An Aggregate Reserve Methodology for Health Claims

$$R = P \cdot \frac{M_{Unpaid}}{M_{Paid}} \cdot \frac{F_{Upaid}}{F_{Paid}}$$

Where:
R = The estimated claim reserve
P = Observed paid claims
$M_{Paid,}$ M_{Unpaid} = Portion of exposure basis that is paid/ unpaid under the lag process, given as members adjusted for scalar factors and trend

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Introduction

This paper will develop an aggregate claim reserve methodology for health claims. The theoretical nature of the unpaid claim process is outlined and discussed. This is then used to develop a paradigm shift, which views the claim reserve estimation as a projection of claims from one period to another, rather than as a matter of estimating residual unpaid claims from observed paid claims.

Theoretical Nature of the Unpaid Claim Estimation Process

This theoretical nature of the unpaid claim estimation process is examined in some detail here, and is stated in terms of a few broad principles or concepts. These will guide the development of the aggregate reserve methodology.

Concept 1: The incurred claims for a group or block of business are the result of an underlying statistical process.

In short, there is some sort of underlying statistical regularity. Without this, there would be no particular reason to think that the unpaid claims could be estimated.

Concept 2: The observed paid claims are the result of a realization of the underlying statistical process for incurred claims.

In other words, for a period of time and for a group of lives, the incurred claims are a particular realization of the underlying random process. Since there is a group of lives, the incurred claims will follow an aggregate loss distribution. The important concept here is that the actual incurred claims are not the underlying statistical process, but rather reflect a random sample from the process. In other words, the results could have been different. Therefore, inferences about the underlying statistical process are subject to uncertainty and variability.

Concept 3: The observed paid claims are the result of a realization of a random payment process.

The paid claims are the subset of the incurred claims that can be observed because they have been paid. The timing of payments reflects a random process, and this randomness contributes to uncertainty in making inferences about the underlying incurred claim process.

Concept 4: The unpaid claims reflect, on average, a different period of time than the observed paid claims. Therefore, the unpaid claims are effectively the result of a <u>different</u> realization of the underlying statistical process for incurred claims.

Note that the unpaid claims have not yet been observed (obviously.) Thus, they are expected to show variability consistent with an aggregate loss distribution derived from the underlying incurred claim process described in Concept 1.

Concept 5: The timing difference between the paid and unpaid claims will introduce differences which must be considered in developing the unpaid claim estimates.

Difference may include the impact of trend, plan changes, number of lives, demographic mix, provider reimbursement changes, etc. The value of these differences may be subject to uncertainty or estimation risk, as well.

Paradigm Shift – E[R | P] → E [I_2 | I_1]

The traditional reserve estimation paradigm is to find E[R | P] = expectation of reserves (R) given paid claims (P). Due to the periodic passing of time, and the accumulation of exposure and claim data by month, the analysis of claim lags and estimation of reserves is generally accomplished through a series of calculations, one for each monthly incurred period.

However, the previous discussion (Theoretical Nature of the Unpaid Claim Estimation Process) provides a basis for a paradigm shift. This shift may be useful, both in terms of understanding, and in developing reserve estimates.

The paradigm shift begins with an assumption and an observation:

Assumption: The Incurred Claim process and the Lag process are independent.

This seems to be generally true and reasonable. Some exceptions might occur. For example, exceptionally high levels of claims may result in increased claim lag.

Observation: Incurred Claims imply Exposure.

This seems obvious, since a lack of exposure should imply no incurred claims; the existence of incurred claims must be the result of exposure. This leads to the paradigm shift.

Paradigm Shift: Therefore, the Lag Process also defines a partition of the Exposure Space.

If we think of the realization of the Incurred claim process as a "space," the Lag Process defines a partition of that space into two regions: that which can be observed (i.e. Paid claims) and that which cannot be observed. Now, consider the underlying exposure as a space as well. For every point in the incurred space, there must be a corresponding point in the exposure space. Thus, the Lag Process also defines a partition of the Exposure Space. (Note that this may require splitting individual exposure units between the two partitions. If this seems objectionable, consider the application of traditional lag factors on a seriatim basis: some claims for some members are paid, some unpaid; with the corresponding split of exposure.)

Paradigm Shift Restated **E[R | P] → E [$\mathbf{I_2}$ | $\mathbf{I_1}$]**:

- E[R | P] (Traditional) : The Lag Process gives **some** of the incurred claims on **all** of the members; find the rest of the incurred claims.

- E [$\mathbf{I_2}$ | $\mathbf{I_1}$] : The Lag Process gives **all** of the incurred claims on **some** of the members; find the incurred claims on the rest of the members.

