	0.901041	0.893486
6	0.942845	0.957045	0.951379	0.970982	0.949071	0.951760	0.943753	0.460231	0.876489	0.812306	0.818199	0.951324
7	0.951410	0.978698	0.919246	0.851764	0.972368	0.877700	0.970896	0.925357	1.000000	0.926631	0.992440	1.000000
8	0.998041	0.983633	0.973326	0.970317	0.937359	0.897861	0.873190	0.891299	0.973104	0.938517	0.997695	0.995415
9	0.974886	0.990401	0.964250	0.967333	0.977958	0.995543	0.996370	0.998578	1.000000	1.000000	0.957902	0.750968
10	1.000000	1.000000	0.992295	0.995061	0.988976	0.962179	0.991372	0.991255	0.984391	0.997592	0.998347	0.989087
11	0.993057	0.963533	0.994776	1.000000	0.991787	1.000000	1.000000	0.994999	0.998079	0.967632	1.000000	0.974140
12	0.986440	0.999485	0.991976	1.000000	0.987795	0.973165	0.996524	1.000834	0.996502	0.986398	0.998949	0.992072
13	0.999119	0.951280	0.999711	0.945483	1.000000	1.000000	0.997713	1.000000	0.996445	0.918261	0.823468	0.995273
14	0.996751	1.000000	0.998442	1.000000	0.994962	0.997288	0.998962	0.998233	1.000000	0.999187	0.995039	0.998217
15	1.000000	1.000000	0.992580	1.000000	1.000000	0.991762	0.994727	1.000000	1.000000	1.000000	0.996629	1.000000
16	1.000000	0.921888	0.966180	0.979551	1.000000	1.000000	0.997689	0.996015	0.956838	1.000000	1.000000	0.977731
17	1.000000	0.998404	1.000000	1.000000	0.992741	0.999172	0.947928	0.996934	1.000000	1.000000	0.995991	1.000000
18	1.000000	0.988653	1.032385	9.997732	1.000000	1.000000	0.999692	1.000000	0.999072	1.000000	0.994938	1.000000
19	1.000000	1.000000	0.998944	1.000000	1.000000	1.000000	1.000000	0.995303	1.000000	1.000000	1.000000	1.000000
20	1.000000	1.000000	1.000000	0.994185	1.000000	1.000000	0.998440	0.991363	1.000000	1.000000	1.000000	1.000000
21	1.000000	1.000000	1.000000	0.997061	0.993736	1.000000	1.000442	1.000000	1.000000	1.000000	1.000000	1.000000
22	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.997542	0.995247	1.000000	0.994822	1.000000	1.000000
23	1.000000	1.000000	0.755490	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.999595	1.000000
24	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.849416	1.000000	1.000000	0.998888	1.000000
25	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.949328	0.996745	1.000000	0.928100	1.000000
26	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.959836	1.000000	1.000000	1.000000	1.000000
27	0.000000	0.000000	0.000000	1.000000	1.000000	0.999054	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
28	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
29	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
30	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	0.997680
32	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000
33	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000
34	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000
35	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000

TABLE 3—*Continued*

	Month Incurred											
Lag t	12/83	11/83	10/83	9/83	8/83	7/83	6/83	5/83	4/83	3/83	2/83	1/83
0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1	0.000000	0.000000	0.011210	0.087642	0.003259	0.030690	0.074555	0.014658	0.037158	0.002851	0.030914	0.000000
2	0.435169	0.083997	0.224925	0.082414	0.178736	0.426138	0.431720	0.178694	0.310042	0.267011	0.424748	0.076422
3	0.713786	0.624717	0.243477	0.446110	0.459309	0.345709	0.627836	0.522706	0.588000	0.378764	0.533488	0.461897
4	0.656498	0.824400	0.551036	0.559120	0.576206	0.663436	0.461773	0.852670	0.738246	0.694898	0.734211	0.832389
5	0.866342	0.815265	0.833466	0.799536	0.751110	0.778112	0.768404	0.776518	0.865697	0.906956	0.869577	0.916340
6	0.935115	0.853408	0.908647	0.918475	0.922772	0.851209	0.922770	0.908561	0.836835	0.952871	0.979058	0.930315
7	0.892655	0.959339	0.975489	1.010544	0.958011	0.950357	0.929978	0.919307	0.954836	0.984419	0.981226	0.962526
8	0.972780	0.988818	0.988477	0.983452	0.993024	0.967081	0.960779	0.968664	0.953499	0.963939	0.958815	0.995396
9	0.889858	0.979755	0.988205	0.986826	0.991482	0.964668	0.977937	0.979527	0.979669	0.956912	0.985216	0.994789
10	0.997059	0.991414	0.986988	0.993347	0.771299	0.969375	0.991667	0.990573	0.982853	0.992262	0.990453	0.988193
11	0.987753	0.997713	0.987500	0.993554	0.996212	0.901561	0.997633	0.984926	0.981583	0.979727	0.992982	1.000628
12	0.998539	0.994202	0.994551	0.876924	0.999501	0.991003	0.999903	0.996485	0.994975	0.997643	0.997096	0.977279
13	0.000000	0.999522	0.994317	0.972312	0.991652	0.998568	0.994012	0.996761	0.992531	0.998993	0.974946	0.999934
14	0.000000	0.000000	0.999782	0.987612	0.998897	0.979706	0.988885	0.998369	0.999658	0.998687	0.988879	0.998426
15	0.000000	0.000000	0.000000	0.997509	0.997499	0.999802	0.999472	0.998985	0.995705	0.999686	0.997301	0.995263
16	0.000000	0.000000	0.000000	0.000000	0.999931	1.000000	0.998377	0.999696	1.000000	0.990436	0.997826	0.997977
17	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.998990	0.999329	0.998547	1.000000	0.999062	0.998373
18	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.999747	0.998197	0.999895	1.000000	1.000000
19	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.999804	0.995770	0.999699	0.995331	0.996024
20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.998249	1.000000	0.999629	0.999888
21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.999336	0.998733	1.000000
22	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.999627
23	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
24	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
26	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
28	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
29	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
30	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
32	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
33	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
34	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
35	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

TABLE 3—*Continued*

	Month Incurred											
Lag t	12/84	11/84	10/84	9/84	8/84	7/84	6/84	5/84	4/84	3/84	2/84	1/84
0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1	0.000000	0.000000	0.001572	0.002962	0.000306	0.001027	0.007846	0.000892	0.012895	0.032076	0.004629	0.029800
2	0.000000	0.000000	0.192563	0.277544	0.305389	0.351836	0.115142	0.305735	0.189373	0.207778	0.293812	0.334018
3	0.000000	0.000000	0.000000	0.492113	0.468281	0.546064	0.451058	0.350140	0.553332	0.568503	0.553553	0.631577
4	0.000000	0.000000	0.000000	0.000000	0.727640	0.716805	0.738410	0.697002	0.618889	0.830784	0.731138	0.714699
5	0.000000	0.000000	0.000000	0.000000	0.000000	0.835132	0.818047	0.672996	0.691110	0.808451	0.866581	0.920142
6	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.934337	0.911638	0.870737	0.900384	0.869306	0.945977
7	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.936514	0.909950	0.954483	0.834235	0.951865
8	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.977593	0.957296	0.960666	0.926645
9	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.965884	0.963493	0.994628
10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.995145	0.985517
11	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.992650
12	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
13	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
15	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
16	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
17	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
18	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
19	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
22	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
23	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
24	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
26	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
28	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
29	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
30	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
32	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
33	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
34	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
35	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

In theory, harmonic averages are preferable to arithmetic averages for these purposes [5]. The following table gives a simplified example of harmonic averages.

Observed Completion Ratio	Number of Observations
0.680	2
0.600	7
0.520	1

The familiar arithmetic average, weighted for number of observations, is 0.608. The harmonic average is 0.605, which is calculated as 10 divided by (2/0.680 + 7/0.600 + 1/0.520). Harmonic average completion factors will give correct incurred claim figures if the underlying probability distribution follows the observations; this is true because completion factors are used as divisors. The harmonic average will be very different from the arithmetic average when the dispersion of observations is greater and the completion ratio is smaller. Under other circumstances the two approaches are close.

The actual difference resulting from the use of straight versus harmonic averages is that the straight average produces the median value of the distribution of possible claim reserves, while the harmonic average produces the mean value. Because the distribution of possible claim reserves is almost always skewed with a relatively long tail, the straight average is theoretically high and low 50 percent of the time compared to the mean or expected value, but the harmonic average is high more than 50 percent of the time. However, the harmonic average produces a lower variance for possible claim reserve values than straight averages.

Use of arithmetic averages produces a reasonable approximation of the actual mean, if the claim volume is sufficiently large so that dispersion is reduced. This relationship depends not only on the volume of claims but also on their frequency and severity. A low-frequency, high-severity-type claim (for example, long-term care) will require much more volume than a high-frequency, low-severity-type claim (for example, Medicare supplement) to produce reasonable results using arithmetic averages. Probability and statistics books with material on sampling from populations (for example, Fraser [7]) generally cover this topic.

Sample completion ratio averages with $n = 6$ are found in the third column of Table 4. Note that when 6 months is not available for averaging, the total number of months available has been used.

