Lecture 4: Loss Development Technique (Chain ladder technique)

AS 8360: Insurance Ratemaking

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Overview

- Introduction to loss reserving
- Loss adjustment process
- Loss development technique (Chain Ladder)
- Why do we need multiple techniques?

Introduction to loss reserving

Loss reserving or *policy valuation* is the determination of present-time liability associated to the promise of future benefits.

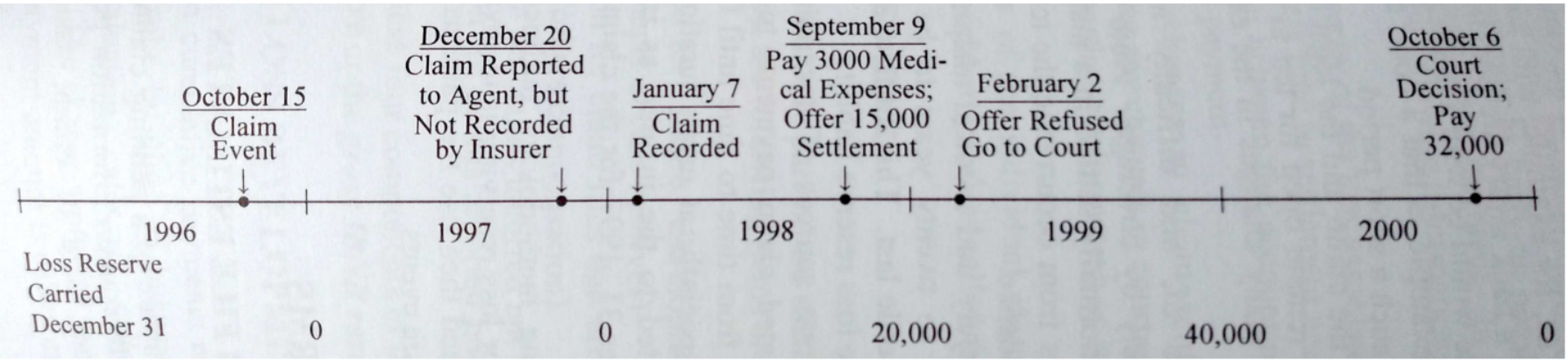
It is required that a qualified actuary sign the reserve calculation. The actuary acts as a *fiduciary* to the regulators by safeguarding the rights of the policyholders, as well as to the owners or investors, by ensuring the company stays solvent and its liabilities are not misstated.

In addition, the ratemaking actuary depends upon the calculation of ultimate losses to perform his duties.

We cover the loss adjustment process and several loss development techniques below.

Loss adjustment process

As we have discussed before, losses are known after they are incurred and their size can't be determined with certainty until weeks/months later (or years later, with bodily injury and medical malpractice claims).



Thus, forecasting future losses becomes necessary, and the actuary relies on data and his professional judgement as to how the data should be used.

The first step in the claim adjustment process is establishing a *claim file*.

It contains an estimate of the ultimate loss payment based on:

- The severity of the loss associated to the claim
- Likely times to settlement and final payment
- Inflation

case O/S

The aggregate of all claim file estimates are the *case reserves*. These are only a part of the total or *gross IBNR* reserves. Also included are:

- Provision for future development in known reserves (adjustments of case reserves)
- Provision for closed claim files which may reopen
- Provision for *incurred-but-not-reported* (IBNR) and *reported-but not recorded* (RBNR) claims

IBNER

In terms of loss development, it happens both at the level of *paid losses* as well as *reported losses*. converge to ultimate

losses

Related terms include *age-to-age* loss development factors and *age-to-ultimate* factors. These factors can vary based on the ability of the insurer to forecast losses and subject to future collections from salvage and subrogation.

Expenses are also incorporated in the estimates, either at the claim file level (for *allocated loss adjustment expenses* or ALAE), or at year-end (for *unallocated loss adjustment expenses* or ULAE).