Thus, the paradigm shift says that the claim lag process partitions the Exposure space into two regions, say region 1 and region 2. Corresponding to each region is the partition of the Incurred Claims space into two regions. If we refer to these as $\mathbf{I_1}$ and $\mathbf{I_2}$ for the paid and unpaid portions, respectively, we get:

- $P = \mathbf{I_1}$;
- $R = \mathbf{I_2}$ and
- $I = \mathbf{I_1} + \mathbf{I_2}$.
- But also, $I = R + P$, so
- $E[R \mid P] = E [\mathbf{I_2} \mid \mathbf{I_1}]$

Thus, the paradigm shift restates the reserve estimation process as an exercise in estimating the incurred claims in one period from the incurred claims in an earlier period. This is seen as a simple claim projection process. This view may aid understanding of the reserve estimation process in two ways:

First, as in any claim projection, differences in the risk from the base period to the projection period must be accounted for. Thus, plan design changes, demographics, and trend, as well as any other pertinent factors, should be factored into the projection. This is certainly not a new idea for health claim reserve estimation, but this expression of the problem demonstrates the necessity of these considerations.

Second, there is the question of risk, which pertains to the issue of "good and sufficient" reserves. The paradigm shift suggests that the reserve estimation has all the risk associated with a claim projection, as well as an additional risk:

- Estimation Risk – The base period incurred claims are used to estimate the parameters of an underlying risk process (Concept 1 above.) Estimation risk is the result of uncertainty in projecting trends, as well as the fluctuation in the base period claims (Concept 2 above.) This applies to any claim projection.

- Realization Risk – Even if parameters of the underlying risk process were specified with complete accuracy, there is risk associated with the projected claims, inasmuch as they will be subject to fluctuation as well (Concept 4 above.) This applies to any claim projection.

- Exposure Risk – Unlike most claim projections, the Claim Lag process introduces uncertainty into the determination of the exposure base. Since the lag process partitions the exposure, the uncertainty has a double impact: Overstated base members understate the risk per unit; the understated risk per unit is then applied to an understated exposure base for the projection period.

An Aggregate Reserve Methodology – Paradigm Shift Applied

The paradigm shift can be used to develop an aggregate reserve methodology. I will do so here, presenting both a conceptual and practical example. This method may or may not be original, but it does not seem to be in common use among health actuaries.

Notation:

- M_i = Members for month i
- A_i = A scalar factor for month i; i.e. plan mix, age/sex, etc.
- T_i = Trend factor for month i
- I_i = Incurred claims for month i, in whole dollars
- F_i = Fluctuation for month i; i.e. a point observation from an aggregate loss distribution
- f_i = Lag factor for month i; usually $0<f_i<1$; a point observation from the lag process
- P_i = Cumulative observed paid claims for incurred month I, in whole dollars
- R_i = Reserve for incurred month i in whole dollars; $P_i + R_i = I_i$
- I = Underlying process incurred claim rate PMPM
- P = Total Paid claims = ΣP_i
- R = Total Unpaid claims = ΣR_i

The following derivation is given:

- $I_i = M_i \cdot A_i \cdot T_i \cdot F_i \cdot I$
- $P_i = f_i \cdot I_i = M_i \cdot A_i \cdot T_i \cdot f_i \cdot F_i \cdot I$
- $P = \Sigma P_i = \Sigma A_i \cdot T_i \cdot f_i \cdot F_i \cdot M_i \cdot I$
- $R = \Sigma R_i = \Sigma A_i \cdot T_i \cdot (1-f_i) \cdot F_i \cdot M_i \cdot I$
- Since $P = \Sigma P_i$; $P / \Sigma P_i = 1$; multiplying this unit to the right side of R gives:
- $R = P \cdot \dfrac{\sum A_i \cdot T_i \cdot (1-f_i) \cdot F_i \cdot M_i \cdot I}{\sum A_i \cdot T_i \cdot f_i \cdot F_i \cdot M_i \cdot I}$

- $R = P \cdot \frac{\sum A_i \cdot T_i \cdot (1 - f_i) \cdot F_i \cdot M_i}{\sum A_i \cdot T_i \cdot f_i \cdot F_i \cdot M_i}$ (eliminating the I/I)

Now, defining a few additional composite measures:

- M_{Paid} = Portion of exposure basis that is paid under the lag process, given as members adjusted for scalar factors and trend

- M_{Unpaid} = Portion of exposure basis that is unpaid under the lag process, given as members adjusted for scalar factors and trend

- $M_{Paid} = \sum A_i \cdot T_i \cdot f_i \cdot M_i$ (Equation 1)

- $M_{Unpaid} = \sum A_i \cdot T_i \cdot (1 - f_i) \cdot F_i \cdot M_i$ (Equation 2)

- Let F_{Paid} = The average fluctuation with respect to the paid claims

- Let F_{Unpaid} = The average fluctuation with respect to the unpaid claims

- $FPaid = \frac{\sum A_i \cdot T_i \cdot f_i \cdot F_i \cdot M_i}{M_{Paid}}$

- $F_{Unpaid} = \frac{\sum A_i \cdot T_i \cdot (1 - f_i) \cdot F_i \cdot M_i}{M_{Unpaid}}$

- $R = P \cdot \frac{M_{Unpaid}}{M_{Paid}} \cdot \frac{F_{Upaid}}{F_{Paid}}$ (Equation 3)

Equations (1), (2) and (3) provide a basis for implementing the aggregate method into a reserve estimation methodology. Note that the fluctuation factors are not used in estimating the reserve, but rather point to the uncertainty in the estimation. Similarly, the actual f_i lag factors will not be used in the estimation process, but rather those estimates of the f_i; thus contributing the additional source of risk noted above.