5. Develop completion factors, $(CF_t)''$, for each incurral month. These represent the proportion of estimated incurred claims attributable to an incurral month that have been paid through duration t.

$$(CF)_t'' = (CR_{t-1})''\,(CR_{t+2})''\,\ldots(CR_w)''$$

TABLE 4

COMPLETION RATIO AVERAGES (CR_t) BY LAG PERIOD AND MONTH OF INCURRAL FOR MAJOR MEDICAL THROUGH DECEMBER 1984*

Month Incurred	Lag t	Completion Ratio Averages $(CR_t)^n$	Completion Factor $(CF_t)^n$	Cumulative Paid Claims to Date (CP_t)	Incurred Claims $(IC_t)^n$	Claim Reserve
12/84	0	0.00000000	0.00003638	0	0.00	0.0
11/84	1	0.00093607	0.03886317	32,346	832,304.67	799,958.7
10/84	2	0.22330830	0.17403372	270,925	1,556,738.58	1,285,813.6
9/84	3	0.46587273	0.37356493	449,937	1,204,441.21	754,504.2
8/84	4	0.71617463	0.52161151	784,657	1,504,293.87	719,636.9
7/84	5	0.77483634	0.67318927	1,185,817	1,761,491.23	575,574.2
6/84	6	0.90446652	0.74429430	1,130,561	1,518,970.39	388,409.4
5/84	7	0.91130494	0.81673462	1,307,948	1,601,435.72	293,487.7
4/84	8	0.96355738	0.84762427	1,020,837	1,204,350.84	183,513.8
3/84	9	0.96231187	0.88082076	1,030,080	1,169,454.73	139,374.7
2/84	10	0.99156066	0.88831757	979,106	1,102,202.67	123,096.7
1/84	11	0.99254850	0.89498656	969,187	1,082,906.76	113,719.8
12/83	12	0.97359916	0.91925569	756,382	822,820.03	66,438.0
11/83	13	0.99164586	0.92699998	741,332	799,710.91	58,378.9
10/83	14	0.99215299	0.93433169	769,424	823,501.99	54,078.0
9/83	15	0.99815996	0.93605407	661,907	707,124.75	45,217.8
8/83	16	0.99806128	0.93787234	706,104	752,878.58	46,774.6
7/83	17	0.99932093	0.93850965	489,899	521,996.76	32,097.8
6/83	18	0.99963942	0.93884818	391,144	416,621.14	25,477.1
5/83	19	0.99776687	0.94094945	315,858	335,680.10	19,822.1
4/83	20	0.99962718	0.94130038	242,740	257,977.30	15,137.3
3/83	21	0.99967789	0.94160368	305,650	324,605.78	18,955.8
2/83	22	0.99993779	0.94166227	194,146	206,173.71	12,027.7
1/83	23	0.94882009	0.99245608	276,018	278,116.09	2,098.1
12/82	24	1.00000000	0.99245608	102,491	103,270.06	779.1
11/82	25	1.00000000	0.99245608	136,870	137,910.39	1,040.4
10/82	26	0.99307420	0.99937756	152,902	152,997.23	95.2
9/82	27	0.99984227	0.99953522	73,823	73,857.33	34.3
8/82	28	1.00000000	0.99953522	100,091	100,137.54	46.5
7/82	29	1.00000000	0.99953522	59,220	59,247.54	27.5
6/82	30	1.00000000	0.99953522	97,629	97,674.40	45.4
5/82	31	0.99953522	1.00000000	61,971	61,971.00	0.0
4/82	32	1.00000000	1.00000000	60,515	60,515.00	0.0
3/82	33	1.00000000	1.00000000	51,951	51,951.00	0.0
2/82	34	1.00000000	1.00000000	53,296	53,296.00	0.0
1/82	35	1.00000000	1.00000000	27,591	27,591.00	0.0
				15,990,355	21,766,116.30	5,775,761.3

*36 = Number of months before claims runoff is assumed complete.
n = 6 = Number of factors used in computing completion ratio averages.
Using harmonic means for average $(CR_t)^n$ computation.
Using CF_{36} = 1.0000.

where W is the highest possible value of t. Completion factors based on the sample completion ratio averages noted above are also found in Table 4.

6. Develop preliminary incurred claims and claim reserves by month of incurral, where the formulas by incurred month are as follows:

   Monthly incurred claims

$$(IC_t)^n = \frac{CP_t}{(CF_t)^n}$$

   Monthly claim reserve

$$(IC_t)^n - CP_t$$

   Incurred claims and claim reserve estimated by month of incurral are developed in Table 4.

7. Compare the incurred claims in step 6 with the exposure unit. An example using the incurred claims and claim reserves of Table 4 with sample earned premiums is shown in Table 5; cumulative paid claims and the loss ratios are also included.

TABLE 5

INCURRED CLAIMS AND CLAIM RESERVE ESTIMATES BY MONTH OF INCURRAL FOR MAJOR MEDICAL THROUGH DECEMBER 1984

Incurral Period	Cumulative Claims Paid to Date	Incurred Claims	Claim Reserve	Earned Premium	Loss Ratio
1982	$ 978,350	$ 980,418	$ 2,068	$ 1,894,998	51.7%
1983					
1Q	$ 775,814	$ 808,896	$ 33,082	$ 1,228,000	65.9%
2Q	949,742	1,010,178	60,436	1,837,000	55.0
3Q	1,857,910	1,982,001	124,091	2,380,000	83.3
4Q	2,267,138	2,446,003	178,895	3,645,000	67.1
Total	$ 5,850,604	$ 6,247,108	$ 396,504	$ 9,090,000	68.7%
1984					
1Q	$ 2,978,373	$ 3,354,564	$ 376,191	$ 5,551,000	60.4%
2Q	3,459,346	4,324,757	865,411	7,077,000	61.1
3Q	2,420,411	4,470,226	2,049,815	8,471,000	52.8
4Q	303,271	2,389,043	2,085,772	9,582,000	24.9
Total	$ 9,161,401	$14,538,590	$5,377,189	$30,681,000	47.4%
Grand Total	$15,990,355	$21,766,116	$5,775,761		

The incurred claims and claim reserves developed in this seven-step approach afford a starting point for further review. The next step is to analyze the credibility of these estimates based on influences that may affect the results. The identification and impact of these influences are covered in the following section, and examples depict methods for analyzing the initial

incurred claim and claim reserve estimates. Final adjustments to values in Tables 4 and 5, as necessary to recognize various influences, are shown in Table 6; these adjustments are discussed in Section III.

TABLE 6

INCURRED CLAIMS AND CLAIM RESERVE ESTIMATES BY MONTH OF INCURRAL WITH ADJUSTMENTS FOR VARIOUS INFLUENCES FOR MAJOR MEDICAL THROUGH DECEMBER 1984

Incurral Period	Cumulative Claims Paid to date	Incurred Claims	Claim Reserve	Earned Premium	Loss Ratio
1982	$ 978,350	$ 980,418	$ 2,068	$ 1,894,998	51.7%
1983					
1Q	$ 775,814	$ 784,261	$ 8,447	$ 1,228,000	63.9%
2Q	949,742	963,295	13,553	1,837,000	52.4
3Q	1,857,910	1,890,011	32,101	2,380,000	79.4
4Q	2,267,138	2,332,508	65,370	3,645,000	64.0
Total	$ 5,850,604	$ 5,970,075	$ 119,471	$ 9,090,000	65.7%
1984					
1Q	$ 2,978,373	$ 3,153,842	$ 175,469	$ 5,551,000	56.8%
2Q	3,459,346	4,065,983	606,637	7,007,000	57.5
3Q	2,420,411	4,473,760	2,323,349	8,471,000	56.0
4Q	303,271	5,365,920	5,062,649	9,582,000	56.0
Total	9,161,401	$17,329,505	$8,168,104	$30,681,000	56.5%
Grand Total	$15,990,355	$24,279,998	$8,289,643		

II. ADJUSTMENTS TO BASIC METHOD RESULTS

This section discusses the various influences that may affect claim reserve calculations and methods of adjustment for recognizing them. Modifications depend on the type of product, company operating practices, and the external health care environment in general. The use of a particular adjustment method herein does not preclude the use of other reasonable methods.

Influences are discussed in regard to both credible and noncredible experience periods. A credible period means the preliminary $(CF_t)^n$ is at or above a target level. This target level should be established initially based on past experience or the actuary's judgment, but subsequent analysis will indicate the reasonableness of the initial choice in any case; the author has found values of 0.40 to 0.50 to be satisfactory in the majority of cases. Noncredible periods refer to a time period for which the factors are lower than the target level.

Table 7 shows a list of the influences on incurred claims and claim reserves; this list is not necessarily all-inclusive. The first group of influences is more important in developing completion factors for credible experience

periods, but they also have an impact on noncredible experience periods. The second group of influences is more important in estimating results for noncredible experience periods. A list of reasonableness tests for each group of influences is also included. Discussions corresponding to each item follow.

TABLE 7

INFLUENCES ON INCURRED CLAIMS AND CLAIM RESERVES

A.	*Influences More Significant in Reviewing Credible Experience Periods*
	1. Incurral dating rules
	2. Variations in claims processing
	3. Claim characteristics
	4. Claim anomalies
	5. Insured characteristics
	6. Open or closed blocks
B.	*Reasonableness Tests for Credible Experience Periods*
	R1. Compare actual and expected payments by incurral period
	R2. Develop expected completion factors at any lag
	R3. Reasonableness of current reserve by incurral period
	R4. Reasonableness of past (retrospective) reserve
	R5. Comparison of *CF*'s at a particular lag
C.	*Influences More Significant in Reviewing Noncredible Experience Periods*
	7. Secular trends
	8. Change in exposure and/or mix of business by policy duration
	9. Seasonal effects
D.	*Reasonableness Tests for Noncredible Experience Periods*
	R6. Compare credible and noncredible experience periods
	R7. Review retrospective reserves of other noncredible periods

A. *Influences More Important in Reviewing Credible Experience Periods*

1. Incurral Dating Rules

The rules for assigning claim payments to incurral or loss dates determine the methods or tests that can be employed in evaluating claim experience and reserves. A method can be expected to produce a reasonable estimate only if incurral dating rules are properly reflected in the calculations.

This paper does not include a discussion of what incurral dating rules should be used in a particular situation or how these rules relate to the question of what claim reserves should be used in financial reporting; such issues are so broad that they require a separate paper and, in fact, are currently being debated by the actuarial profession.

In general, four types of incurral dating rules exist. These are briefly defined on the next page, followed by discussion. Many modifications and blends of these rules exist; the list is not all-inclusive.

- *Per Cause*. The incurral date is the initial date of injury or sickness or the date a deductible is satisfied. This rule is generally used for policies paying claims on a per-cause basis.
- *Service Date*. The incurral date is the date of treatment or service, except that for a continuous hospital or nursing home confinement, it is often the first date of such a confinement (normally used for group policies).
- *Calendar Year Per Cause*. The incurral date is the earliest date of treatment or service for a particular cause in the calendar year of service (often used for plans with calendar-year deductibles or maximums, of which Medicare supplement policies are common examples).
- *Calendar Year All Cause*. The incurral date is the earliest date of treatment or service in the calendar year regardless of cause (represents an alternative to the calendar year per cause rule).

If per-cause or service-date rules are used, the preliminary completion factors developed under the basic method in Section I are appropriate as a starting point for further review; figures in Tables 1–6 are based on a per-cause rule. If either of the calendar-year methods is used, revised average completion ratios and factors need to be defined.

The calendar-year methods require revised completion ratios and factors because the runout pattern varies by the time of year of the incurral. A general rule for a stable or mature block of business is the closer the month or other time period to the beginning of the calendar year, the greater the incurred claim but the slower the runout pattern.

In other words, January incurred claims can include service dates from all months, February incurred claims can include service dates from all but January, March incurred claims can include service dates from all but January and February, and so on. Therefore, the completion factor for the same lag month t is generally lowest for January incurred claims and highest for December, with the factor increasing by incurral month throughout the year.

Two possible methods of adjusting the completion ratio averages and corresponding completion factors (as developed in the basic method) to a calendar-year basis are as follows:

(i) Calculate a set of completion ratio averages for each calendar month or incurral period by using the last two or three years of experience for the same calendar month of incurral; these adjusted ratios are called $(ACR)_t$. This method is generally much simpler than method ii below and would normally be used. However, where significant influences are at work such as rapid changes in volume, trends, or the like, the more involved method below may do a better job of predicting trends in factors and incurred claims.

(ii) Develop a grid of exponential factors relating the completion ratio for each month or other incurral period to completion ratio averages representative of a full calendar year. This method is referred to hereafter as the exponential method. In general, the CR_t's are developed from several twelve-month periods preceding the valuation date if available. The formula for the exponential method can be expressed as follows:

CR_t = monthly completion ratio.

$(CR_t)^{12}$ = average completion ratio using CR_t for a full calendar year (12 months).

CE_t^m, GE_t^m = exponential adjustment factor for month-to-month completion ratios; m = month; t = duration, where a prefix of C represents a crude value and G represents a graduated value. (This is calculated as shown below.)

Step 1. Start with several years of history of completion factors by lag month and incurral month. Compute the average completion ratio, CR_t, across all twelve incurral months for each specific lag month.

Step 2. Separately for each lag month, compute the crude value of each incurral month's ratio of the logarithm of the completion ratio for that incurral month to the logarithm of the average completion ratio across all incurral months. Using judgment, develop a smooth curve of these exponential adjustment factors. Presumably, these factors will not have to be changed too often.

$$CE_t^m = \frac{\log CR_t}{\log (CR_t)^{12}};\ GE_t^m = \text{graduation of } CE_t^m$$

Step 3. Assume that an average completion ratio for a specific lag month has already been computed across all incurral months. The exponential adjustment factors can now be used to translate (decompose) this average into separate completion ratios for each lag and incurral month combination.

$$(ACR)_t = [(CR_t)^{12}]\ GE_t^m$$

Step 4. Finally, check that the average of the newly computed completion ratios reproduces, to an acceptable degree, the original average factors. For example, assume that the following exponential adjustment factors (GE_t^m) have already been calculated by steps 1 and 2.

Lag Month	Exponential Adjustment Factors											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4	1.45	1.10	1.03	1.00	0.99	0.97	0.95	0.93	0.91	0.89	0.87	0.83
5	1.65	1.22	1.09	1.04	1.00	0.97	0.95	0.92	0.88	0.83	0.75	0.65

If the newly developed average completion factors for the fourth and fifth lag month are 0.6863 and 0.8004, respectively, the following completion ratio table will result when each of these averages is raised to the power of the corresponding exponent from the previous table.

Lag Month	Completion Ratio											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4	0.5794	0.6609	0.6786	0.6863	0.6889	0.6941	0.6993	0.7046	0.7099	0.7153	0.7207	0.7317
5	0.6926	0.7621	0.7845	0.7933	0.8004	0.8058	0.8094	0.8148	0.8221	0.8313	0.8462	0.8653

To further illustrate adjustment of completion ratio averages and factors to a calendar-year basis, assume that the claim payments used in Tables 1–6 have been dated by using a calendar-year method. Assume that we have developed adjusted completion ratios (ACR_t) for each month, under method i. Results for this illustration are found in Tables 8 and 9, where

$$(ACF)_t = (ACR)_{t+1} \cdot (ACR)_{t+2} \ldots (ACR)_w$$

and w is the oldest incurred month, for example, January 1982 in Table 1. Table 8 depicts illustrative $(ACF)_t$ values by month using the same payment levels found in Tables 1–6. Also included are cumulative claims and claim reserves corresponding to each month of incurral.

Table 9 summarizes the results of Table 8 by quarter of incurral and includes earned premiums and loss ratios; loss ratio equals incurred claim divided by earned premiums. The incurred claims for the fourth quarter of 1984, as found in Table 8, have been adjusted to a more reasonable level, based on the progression of loss ratios for earlier time periods.

From these two tables, the following observations can be made:

(i) Completion factors for a higher lag t may be smaller than for a lower lag t (for example, in Table 8, $CF_{11} = 0.704$ and $CF_{10} = 0.748$). This relationship does not occur with per-cause or service-date rules, except when credits (negative payments) occur.

(ii) Incurred claims by month or period of incurral will decrease throughout a calendar year in general, unless growth is very rapid; this results from claims being "pushed back" into earlier time periods during the year.

(iii) The claim reserve at year-end is substantially lower for a calendar-year rule than for a per-cause rule (as used in Table 6). The reason for this result is that a per-cause rule assigns service dates to current or previous calendar years of incurral, whereas calendar-year rules generally assign service dates only to an incurral date occurring in the same calendar year. As a rough guideline, the year-end claim

TABLE 8

ILLUSTRATION OF CALENDAR-YEAR INCURRAL DATING USING PAID CLAIMS OF TABLE 1 FOR MAJOR MEDICAL THROUGH DECEMBER 1984

Month Incurred	Lag Month	Completion Factor $(ACF)_t$	Cumulative Claims Paid to Date	Incurred Claims	Claim Reserve
12/84	0	0.001	127	127,000*	126,843*
11/84	1	0.010	12,000	120,000*	108,000*
10/84	2	0.130	129,000	992,308*	863,308*
9/84	3	0.333	349,933	1,050,000	700,067
8/84	4	0.432	598,500	1,125,000	526,500
7/84	5	0.625	750,000	1,200,000	450,000
6/84	6	0.681	885,300	1,300,000	414,700
5/84	7	0.721	1,009,400	1,400,000	390,600
4/84	8	0.754	1,131,000	1,500,000	369,000
3/84	9	0.756	1,285,200	1,700,000	414,800
2/84	10	0.748	1,496,000	2,000,000	504,000
1/84	11	0.704	1,900,800	2,700,000	799,200
12/83	12	0.951	523,050	550,000	26,950
11/83	13	0.953	524,150	550,000	25,850
10/83	14	0.958	479,000	500,000	21,000
9/83	15	0.965	443,900	460,000	16,100
8/83	16	0.965	424,600	440,000	15,400
7/83	17	0.965	410,125	425,000	14,875
6/83	18	0.965	410,125	425,000	14,875
5/83	19	0.965	410,125	425,000	14,875
4/83	20	0.965	434,250	450,000	15,750
3/83	21	0.964	462,720	480,000	17,280
2/83	22	0.964	482,000	500,000	18,000
1/83	23	0.948	511,920	540,000	28,080
12/82	24	0.992	124,000	125,000	1,000
11/82	25	0.994	114,310	115,000	690
10/82	26	0.995	99,500	100,000	500
9/82	26	0.996	99,600	100,000	400
8/82	27	0.998	94,810	95,000	190
7/82	29	0.999	89,910	90,000	90
6/82	30	1.000	80,000	80,000	0
5/82	31	1.000	70,000	70,000	0
4/82	32	1.000	60,000	60,000	0
3/82	33	1.000	45,000	45,000	0
2/82	34	1.000	30,000	30,000	0
1/82	35	1.000	20,000	20,000	0
Total			$15,990,335	$21,889,308*	$5,898,923*

*Revised in Table 9.

TABLE 9

ILLUSTRATION OF CALENDAR-YEAR INCURRAL DATING CLAIM RESERVE SUMMARY TABLE
AS OF DECEMBER 1984

Incurral Period	Cummulative Claims Paid to Date	Incurred Claims	Claim Reserve	Earned Premium	Loss Ratio
1982					
1Q	$ 95,000	$ 95,000	$ 0	$ 94,998	100.0%
2Q	210,000	210,000	0	350,000	60.0
3Q	284,320	285,000	680	600,000	47.5
4Q	337,810	930,000	2,190	850,000	40.0
Total	$ 927,130	$ 930,000	$ 2,870	$ 1,894,998	49.1%
1983					
1Q	$ 1,456,640	$ 1,520,000	$ 63,360	$ 1,228,000	123.8%
2Q	1,254,500	1,300,000	45,500	1,837,000	70.8
3Q	1,278,625	1,325,000	46,375	2,380,000	55.7
4Q	1,526,200	1,600,000	73,800	3,645,000	43.9
Total	$ 5,515,965	$ 5,745,000	$ 229,035	$ 9,090,000	63.2%
1984					
1Q	$ 4,682,000	$ 6,400,000	$1,718,000	$ 5,551,000	115.3%
2Q	3,025,700	4,200,000	1,174,300	7,077,000	59.3
3Q	1,698,433	3,375,000	1,676,567	8,471,000	39.8
4Q	141,127	2,682,960	2,541,833	9,582,000	28.0
Total	$ 9,547,260	$16,657,960	$7,110,700	$30,681,000	54.3%
Grand Total	$15,990,355	$23,332,960	$7,342,605		

reserve using a calendar-year rule is usually between 65 and 90 percent of the same reserve based on a per-cause rule.

(iv) The year-end claim reserve using a calendar-year rule should be equivalent to the claim reserve using a service-date rule, if all services performed or hospital confinements beginning in the following year are placed in the same year of incurral. The service-date rule, as noted earlier, is commonly used for group business.

(v) Loss ratios generally decrease as the calendar year progresses (see Table 9 for quarterly results). Further, the steepness of loss ratios by quarter or other incurral period tends to increase as the business matures. The reason for this relationship is that in-force business at year-end produces a full year of exposure in the next calendar year, or more exposure for the first part of the year if lapsing occurs, whereas new business produces greater exposure in the latter part of a calendar year. Therefore, as new business is replaced by renewal business on an overall percentage basis, the potential for "pushing back" service dates to earlier time periods in the calendar year is increased.

(vi) The steepness of loss ratios by quarter of incurral can be seen in Table 9 to be increasing for 1983–1984. In this case Tables 8 and 9 results are indications of calendar-year per-cause dating. Calendar-year all-cause dating would produce even

steeper loss ratios due to pushing back more claims to earlier time periods during the calendar year.

(vii) Because calendar-year incurral dating normally generates a decreasing pattern of incurred claims during the year, it produces an unreasonable matching of incurred claims and earned premiums over that same time period as well as a generally decreasing claim reserve pattern. Thus, a calculation of reserves at any point in time may need to be restated so that large fluctuations in earnings do not occur during the calendar year.

Two methods of restating earnings during the calendar year are as follows:

(*a*) Restate all results to be consistent with a year-end basis. This restatement may be done in several ways; the most common is to estimate a projected loss ratio for the current year and then use adjusted incurred claims based on the projected loss ratio.

(*b*) Transform calendar-year estimates to a per-cause rule basis, and use the earnings pattern developed or projected by incurral period as a model for earnings during the calendar year. This method requires a technique for redating claim payments to different incurral periods and substituting a set of typical per-cause completion factors as appropriate for the type of benefits. The results should be reasonably consistent with the claim reserves at or slightly after the end of the third quarter using a calendar-year rule.