Note the aggregate nature of this estimate: the reserve is not estimated or allocated with respect to any one month.

A spreadsheet illustrating this method is attached.

Discussion

This aggregate reserve methodology provides several benefits, both conceptual and practical:

- Claims for the most recent months of incurred experience are given their due weight. Traditional reserve methods in practical, current use have difficulty recognizing this data. Due to the low lag factors involved for the most recent months, the data is often disregarded. Disregarding data should generally be avoided. However, the variability of the lag process combined with the low volume of claims for the most recent months result in an unreliable estimation process. The aggregate reserve methodology allows all the data to be used.

- The aggregate paid experience provides a broader base for estimating the more recent experience. In contrast, reserve methods in current use require developing an estimate of PMPM claims costs from a series of prior months estimated incurred claims costs PMPM. Each of these months reflects a smaller exposure base, and contains an element of unpaid claims. This may result in the application of subjective judgment in selecting a PMPM assumption for the most recent months incurred claim estimates. In contrast, the broader base of the aggregate method provides a direct method for estimating the reserve without resorting to subjective judgment.

- The aggregate method allows for identifying the sources of risk, i.e. the estimation risk, the realization risk, and the exposure risk, which impact the claim reserve estimate. This provides a basis for objectively addressing the level of conservatism required to develop "good and sufficient" reserves.

One possible criticism of the methodology is that estimates are not developed for individual incurred months. Individual monthly estimates are useful, particularly for accounting entries with respect to individual monthly accruals, as well as for following emerging paid claims versus reserve estimates. However, a comparison may be made with making a rate projection. Most rate projections are made for a period of a year in aggregate, with the understanding that monthly claims will be subject to variability. Generally, no attempt is made to estimate the rate projection for each month individually.

Academic Disclaimer

No attempt has been made to research the originality of the ideas presented in this paper. The author observes that, in his experience, this approach is not in common use among health actuaries, and that the approach, as well as the conceptual framework which supports it, would be beneficial to the practicing health actuary.

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Illustration of the Aggregate Method

Example Lag Factor									
Average Lag Months		2.000				Weighted Average Members			
							Expected		
Month	f	(1-f)	Members	Age/Sex	Plan	Total	Paid	Unpaid	
Dec-06	0.200	0.800	105,000	1.010	0.940	99,687	19,937	79,750	
Nov-06	0.600	0.400	105,000	1.010	0.940	99,687	59,812	39,875	
Oct-06	0.750	0.250	105,000	1.010	0.940	99,687	74,765	24,922	
Sep-06	0.840	0.160	105,000	1.010	0.940	99,687	83,737	15,950	
Aug-06	0.890	0.110	105,000	1.010	0.940	99,687	88,721	10,966	
Jul-06	0.930	0.070	105,000	1.010	0.940	99,687	92,709	6,978	
Jun-06	0.950	0.050	100,000	1.005	0.950	95,475	90,701	4,774	
May-06	0.960	0.040	100,000	1.005	0.950	95,475	91,656	3,819	
Apr-06	0.970	0.030	100,000	1.005	0.950	95,475	92,611	2,864	
Mar-06	0.975	0.025	100,000	1.005	0.960	96,480	94,068	2,412	
Feb-06	0.980	0.020	100,000	1.005	0.960	96,480	94,550	1,930	
Jan-06	0.985	0.015	100,000	1.005	0.960	96,480	95,033	1,447	
Dec-05	0.990	0.010	90,000	1.000	0.990	89,100	88,209	891	
Nov-05	0.992	0.008	90,000	1.000	0.990	89,100	88,387	713	
Oct-05	0.994	0.006	90,000	1.000	0.990	89,100	88,565	535	
Sep-05	0.997	0.003	90,000	1.000	1.000	90,000	89,730	270	
Aug-05	0.998	0.002	90,000	1.000	1.000	90,000	89,820	180	
Jul-05	0.999	0.001	90,000	1.000	1.000	90,000	89,910	90	
Jun-05	1.000	0.000	90,000	1.000	1.000	90,000	90,000	-	
Total			1,860,000			1,801,287	1,602,923	198,364	
Weighted Average Effective Date			03/12/06			03/08/06	02/11/06	10/02/06	
Months for Trending								6.83	
				Risk Due to Lag Process - Shift Paid Members					
Incurred and Paid Claims		340,000,000		0.50%	340,000,000				
Weighted Paid Member Months		1,602,923		8,015	1,594,908	-0.5%			
Claim Rate PMPM		$ 212.11			$ 213.18	0.5%			
Trend									
Annual	10.0%								
Months	6.83								
Factor		1.056			1.056				
Projected Claim Rate PMPM		$ 223.94			$ 225.06	0.5%			
Weighted Unpaid Member Months		198,364			206,379	4.0%			
Estimated Unpaid Claims		44,420,933			46,448,036	4.6%	Impact on Reserve		

Additional Risk due to potential fluctuation in base and projected claims not evaluated.
This risk due to lag process is illustrative.