These two methods for restating earnings or reserves produce quite different results: Method *a* establishes a lower reserve characteristic of a service-date rule, and method *b* establishes a higher reserve characteristic of a per-cause-type rule. Other methods can also be used, but they should result in reserve levels consistent with either method *a* or *b*. The appropriate level of reserve depends on reserving principles as applicable to the particular situation; as noted earlier, this subject is beyond the scope of this paper.

The usual relationship of claim reserves at quarterly valuation dates under either type of calendar-year rule versus per-cause or service-date rules is shown in Table 10. In all cases, the calendar-year methods are denoted as providing a claim reserve that is higher, similar, identical (theoretically at least), or lower than the other method noted.

TABLE 10

CLAIM RESERVES VIA CALENDAR-YEAR INCURRAL DATING RULES COMPARED TO OTHER INCURRAL DATING RULES FOR ANY YEAR *Y*

Other Rules	March 31, *Y*	June 30, *Y*	September 30, *Y*	December 31, *Y*
Per-Cause Rule	Higher	Higher	Similar	Lower
Service-Date Rule	Higher	Higher	Higher	Identical*

2. Variations in Claims Processing

This influence can include factors both internal and external to the company. In either case, underlying changes in the lag or runout factors can occur that will substantially alter the reserve calculations. Examples of such factors are:

- Backlogs of claims
- Mail disruptions
- Economy (for example, people submit claims sooner when money is tight)
- Staff vacations and/or turnover
- Fewer or more payment dates in some months versus others (for example, closing dates for claim payments at other than the end of the month)
- Computer system conversions and/or capabilities.

The impact of this influence can be reviewed by examining completion ratio averages over various periods of time. For example, a review of three-, six-, and twelve-month averages from Table 3 as of December 31, 1984 indicates a slight speedup in recent payments. These factors are as follows for lag months 4–11:

Lag in Months	Completion Ratio Averages		
	3 Month	6 Month	12 Month
4	0.728	0.716	0.686
5	0.768	0.775	0.800
6	0.905	0.904	0.901
7	0.933	0.911	0.937
8	0.965	0.964	0.970
9	0.974	0.962	0.971
10	0.993	0.992	0.966
11	0.993	0.993	0.982

The number of months chosen for averaging should be sufficient to smooth out unusual variations if possible, but should only include payment periods that are indicative of current company practice. For the latter reason, averaging for more than the last twelve months may not be acceptable.

Other tests can also be conducted to check for a backlog or other disruption in claim payments. For instance,

(i) The average time between the loss or incurral date and payment month can be calculated for any one payment month or period. This result is obtained by multiplying the lag between the incurral date and payment date by the proportion of monthly or periodic payments in that time period, and summing the results for the same payment month. For example, if a payment month has $1,000,000 of payments with 10 percent at $t = 0$, 30 percent at $t = 1$, 30 percent at $t = 2$, 20 percent

at $t = 3$, 10 percent at $t = 4$, and no payments thereafter, the average lag is calculated as follows:

let t = lag
P = payments at time t
TP = total payment = 1,000,000
AL = average lag, in months =

$$\frac{1}{1{,}000{,}000}[0(100{,}000) + 1(300{,}000) + 2(300{,}000) + 3(200{,}000) + 4(100{,}000)]$$
$$= 1.9 \text{ months.}$$

(ii) Review the general level of monthly payments to determine whether any anomalies are evident.

If a backlog of claims is discovered, one method for calculating the claim reserve is to increase actual claim payments to previously expected levels and then generate incurred claims from these expected payments. The claim reserve is then calculated as expected incurred claims minus the actual payments made as of the date of valuation.

3. Claim Characteristics

This means the type of benefit, utilization of benefits, claim sizes in general, benefit period, elimination period or deductible, and preexisting condition requirement. A review of this information, including marketing and underwriting practices of the company, may provide some idea of the characteristics of the runout pattern for a claim, such as:

- The frequency of claim payments
- The severity or amount of a claim
- Anomalies that may occur in the runout pattern (this is discussed in detail in "Claim Anomalies" later).

Occasionally the frequency of claim payments is uneven. In these cases, methods employed to reflect calendar-year incurral dating will generally produce a satisfactory result. For example, if a policy contains a prescription drug benefit with a calendar-year deductible, claim payments in January and February of each year will often be much higher than in other months. This occurs because some insureds hold all bills relating to a calendar year and submit them only after the year is complete. The result is a seasonal payment pattern that can be analyzed by using any of the methods available for calendar-year incurral-dating patterns.

The severity and runout pattern of a claim may be limited by benefit provisions. For instance, a nursing home plan with a three-year benefit period that provides a fixed benefit per day of confinement should have a runout period in the vicinity of four years.

4. Claim Anomalies

Included here are influences generally beyond the control of the company's claim administrative practices. These are often discovered in examining variations in claims processing. A list of possible anomalies follows, and one method of recognizing each anomaly is included.

(i) *Large Claims.* An example of the impact of a large claim is shown in the table below. This example uses six-month completion ratio averages as found in Table 4 for incurral months May 1982 through February 1983 and payment months July through December 1984. The large claim responsible for the unusual completion ratio average at lag 23 is an October 1982 incurral paid in September 1984. (The total amount paid in September 1984 on October 1982 incurrals is $37,386; see Table 1.)

Month/Year of Incurral*	Lag Period	Completion Ratio Average	Completion Factor
2/83	22	0.99993779	0.94166227
1/83	23	0.94882009	0.99245608
12/82	24	1.000	0.99245608
11/82	25	1.000	0.99245608
10/82	26	0.99307420	0.99937756
9/82	27	0.99984227	0.99953522
8/82	28	1.000	0.99953522
7/82	29	1.000	0.99953522
6/82	30	1.000	0.99953522
5/82	31	0.99953522	1.000

*Corresponds to the lag period shown for a valuation date of December 31, 1984.

Although the completion ratio average derived for lag 23 is generated from actual experience, the inclusion of this ratio would appear to produce too large a claim reserve for incurral months February 1983 and later. Instead, a completion ratio average of 0.995 or similar estimate at lag 23 should be substituted, because this will be more consistent with future expectations; a small extra reserve for large claims is spread among all future incurral periods here, as opposed to assigning a larger extra amount to one or only a few incurral periods. The substituted ratio should also be slightly conservative for that lag period to allow for the possibility of additional large claims. If a 0.995 ratio is substituted above, incurred claims in February 1983 and later are multiplied by $0.94882009 \div 0.995 = 0.95358803$.

Other types of adjustments, in general, that can be made to allow for the possibility of large claims are:

- An adjustment to the final or earliest completion factor (that is, *CF* for January 1982 in Table 4) to increase the claim reserve for all incurral periods.
- Modifications to completion factors representing only certain periods of time so that the claim reserve is increased for the corresponding incurral periods only. This technique is employed when particular incurral periods reflect a tendency toward large claims not exhibited by other incurral periods.
- Specific adjustments to completion ratios similar to those covered in discussing insured characteristics under "Insured Characteristics" later.

(ii) *Claim Payment Interruptions.* Claim payments may be discontinued on occasion. Possible reasons may be change in ownership on a block of business, a new computer system being installed, a management decision intended to resolve serious internal problems, and the like.

One method of recognizing these types of problems is to calculate completion ratio averages and exclude payment months in which payments are unusually small or large. If most or all of the months are not believed indicative of lag patterns, an expected payment pattern can be developed or other methods of establishing claim reserves may be used (see Bragg [4]).

(iii) *Changes in the Reporting Lag.* If a change in the reporting lag occurs, this will probably affect the lag between the incurred or loss date and payment date. To recognize this occurrence, completion ratio averages should be based on payments only for the time period after the change became evident.

5. *Insured Characteristics*

Loss ratios generally increase with policy duration due to the increasing age of insureds and wearing off of company selection and insured antiselection. This may result in a slow decrease of completion factors over time because of increases in the severity of claims during the same period, a component of cumulative antiselection as noted by Bluhm [3].

A decrease in completion factors due to increased claim severity is necessary because the basic method in Section I does not fully reflect the current status of an incurral period at the valuation date, but rather the status at the midpoint of the averaging period; for a twelve-month average this would be six months ago. This decrease is usually most significant on major medical policies or policies for which underwriting plays a significant role.

Three possible methods of implementing an adjustment to recognize increasing severity of claims are as follows:

(i) Use past changes in completion ratio averages under similar conditions to project adjusted completion ratios. Adjustments probably would need to vary by incurral

period. For instance, if the completion ratio at lag month 4 decreased by 1 percent from December 31, 1983 to December 31, 1984 and the wearing off of selection in 1985 was expected to be similar to that in 1984, a 1 percent additional decrease might be expected as of December 31, 1985.

(ii) Multiply all completion factors by the same constant factor to reflect an expected increase in total incurred claims (for example, 0.9995). This method does not produce an appropriate adjustment necessarily for each lag period, but rather is intended to derive an appropriate aggregate adjustment.

(iii) Multiply each completion ratio average by a constant factor with this adjustment being cumulative. For instance, if 0.9995 is the designated adjustment factor for lags 0–35, CF_{35} would be multiplied by 0.9995, CF_1 by $(0.9995)^{35}$ and CF_0 by $(0.9995)^{36}$. This method would be used to reflect an expected general understatement of all completion ratio averages by a specified amount.

6. Open or Closed Blocks

Another factor to consider is whether a block of business is closed (no new business) or open (new business is being sold). If closed, completion factors may increase with time; this event will occur when continuing claims cease due to lapsation and the severity factor is no longer significant or is diminishing in significance. If open, the following "rules of thumb" apply:

(i) If new business is the majority of business and increasing in volume, completion factors generally decrease with passing time.

(ii) If new business is offset by lapses such that no growth occurs or growth is due only to rate increases, completion factors should be relatively stable.

(iii) If lapses are greater than the amount of new business (a decrease in policy counts), completion factors generally increase if other offsetting factors are not present.

Circumstances often may result in a combination of 1–6 above working in opposite directions such that a clear direction in completion factors is not evident. However, understanding of the impacts of business mix and type can be invaluable in producing reasonable claim reserve estimates.

After establishing the basic method and reviewing the influences noted above, a series of completion ratio averages will have been derived for each lag month. If 1.0 is assumed to be an appropriate $(CF_t)^n$ for the earliest incurral month for which data are available, a set of test CF's for all incurral months is then available. In many cases, the final CF is quickly established to be less than 1.0, due to payments currently being made on the oldest incurral periods or the immaturity of the business. In these instances, the set of test CF's should be based on a preliminary estimate of that final CF.

Once the test *CF*'s are established, reasonableness tests should be applied to either confirm or cause the series of $(CR_t)^n$'s and the $(CF_t)^n$'s to be modified. These tests should be made only for periods in which the *CF* is credible and should show whether the final CF is a viable factor. Note that the impact of all influences should be kept in mind during these tests, including those that generally have a greater impact on noncredible experience periods.

B. *Reasonableness Tests for Credible Experience Periods*

R1. Compare Actual and Expected Payments by Incurral Period

The actual payments during the most recent time periods can be compared with expected payments for the same periods; expected payments can be derived from past or current completion factors. This comparison may be helpful in identifying completion factors that need adjustment. The formula for expected payments for any incurral month is:

$$\text{Expected Payment}_{t+1} = \frac{(CF_{t+1})^n - (CF_t)^n}{1 - (CF_t)^n} \times (\text{the claim reserve for month } t)$$

For example, the expected payments for the next three months in Table 4 for incurral month June 1984 (using six-month averages) would be as follows:

$$\begin{aligned}\text{Payments} &= \frac{(CF_9)^6 - (CF_6)^6}{1 - (CF_6)^6} \text{ (reserve for June 1984 incurrals)} \\ &= \frac{0.96231187 - 0.90446652}{1 - 0.90446652} (\$388{,}409.4) \\ &= \$235{,}181.2\end{aligned}$$

R2. Develop "Expected Completion Factors" at Any Lag (Time t*), Called* $(\text{ECF}_t)^n$

Corresponding to any incurral month, the expected completion factor equals the multiplication of all $(CR_t)^n$'s subsequent to lag time t for that incurral month. Corresponding to any payment month, the expected completion factor equals the multiplication of all CR_t's greater than lag time t for that payment month; a harmonic average of these expected completion factors for as many months as desired or available can then be used as a guideline. In either case, if the number of CR_t's available is not sufficient to produce a complete runout pattern, additional runout will have to be estimated. Note

that the resulting expected completion factors should be compared with the test *CF*'s to determine whether changes are necessary.

By incurral month

$$(ECF_t)^n = (CR_{t+1})^n \times (CR_{t+2}^n) \times (CR_{t+3}) \ldots (CR_w)^n$$
$$\times \ldots \text{ the additional runout.}$$

By payment month

$$ECF_{\cdot} = CR_{t+1} \times CR_{t+2} \times CR_{t+3} \ldots CR_w$$
$$\times \ldots \text{ the additional runout.}$$

Note that W is the duration of the oldest completion factor in the table (for example, January 1982 in Table 4). For example, by using Table 3, the expected completion factor for January 1983 would be calculated as follows assuming a payout of 0.5 percent of incurred claims beyond lag 23.

$(\text{ECF})_{23}$ *by incurral month*

$$= (CR_{24})^{12} \times (CR_{25})^{12} \ldots (CR_{35})^{12} \times 0.995$$
$$= 0.985352 \times 0.987855 \times 0.998833 \times 0.999898$$
$$\times 1.00 \times 1.00 \times 1.00 \times 0.999535 \times 1.000 \times 1.00$$
$$\times 1.00 \times 1.00 \times 0.995$$
$$= 0.964030$$

Note:

$$(CR_{24})^{12} = 0.985352 = \frac{1}{\left(\frac{1}{0.849416} + \frac{1}{0.998888} + 10\right)/12}$$

$$(CR_{25})^{12} = 0.987955 = \frac{1}{\left(\frac{1}{0.949328} + \frac{1}{0.996745} + \frac{1}{0.928100} + 8\right)/11}$$

ECF_{23} *by payment month for December 1984 payments only*

$$\begin{aligned} ECF_{23} &= CR_{24} \times CR_{25} \ldots CR_{35} \times 0.995 \\ &= 1.00 \times \ldots \times 1.00 \times 0.995 \\ &= 0.995. \end{aligned}$$

In the calculation per Table 4, the value used is about 0.9925, which falls between the two test values. This test indicates some significant variation at later durations and may suggest adding some extra margin to cover large claims on an aggregate basis. In this regard, note that final values in Table 6 used *CR*'s that included some margin for larger claims.

R3. Examine the Reasonableness of the Current Reserve for Any Incurral Period Based on the Level of Payments Made during Recent Months

This is a common sense approach. If the recent payments do not appear to suggest a reserve near that derived from the test *CF*'s, a modification should be made.

R4. Check the Reasonableness of Past Reserves by Incurral Period (Retrospective Checks)

Add the claims paid since the valuation date of the past reserve estimate to the remaining reserve at the new valuation date and compare this to the past reserve estimate, with all comparisons for the same incurral periods. If the level of the new remaining reserve cannot be explained in terms of this comparison, adjustments are probably necessary.

R5. Comparisons of CF*'s at a Particular Lag with the Same CF for Other Valuation Dates*

This means the test *CF*'s by lag month or other periods are compared with *CF*'s that were or would have been produced in an earlier valuation.

R6. An Estimate of the Reserve for an Incurral Month or Period Based on a Supplied or Judgmental Runout Pattern in Dollars

This should be based on the actuary's experience and judgment.

These reasonableness tests should form the basis for any adjustments to the test *CF*'s and the final set of $(CF)_i''$'s selected for credible experience periods.

C. *Influences More Important in Reviewing Noncredible Experience Periods*

The influences noted below are more important in establishing incurred claim and claim reserve estimates for noncredible experience periods. Because these estimates generally utilize information developed from credible experience periods, they obviously also rely on influences 1–6.

7. Secular Trends

These trends reflect the impact of various items, as listed below, on the claim reserve and overall experience; included are:

(a) Inflation
(b) Utilization changes (due to changes in medical technology, changes in the health care environment, and so on)
(c) Cost shifting
(d) Unemployment
(e) Regulation.

A method of recognizing this influence and its possible components is discussed in conjunction with the following influence.

8. Change in Exposure and/or Mix of Business by Policy Duration

Included under this influence are new sales and policy persistency, benefit changes, and rate increases. A method that develops incurred claims and recognizes secular trend, change in exposure, and rate increases is shown below. The method uses the loss ratio and earned premium for a past incurral period as a starting point.

Incurred Claims for Noncredible Experience Period

$=$ Earned Premium for Recent Period
$\times$ Loss Ratio for Credible Experience Period
$\times$ Secular Trend from Credible Experience Period to Recent Period
$\div$ Impact of Rate Increase.

Note that the impact of a rate increase can be estimated by considering the modal distribution and the likely effectiveness of such a rate increase. Also, this formula can generally be modified to reflect the mix of business by policy duration. A possible technique is to use the above formula for existing business in conjunction with earned premium and an estimated loss ratio for new sales only.

An example calculating incurred claims for the fourth quarter of 1984, with a December 31, 1984 valuation date, is shown in Table 11. This example uses the incurred claims as calculated by the basic method, but with adjustments to completion ratio averages as deemed necessary (summarized in Section III).

TABLE 11

CALCULATION OF INCURRED CLAIMS FOR OCTOBER–DECEMBER 1984 WITH A DECEMBER 31, 1984 VALUATION DATE

Formula		Calculation
	Existing Business Only	
	Earned Premium for October–December 1984	$7,950,000
times	Loss ratio for January–June 1984	57.2%
times	Secular trend (15% annual trend is used, but for only 7.5 months, from midpoint of Jan.–June 1984 to midpoint of Oct.–Dec. 1984)	$(1.15)^{.625}$
divided by	Impact of Rate Increase	None
Result		$4,962,486
(loss ratio)	Incurred Claims	(62.4%)
	New Business Only	
	Earned Premium	$1,632,000
times	Estimated Loss Ratio	40%
Result	Incurred Claims	$ 652,800
	Existing and New Business Combined	
	Aggregate Incurred Claims	$5,615,286
Result	Earned Premium	$9,582,000
	Loss Ratio	58.6%

9. *Seasonal Effects*

Claim frequencies and amounts often vary by the time of year. As an example, accidents are usually more frequent during the summer months, but hospitalizations are less frequent in December during the holiday season.

One method of calculating incurred claims by a seasonal method is as follows:

Step 1. Compute the ratio of the estimated incurred claims for the most recent credible incurral period to those for the same period one year earlier.

Step 2. Multiply the result in step 1 by the estimated incurred claims for the incurral period one year before the noncredible incurral period being analyzed.

A sample calculation for fourth quarter 1984 incurrals for the major medical data as found in Table 4, without adjustment, is shown on the next page.

The example uses quarterly experience as the basis for the estimate, with third quarter 1984 experience assumed to be the most recent credible experience period.

Incurred Claims by Month

Incurred Month	Incurred Claims	Incurred Month	Incurred Claims
7/83	497,770	7/84*	1,869,277
8/83	717,936	8/84*	1,596,342
9/83	674,305	9/84*	1,278,141
10/83	785,282		
11/83	762,595		
12/83	784,631		

*Third quarter 1984 incurrals adjusted to produce a 56 percent loss ratio, based on a review of results for credible experience periods.

The ratio of the total incurred claims for the third quarter of 1984 to the third quarter of 1983 times the monthly incurred claims estimated for October, November and December of 1983, respectively, produces estimates for the corresponding month in the fourth quarter of 1984 as follows:

Incurral Month	Estimated Incurred Claims
10/84	$1,970,988
11/84	1,914,046
12/84	1,969,354
Total	$5,854,388

In addition, loss ratios by quarter or other incurral period within a calendar year can be reviewed to estimate the effect of seasonality. This method is very simple, but it can be as effective as other methods for discerning the effect of seasonality.

After the impact of influences on noncredible experience periods has been analyzed, the estimates obtained should be reviewed for reasonableness as noted below.

D. *Reasonableness Tests for Noncredible Experience Periods*

R6. Compare the Level of Incurrals in Credible Experience Periods Immediately Preceding Noncredible Experience Periods with Estimated Incurred Claims for the Noncredible Experience Periods

Some consistency should be evident when the change in exposure (premiums and/or lives) is taken into account.

R7. Review Retrospective Results for Noncredible Experience Periods at Earlier Valuation Dates

For instance, in analyzing fourth quarter 1984 incurrals as of December 31, 1984, the completion factor for third quarter 1984 incurrals with a September 30, 1984 valuation date could be analyzed, as well as earlier quarters of incurral for corresponding valuation dates.

Incurred claim estimates for quarters or periods of incurral with relatively small completion factors and/or paid claim levels can exhibit a wide range of possible estimates. Therefore, various methods of calculation should be employed and a reasonable value selected from possible scenarios. No one method is known to work consistently well under these circumstances, and estimates should take into account all the factors affecting noncredible experience periods. This is an area for further research.

When the final estimate for noncredible experience has been made, only the final review and checking stage remains.

III. THE FINAL RESULT

Once all influences have been considered and corresponding modifications made, the adjusted result can be compiled. Table 6 depicts these adjusted results with the preliminary results of Table 4 (also applies to Table 5) being modified as follows:

- The completion ratio average at lag 23 has been adjusted from 0.94882009 to 0.995; this reflects the large claims adjustment noted in Section II under "Claim Anomalies."
- The completion ratio average at lag 12 has been adjusted from 0.97359916 to 0.9875; this is similar to the type of large claims adjustment noted above for lag 23.
- A loss ratio of 56 percent has been assumed for the third and fourth quarters of 1984 based on a review of past results and the likely impact of various influences on these periods, as discussed in the previous section.

After all adjustments have been made and a final result calculated, two additional reviews should be performed to ensure that this result is consistent with the information available.

A. *A Calculation of the Retrospective Reserves at Various Points in Time during the Last Year*

This includes deriving the paid portion and remaining reserve portion of the retrospective reserve. Note that retrospective checks have already been made to some extent in the reasonableness review of results for credible experience periods.

As an example of a retrospective reserve calculation, major medical retrospective reserves as of December 31, 1984 are shown in Table 12 for initial valuation dates of December 31, 1983, June 30, 1984, and October 31, 1984 and compared with initial estimates made as of those dates. For instances in which these results do not appear to provide a reasonable progression in comparison with the current estimate, a further review of test results or additional testing may be necessary. The impact of plan growth and other influences affecting claim reserve levels should be considered in making these comparisons. Berquist and Sherman [2] present "guidelines for any comprehensive and systematic approach to testing the adequacy of loss reserves," referred to herein as claim reserves.

TABLE 12

COMPARISON OF RETROSPECTIVE CLAIM RESERVE ESTIMATES AS OF DECEMBER 31, 1984 WITH INITIAL ESTIMATE AS OF DECEMBER 31, 1984, JUNE 30, 1984 AND OCTOBER 31, 1984

	Initial Valuation Date		
	12/31/83	6/30/84	10/31/84
(i) Paid since initial valuation date	$3,360,623	$4,742,492	$2,395,765
(ii) Reserve remaining as of December 31, 1984 for incurrals on or before the initial valuation date	121,539	903,645	4,701,761
(iii) Total retrospective reserve (sum of i and ii)	3,482,162	5,646,137	7,097,526
(iv) Initial reserve estimate (from previous valuation)	3,135,163	6,116,640	7,840,191
(v) Difference between iv and iii or initial estimate minus retrospective estimate	(346,999)	470,503	742,665

B. *An "Eyeball" Review of Final Results*

This means that the final claim reserve estimate is reviewed to determine whether the findings and judgments established by previous calculations are as consistent as possible with the final result.

A final consideration in reviewing claim reserves and related items is the potential variation that can occur. One means of analyzing this is to test different scenarios of completion factors and/or loss ratios and develop a probability distribution of possible results. This may be another area for further research.

IV. SUMMARY

The method described herein has been designed to recognize particularly troublesome influences that have an impact on claims experience; other methods have often not dealt with these. Failure to reflect such influences can result in faulty loss ratio estimates and inappropriate management decisions. Proper use of this method should diminish the likelihood of this occurrence.

General advantages and disadvantages of the method are listed below.

Advantages	Disadvantages
1. Provides a generally good measure of claims experience.	1. The method is time-consuming.
2. Recognizes various influences that are difficult to evaluate.	2. In general, claim payments of at least $250,000 are needed to use the method.
3. Matches claims and premiums and recognizes reserving principles employed.	3. Familiarity with the line of business being analyzed is critical to making appropriate estimates of experience. Therefore, initial estimates made for a line of business may be less accurate than later estimates.
4. Tests can be applied at the user's option, depending on those that are applicable for a given situation.	4. Claim experience estimates are clearly dependent on incurral dating practices. Inconsistencies or errors here may result in an improper evaluation of actual experience.
5. Effectively combines a completion factor approach with a pure premium-type approach; the latter refers to the analysis of loss ratios and trends over various time periods.	

This method should be used only when the user understands the concepts underlying the method. Other methods may provide better estimates in some cases and certainly can be used to provide additional input or confirming estimates. The method or methods appropriate for a particular situation depend on the volume of business, characteristics of the business and the data available.

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DISCUSSION OF PRECEDING PAPER

E. PAUL BARNHART:

I thank and compliment Mark Litow for a very valuable paper on the troublesome and complicated topic of health claim reserves.

The paper abounds in practical suggestions and valuable cautionary advice. It should be of immense value to all those actuaries, whether of greater or lesser practical experience, who must contend with the problems that complicate and frustrate the never-ending task of placing a "sound value" on the unpaid claim liabilities hiding out there on such volatile and trend-prone coverages as major medical insurance.

My discussion focuses on dealing with the longer term part of what Mark defines as "short-term" health insurance benefits, involving claims with a runout of 10 years or fewer. I view claim runout patterns reaching five years or longer as getting to be rather long term, although I think the development techniques discussed in the paper are entirely appropriate for use in valuing such longer period runoffs, at least in most cases.

I briefly address the problem of estimating reasonable completion factors for benefits expected to exceed three years or so in runout, when available experience does not extend out as far as three years: In other words, the oldest claim data observable has not yet reached 100 percent completion. If the expected runout period is at least, say, five years, as in the case of long-term-care coverage providing for benefit periods of five years or more, and the insurer has only been issuing the coverage for two or three years, there is a vital need for careful determination of the completion ratio to be assumed at the last duration at which credible known data cuts off.

Presumably, the actuary will have already cautiously addressed this problem, even if indirectly, in the original pricing of the product through the construction of reasonable claim costs. A model continuance table, or the equivalent, should have been constructed at that point, which in the absence of sufficiently credible data or assumptions, from whatever outside source, was at least consistent with a reasonable runoff pattern, in combination with the assumed incidence rates. If the original claim costs assumed cannot be shown to match up with a reasonable continuance or runoff pattern, they probably need revision.

I illustrate this, briefly, by using an actual model developed for a plan of long-term-care coverage for which I had the unenviable task of constructing premium rates back in 1984. The coverage provided for a fixed daily benefit,

payable for up to five years from the first day of covered confinement in a nursing care facility. The maximum daily benefit available was $80; hence, the maximum potential claim was $146,000, and a few maximum claims had to be expected.

I constructed, from the assumed continuance values, a composite runoff model based on an expected mix of age and sex making up a "stationary population" of claimants. Constructed on quarter-year intervals and assuming 100 percent completion at the end of 21 quarter-years (five years plus one more quarter for final claim closing payments), the model was as follows:

Quarter	Cumulative Payout	Completion Factors
1	8,000	0.0098
2	100,000	0.1225
3	265,000	0.3246
4	410,000	0.5023
5	530,000	0.6493
6	620,000	0.7595
7	685,000	0.8392
8	730,000	0.8943
9	760,000	0.9310
10	780,000	0.9555
11	793,000	0.9715
12	801,000	0.9813
13	806,000	0.9874
14	809,000	0.9911
15	811,000	0.9935
16	812,500	0.9953
17	813,600	0.9967
18	814,500	0.9978
19	815,200	0.9987
20	815,800	0.9994
21	816,300	1.0000

Incidentally, this useful exercise led to an upward revision in the assumed claim costs.

After monitoring these assumed factors against actual runout results through 17 quarters (more than four tantalizing years), the entire cumulative data indicated the following degree of revision in the factors:

Quarter	Completion Factors
1	0.0088
2	0.1303
3	0.3048
4	0.4544
5	0.5787
6	0.6708
7	0.7466
8	0.8092
9	0.8623
10	0.9036
11	0.9371
12	0.9662
13	0.9874
14	0.9925
15	0.9947
16	0.9957
17	0.9967

The still incomplete ending factor, here, 0.9967, remains identical with that of the original model. I was relieved to conclude (for the moment) that it did not seem to require adjustment.

At this temporarily terminal duration point (17 quarters), more than $12,000,000 in actual claims has been paid out; yet the set of completion factors, now based primarily on actual data, must still be considered immature. Nevertheless, much has been learned about the first four years of the runout pattern. Note the substantial reductions in the factors over the third through the twelfth quarters. Premium rates for the coverage, needless to say, have been revised once or twice since original pricing of the product.

This is only one illustration, but it does show the extreme importance of originally giving careful attention, not only to construction of claim costs and other pricing assumptions, but also to the runoff pattern on which unpaid claim reserves will need to be estimated. This not only is essential in its own right, but also serves as an important test of the reasonableness of the assumed claim costs. Assumed "average claims," along with claim incidence rates, that is, the usual claim cost elements of "frequency" and "severity," are not enough when long-term runout is involved. Actual continuance models are indispensable to the total process.

JOHN M. BRAGG:

I was very pleased to see this paper because it is a true intellectual effort to inquire into the nature of health claim reserves. Mr. Litow is to be congratulated.

When I wrote the original paper in 1964*, I estimated that health reserves totaled "well over $1 billion." My present estimate is close to $50 billion, including the reserves of insurance companies, Blues, and HMOs. Because of the tremendous growth, increased complexity, and continuing lack of understanding, we need more papers like this one.

The paper is particularly good in discussing the wide differences that can occur by changing incurral dating rules; in pointing out impacts on mid-year statements; and in showing influences to be taken into account in order to adjust results.

The major difference between Litow's unadjusted reserve ($5,775,761 from Table 5) and his adjusted reserve ($8,289,643 from Table 6) was caused by assuming a 56 percent incurred loss ratio in the last two quarters of 1984 and allowing the claim reserve to be a balancing item. The development method was not used for those quarters. What he has done is roughly equivalent to using the tabular method I described in 1964, for those two quarters. However, there is a difference, because tabular factors (if available) would be independent of the quite small actual paid claim figures and would not be "balancing" to them, as in Litow's adjustment. As readers will realize, the development method results from "the track record," whereas the tabular method (or Litow's adjustment) is based on "what the reserve should be, theoretically."

I thought it would be instructive and interesting to apply the classical development method, as I described it on pages 25-26 of that paper and as I illustrated it on pages 2513-2515 of the *Record*†. The method, which is sometimes called the pyramid method (because of the shape of the data on the worksheet), does not use completion factors as such and differs in this way from Litow's paper. It does use proportioning methods to account for changes in volume of business, as measured by a stabilizing factor such as premium income.

To apply the method at the end of 1984, the only data actually needed are:

*BRAGG, J.M. "Health Insurance Claim Research and Liabilities," *TSA* XVI (1964): 17-54.
†DOBSON, R.M. "Individual Health Insurance Reserve Issues," *RSA* 11 (1985): 2411-515.

Premiums Earned:	
1982	$1,894,998
1983	9,090,000
1984	30,681,000
Claims Paid in 1984	
Incurred in 1982	$72,048
Incurred in 1983	3,288,574

This information might be all that is available in the rush of year-end. The calculations are simple and proceed as follows:

A. Estimated Runoff after the End of 1983

$$3{,}288{,}574 + 72{,}048 \left(\frac{9{,}090{,}000}{1{,}894{,}998}\right) + 72{,}048 = 3{,}706{,}226$$

B. Estimated Runoff after the End of 1984

$$3{,}706{,}226 \left(\frac{30{,}681{,}000}{9{,}090{,}000}\right) = 12{,}509{,}431$$

C. Claim Reserve December 31, 1984

Add 10 percent margin:

$$12{,}509{,}431\ (1.1) = 13{,}760{,}374$$

This is considerably in excess of Litow's adjusted reserve ($8,289,643). One is impressed by the conservatism of the result, but we may just have demonstrated something we already knew: The development method is not too good for new and rapidly growing blocks (which this one certainly is).

I then applied the classical development method on a quarterly basis by using just the claims paid in the fourth quarter of 1984, and earned premiums by quarter, going back to the first quarter of 1983. The calculations were somewhat more cumbersome, but still practical. They reflected the fact that earned premiums tended to level off in the last half of 1984—a fact that would have a major impact on reserves. The resulting claim reserve was $7,708,000 (including the 10 percent margin) and was quite close to Litow's adjusted result.

I hope we will see more papers of such high quality as this one by Mark Litow.

CHARLES S. FUHRER:

The author of this paper is to be commended for bringing the problem of estimating health insurance claim reserves to the readers of the *Transactions*, where there has been an absence of papers on this subject. The paper presents a set of practical considerations and somewhat unrelated methods to adjust claim reserves. Some of these adjustment methods are interesting and probably worthwhile. The methods all are modifications to what he calls (Section I) "The Basic Development Method (A Starting Point)." Unfortunately this starting point and some of the modifications do not reflect the fine work that has been published on claim reserves in the last 20 years. As a result, it is very difficult to know whether previously published work handled a particular problem in a better way.

I believe that most of the actuaries working in health insurance, most of whom are members of the Society of Actuaries, are unaware of or uninterested in this large volume of published work. I therefore have attached to this discussion a bibliography that I have prepared on estimating claim reserves. I would like to thank Donna Richardson, Research Librarian, Society of Actuaries, for her valuable assistance in the preparation of the bibliography.

I am not sure why health actuaries are not using some of the methods presented in these books and papers. One reason might be that our examination syllabus largely ignores these works. Furthermore, this bibliography may be the first time that many of these works have been mentioned here in the *Transactions*. Another reason may be the result of one or more of three misconceptions about these works. The first misconception is that all this work is very theoretical and of no practical value. Based on the last paragraph of his introduction, I think the author of this paper shares this view. Almost all the papers and books cited in the bibliography have some practical conclusions about how to calculate claim reserves.

The second misconception, closely related to the first, is that all this material uses very difficult advanced mathematical and statistical concepts that make them impossible to be understood by the practicing health actuary. A few of the papers use some advanced mathematics to detail their models and derive their formulas; in almost every case the reader could skip the derivation and still find some useful reserving methods.

The third misconception is that because these papers mostly appear in publications of casualty actuarial bodies, are often specifically addressed to

the problems of property-liability insurance reserves, and therefore use the terminology of casualty insurance (for example, "claim" equals "loss"), the papers are not very applicable to health insurance. Although there are some differences, almost all the material in these books and papers can be applied without change to health insurance work.

One difference between the casualty and the health environments is that loss reserves in casualty have a longer runout period, and yearly incurral and paid periods are used. This is not a problem in using the casualty methods for health insurance. One area for further research might be how to determine the effects of possible seasonal patterns in the reserve factors and the fact that months are not all the same length.

I offer two examples to demonstrate that a much more thorough analysis could be taken from the literature.

Example 1

The basic development method, item 4, Section I, discusses two methods of averaging completion ratios CR_t. There are many conceivable methods of doing this, some of which may be superior to the two in the paper. I discuss five such averaging methods, which include the two from the paper. I speak in terms of averaging the reciprocals of completion factors ($1/CR_t$), which I call reserve factors. Any method of averaging reserve factors would be the equivalent of averaging reserve estimates (to be paid during each period) because the reserve factor would be multiplied by claims paid (or estimated paid) to date. The completion factors are divided into the claims paid to date. I do not include the myriad methods that make use of the premium or exposures in each incurred period. These probably are better than the methods that ignore exposure, but there is a need to keep this discussion at a reasonable length. Note that the development method in the *Record* (author's reference [6]) does use premiums.

1. The first method is to use a simple mean of the reserve factors. This is the harmonic average method of the paper. The paper is correct that this method produces the mean of the possible claim reserve values. The properties of the sample mean (for example, that it is the minimum variance unbiased estimator for the mean of a population) are well-known.
2. Another method is to take a weighted average where the weights are the claims paid to date through period $t-1$. This is the equivalent of dividing the sum, over all n prior periods, of claims paid to period t by the same sum for claims paid through period $t-1$. This method is so easy to use, so accepted and well-known that it is called the traditional or classical method. In recent years it has been recognized that

weighting the factors by the volume of claims tends to give the greater weight to the more reliable (greater volume of claims) parts of the data and therefore is more robust or less susceptible to outliers. Taylor and Mathews [62] (also quoted in Taylor [57, page 57]) prove that "methods which take means and then ratios of these means tend to be superior to methods which take ratios and then means of these ratios."

3. The method called straight average by the author is equivalent to taking the harmonic average of the reserve factors. I have not seen this method before and can see little value in it. It is not apparent why the author thinks that this will produce the median of the claim reserves.
4. Another method would be to use other estimates of the location of the reserve factor distribution. One of these is the median of the reserve factors. Medians are used in robust statistics because they essentially ignore outliers. Nevertheless, they might be considered to go a little too far in that some of the quality of the data near the mean is also ignored. The use of certain *M*-estimators [26, pp. 104–106] is a compromise between the mean and median. The mean of the values is computed, but the values are adjusted to be no more than a certain distance from the mean. This requires an iterative process, and the certain distance is related to the mean deviation from the mean.
5. Another method uses weights equal to the squares of the claims paid to date. This method was derived by Kremer [36] and results from using autoregressive time series methods.

Example 2

The author treats the problem of noncredible experience periods in Section II, part D. In this section he states that no one method works consistently and that this is an area for further research. In Section III, he uses a straight loss ratio method to calculate the reserve for the two most recent quarters.

An important paper by DeVylder [13] gives a solution to this problem. He uses a credibility average between a claim reserve factor method and a loss ratio method. He gives a formula to calculate this credibility. By using this method an optimum smooth grading from loss ratio to reserve factor is achieved. Health actuaries would do well to become familiar with this paper. A modification of this method could be used to credibility weight a particular large group's own claim reserve factors versus company factors and use the resulting reserve for renewal rating and retrospective experience rating.

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SAM GUTTERMAN:

Mr. Litow is to be commended for his discussion of practical problems that commonly arise in the estimation of loss reserves for health insurance and techniques to be used to address these problems. Particularly valuable is his discussion of reasonableness tests. As he correctly points out, there are several areas in which further research and refinement may prove valuable.

One potential refinement not identified in the paper is the use of credibility theory or the assignment of weights to reserve estimates derived from alternative approaches, particularly for incurral periods in which experience may be neither fully credible nor fully noncredible. The objective of such a refinement is to provide for a smooth transition between estimates produced by different models or techniques. Several approaches could be used to satisfy this objective, three of which follow:

- Most simply, use weights applied to estimates derived from the application of two methods. For example,

Lag Months	Percent Weight Applied to Estimates from Techniques Used for the Following Periods	
	Credible Period	Noncredible Period
0 and 1	100%	0%
2	75	25
3	50	50
4	25	75
5 and later	0	100

- The estimate of ultimate losses for an incurral month is equal to (1) the total original (or otherwise modified) estimate of losses times the completion factor for that lag month, plus (2) the cumulative paid losses through the valuation date.
  - This technique, as commonly applied in the property/casualty actuarial field, is referred to as the Bornhuetter-Ferguson* method.
  - The original estimate of ultimate losses could equal the earned premiums for the incurral month times a trended loss ratio, or a trended claim cost per exposure unit (for example, the number of members of an HMO or the number of insurance policies), multiplied by the corresponding exposure for the incurral month.
- Use a credibility-determined estimate or weighting methodology, with credibility factors reflecting the characteristics of the underlying exposure, including the degree of heterogeneity of anticipated loss experience compared to that of the experience that formed the basis of the prior estimate, and any change in expected payment pattern between periods. An extensive literature has been developed on credibility theory that may prove useful in this area.

For reasonably mature incurral months, a review of the correlation, measured at different lag periods, between the amount of cumulative paid losses and the corresponding ultimate incurred losses can assist the actuary in determining the weighting factors or the lag month at which the experience for the credible period should be utilized.

In the section of the paper on claim anomalies, several approaches to adjust completion factors for large claims are described. An additional approach is to exclude the excess portion per claim (over a certain predetermined limit, say, $25,000) from the calculation of the estimates of completion factors. A separate analysis of the likelihood and payment pattern of such excess claims can be conducted to estimate the frequency and severity of future excess claim amounts. Advantages of this approach include potentially more stable estimates and additional focus on large claims. In addition, separate trend or completion factors can be applied to "basic" and "excess" losses.

*BORNHUETTER, R.L., AND FERGUSON, R.E. "The Actuary and IBNR," *Proceedings of the Casualty Actuarial Society* LIX (1972):181-95.

Another area that warrants additional refinement is the analysis of implications of variations in claim backlogs, a leading indicator of claim lag and claim payment patterns. The approach a company takes to deal with claim backlog problems also may affect the estimation of the impact of these variations.

Property/casualty actuaries frequently estimate loss reserves by the use of "development factors," the inverse of completion ratios as defined in this paper and as commonly used by health actuaries. These factors may be called loss development, linkage or age-to-age factors. Use of such factors, rather than completion factors, avoids the use of harmonic averaging as described in the paper. Otherwise, either of the two types of factors can be used in the same model. In general, both health and property/casualty actuaries can learn from each other's practices and literature regarding the estimation of claim or loss reserves.

GEORGE K. HAWKINS, JR.:

Mr. Litow's paper should be a welcome addition to our literature. It gives a good, practical approach to a problem many of us face monthly or quarterly.

I have observed a counterexample to the author's assertion that there may be a slow decrease in completion factors over time. In the small-employer major medical market (underwritten business up to 15 lives), completion factors developed on business in its first year are lower than on business beyond the first year. Completion factors for the third month (incurral plus two) have typically been 0.08 to 0.13 smaller for business in the first year than for the aggregate block.

The most logical explanation for this is that, during the first year of coverage, many claims are being investigated for preexisting conditions, coordination of benefits, and possible misrepresentation on the application. Also, unfamiliarity with benefits and claim-filing procedures can cause longer claim lags in earlier policy durations. Because these factors exist in the individual major medical market, I would be surprised to see completion factors decreasing with increasing policy duration in that market.

In calculating average completion ratios (for example, six-month averages), the author suggests using the number of available ratios if six ratios are not available. This could give some unusual results, because one-month or two-month averages would be used. These ratios could have tremendous variation and would be at the longer durations, which would have an effect on all completion factors of shorter durations. Some adjustments would be necessary, and these adjustments would probably be subjective ones.

I suggest that no ratio be used unless the numerator in its calculation meets some minimum, such as $5,000 or $10,000. This will eliminate many abnormalities. Where a ratio is disqualified because of too small a cumulative payment, or where there are fewer than six ratios available, a standard ratio would be inserted. Standard ratios would be calculated on data available from similar blocks of business and would be reviewed from time to time.

The cells that have too low a payment, or no data at all, will come from early in a block's life and will obviously be from business in its first policy year. Therefore, it could be argued that standard ratios should be calculated solely from data on business in its first year. However, such ratios will be used to calculate completion factors for more recent experience months, where some of the business will be beyond its first year. Therefore, using first-year-only experience to calculate standard ratios should be slightly conservative.

I believe it is appropriate to use a method that throws out unusual ratios. The author describes a subjective approach that substitutes a logical ratio for one that looks out of line. A more objective method would be to examine the most recent eight ratios, throwing out the high and low ones, and taking the harmonic mean of the remaining six.

Some methods give more weight to ratios calculated on the more recent payment months, perhaps by a sum-of-the-digits or exponential method. Also, one can normalize the payments of a given month according to the number of days in the month. While these methods are worth mentioning, it is much easier to get a handle on the simpler methods and to have a better feel for making subjective adjustments, if necessary.

In the section on reasonableness tests for credible experience periods, a formula for computing expected paid claims is given as:

$$\text{Expected Payment}_{t+1} = \frac{CF_{t+1} - CF_t}{1 - CF_t} \times (\text{claim reserve for month } t)$$

Because the claim reserve for month t is completed claims (claims paid to date divided by the completion factor) less the claims paid to date, or

$$\frac{CP_t}{CF_t} - CP_t = \frac{CP_t\,(1 - CF_t)}{CF_t},$$

the author's formula can be restated and reduced to

$$\frac{CP_t}{CF_t} \times (CF_{t+1} - CF_t),$$

which is equal to the total you expect to pay times the difference in "completeness" from one month to the next. This is a much more intuitive statement of the idea.

The author seems to make a distinct separation between credible experience periods and noncredible experience periods and suggests that a completion factor of 0.40 to 0.50 is a good way to distinguish between the two. I think it would be appropriate to use (what else?) a credibility approach. Full credibility could be given for months with a completion factor above, say, 0.60, and no credibility given for months with a completion factor below, say, 0.35. For group major medical coverages, this would result in probably two months for which the loss ratio (or reserve) would be based on some combination of a completion factor calculation and the method described for the noncredible experience periods.

It seems that the average lag calculation described in the paper could mislead the actuary in either of two situations. First, a large claim could be paid at a very late duration, perhaps 24 months after incurral. This claim could cause an increase in the average lag factor unrelated to reporting lag or to backlogs. Second, the block of business could be growing or shrinking rapidly. In the case of rapid growth, the claim payments would be weighted toward the more recent incurral months, even though the underlying pattern of claims had not changed. I also suspect that the average lag number looks strange if the incurred date assigned is something other than the service date.

To allow for the first case above, the average lag could be calculated as suggested, but one calculation would include only claims paid within the first six months after incurral, and another would use only claims paid within the first twelve months after incurral. The six- and twelve-month figures could be compared from month to month.

To allow for a rapidly growing or shrinking block, the average lag could be normalized to the earned premium for each incurred month. A suggested formula follows: First, calculate

$$L_t = \frac{C_t}{P_t},$$

where C_t represents the most recent month's payments on claims incurred t months ago, and P_t represents the corresponding earned premiums.

Then the average lag on claims paid within the first six months after incurral would be:

$$\frac{\sum_{0}^{5} t \cdot L_t}{\sum_{0}^{5} L_t}.$$

Still, the calculation could mislead on a new block of business, because the number would always be increasing in the early months. For example, after one month of being in business, the average lag would be zero, regardless of the method used.

This paper is great for someone beginning to tackle the challenge of setting reserves and for someone more experienced who may be looking for ways to check or fine-tune old methods. I agree that it would be valuable to have simple methods for measuring the potential variation in results and hope that Mr. Litow's paper will inspire some comments on that subject.

(AUTHOR'S REVIEW OF DISCUSSION)

MARK E. LITOW:

Each of the discussions (and the bibliography prepared by Mr. Fuhrer) has contributed significantly to this paper. My follow-up comments are intended to elaborate or clarify points in these discussions on credibility theory, methods of developing completion factors, the variations in completion factors over time, and the use of completion factors for long-term claims. A brief summary is also included.

I. CREDIBILITY THEORY

Several of the discussants have expounded upon how credibility theory can be used in calculating incurred claims, especially for noncredible experience periods. Mr. Gutterman points out three possible solutions that can be very useful. Further, other methods exist for estimating claims through credibility theory, as noted by Mr. Fuhrer, a few of which are covered in articles in his bibliography.

Unfortunately, any particular method for estimating incurred claims during noncredible experience periods does not work in all situations, because of either external influences or irregularities in the following lags:

a. Lag between the date of claim and the date of reporting
b. Lag between the date of reporting and the date at which processing begins

c. Lag between the date at which processing begins and the date at which processing is completed
d. Lag between the date at which processing is completed and the date at which payment is made.

These lags can change suddenly after long periods of consistent behavior, which is why continued use of one credibility method without close evaluation and testing by other methods is not recommended.

II. METHODS OF DETERMINING COMPLETION FACTOR AVERAGES

Both Mr. Hawkins and Mr. Fuhrer have noted several ways of developing completion ratio averages and corresponding completion factors, in addition to those found in the paper. These methods are certainly acceptable, and the actuary should use whatever works best. The series of reasonable tests included in the paper are intended in part to determine whether a specific set of completion ratios and factors are good estimators of total incurred claims and reserves. Whatever method of estimating ratios and factors is used, such tests (or others) should be performed to review the reasonableness of results.

Mr. Fuhrer has also pointed out that months having a different number of working days (claim payment dates) may cause lag factors to be distorted spuriously. I agree that this can cause a problem, and the actuary should be aware of this potential difference before concluding that high or low monthly payments are indicative of a trend or pattern.

Mr. Hawkins further points out that use of three-month periods for averaging completion ratios may seriously distort results due to potentially severe aberrations if only a few values are included. I agree with that assessment, except that use of longer averaging period factors could prove inappropriate when the company has drastically altered its mechanics for paying claims (that is, addition of a new computer system, loss of experienced personnel, and so on). Therefore, the choice of a method must be balanced between potential credibility and appropriateness of the data.

In regard to methods of averaging factors, Mr. Fuhrer apparently believes I am recommending straight averaging of divisors. To the contrary, this method produces the median value and not the mean value, as I noted in the paper, and thus is technically not accurate. However, I have observed actuaries using this method, and in some cases, reasonable estimates are produced because adjustments are made to account for differences between the mean and median value.

Mr. Hawkins' use of standard factors to replace factors when credible experience is not available is appropriate, but several caveats are needed. The plans obviously need to have, first, similar benefits and, second, a likelihood of consistent claim runout patterns. Thus, actuaries should be aware of the potential for possibly different runout patterns due to influences discussed in the paper. For example, completion factors could change over time due to modifications in claim severity; this item is discussed in the following section.

An illustration of how completion factors can vary through use of a different method is illustrated by Mr. Bragg's example, which uses the classical development method. In particular, his illustration demonstrates the sensitivity of reserve calculations and the necessity for reasonableness tests.

III. LAG FACTORS RELATIVE TO THE TIME OF POLICY ISSUE

Mr. Hawkins has stated that he has not observed decreases in completion factors over time in his work and, further, that claim investigations of preexisting conditions often result in lower completion factors during the first policy year from issue. This comment seems applicable to a comparison of factors in the first versus second year from policy issue; antiselection against rate increases will often not be an issue in this comparison since rate increases are not generally implemented until the second or later policy years from issue.

On business without any underwriting and little antiselection influence, completion factors by policy duration should generally be level except for claim investigation problems and rate increase antiselection. However, underwritten businesses should generally have better experience in earlier durations because of the company's selection process and poorer experience as time passes because of the wearing off of underwriting and rate increase antiselection. These underwritting and/or antiselection influences should in fact cause completion factors to decrease over a period of years. Note that the factors in the first versus second year from issue may well be increasing due to claim investigations offsetting this deterioration, but this scenario should only be temporary. For underwritten business, with all policy durations mixed together, completion factors will normally increase only if a significant portion of business is in the first two policy years from issue such that: (1) the aggregate underwriting impact (selection factor) does not increase materially and (2) the antiselection generated by rate increases does does not cause morbidity to deteriorate significantly.

In another scenario in which lag factors do not decrease over time, lapses exceed new entrants and the product is not of a low-frequency/high-severity

type. For instance, significant lapsation on Medicare Supplement business may actually cause completion factors to speed up because most people have Medicare Supplement claims during the course of a year. This scenario of lapses exceeding new business may actually shorten the duration of the claim on average, especially if the incurral date is defined according to a calendar-year dating rule.

IV. LONG-TERM CLAIMS

I would like to thank Mr. Barnhart for his demonstration of how a continuance curve can be used to calculate claim reserves. This method is of particular significance for long-term care, per his illustration. Because long-term-care experience takes so long to develop, this method can always be used for a reasonableness test even when sufficient data are available to produce a lag study. If nothing else, the lag study may help in revising the continuance curve, as shown in Mr. Barnhart's example.

One item worth noting in Mr. Barnhart's example is that the continuance curve runs only to three months after the end of the benefit period. I have noted that payments for long-term-care policies are often not complete until roughly one year after completion of the long-term-care benefit period. However, payments are usually quite small in the last nine months of the runout pattern.

V. SUMMARY

Because of the substantial amount of health claim reserves held by companies in the U.S., as denoted by Mr. Bragg, the issue of appropriate levels of health claim reserves is an important one. Clearly, the well-being of many companies depends on accurate estimates of reserves, because inappropriate estimates can lead to lack of timeliness in rate increases and ensuing losses. Thus, I believe the evaluation of health claim reserves should be viewed as an area in which more and better techniques can potentially be developed, rather than an area in which the actuary knows everything there is to know. For this reason, I support statements by Messrs. Gutterman and Fuhrer that health actuaries can learn a great deal about techniques from casualty actuaries. Further, I hope the profession does not forego additional research that could improve our reserving capabilities.