For high-frequency low severity claims that settle quickly, a *fast track average reserve* is used from past experience plus trend to streamline the process.

More generally, the actuary should be intimately familiar with the company's data and procedures, and be knowledgeable of external developments affecting the adjudication of claims.

Example

Recently an actuary evaluated a company's loss reserves, which were based on both paid loss development and reported loss development (net of reinsurance). The company recently increased its retention limit from 75,000 to 150,000.

Which method would you adopt as more appropriate for estimating the actual reserve liability (net of reinsurance)? Why?

It makes sense that recent paid loss data are more likely to be below 75,000 and thus uncensored than reported loss data.

Thus use paid losses to try to forecast ultimate losses and then apply the 150,000 cap.

Loss development technique

Let's start with a simple technique to estimate gross reserves.

Case reserves plus: A percentage of case reserves is added to account for future adjustments, reopened, IBNR and RBNR claims. In high profit years, more is set aside, so that taxable income stays low.

This methodology is no longer accepted as valid or in wide use.

The next technique is widely used yet simple:

Loss development (*chain ladder*) technique: This technique is based on the incremental or cumulative loss payments from triangles like the ones below.

Incremental

Accident Year	Development Year 0	1	2	3	4
2012	8,525	1,760	1,019	580	38
2013	10,063	2,342	1,280	453	
2014	12,265	1,836	1,532		
2015	16,943	4,643			
2016	20,175				

Cumulative

Accident Year	Development Year 0	1	2	3	4
2012	8,525	10,285	11,304	11,884	11,922
2013	10,063	12,405	13,685	14,138	
2014	12,265	14,101	15,633		
2015	16,943	21,586			
2016	20,175				

The same methodology is applied to reported losses. Age-to-age loss development factors (or *link ratios*) are computed and then compounded to age-to-ultimate factors to compute ultimate losses.

To compute the average age-to-age factors, actuaries use several different methods:

1. Arithmetic average (last 3 or 5 years)
2. Volume-weighted average (last 3 or 5 years)
3. Medial average (excludes highest, lowest value)

AY	0/1	1/2	2/3	3/4	Age-to-age
2012	1.206	1.099	1.051	1.003	
2013	1.233	1.103	1.033		
2014	1.15	1.109			
2015	1.274				
2016					

AY	0/∞	1/∞	2/∞	3/∞	Age-to-ultimat
2012	1.397	1.159	1.054	1.003	

Arithmetic Average	0/1	1/2	2/3	3/4
	1.216	1.104	1.042	1.003

(just one of the ways to compute link ratios that are applied to all AYs)

- Geometric average (last 4 years)

Here is how the numbers would look in the previous example:

Accident Year	Development Year 0	1	2	3	4	Ultimate Losses		Paid Losses		Loss Reserve
2012						11,922	−	11,922	=	0
2013					14,183	14,183	−	14,138	=	45
2014				16,293	16,345	16,345	−	15,633	=	712
2015			*	*	*			21,586		
2016		*	*	*	*			20,175		

* Calculation using arithmetic average loss development factors

Changes in the speed of issuing claims payments or the overall reserving philosophy (which may be detected by looking at the diagonals) will significantly affect these estimates, so care must be exercised and all relevant information should be retained and examined.

Example

You are given the following information on losses paid during each of 1996-1999:

Accident Year	1996	1997	1998	1999	Earned Premium	Exp LR
1996	10,000	5,000	2,000	0	25,000	0.680
1997		12,050	6,025	2,400	29,750	0.688
1998			14,500	7,250	33,000	0.700
1999				17,465	38,000	0.700

= 17,000
= 20,468
= 23,100
= 26,600

Find the end-of-1999 estimated loss reserve using the chain ladder method (round factors to 3 decimals).

what method?

AY	0	1	2	3
1996	10,000	15,000	17,000	17,000

(Cumulative)

1997	12,050	18,075	20,475	*
1998	14,500	21,750		*
1999	17,465			*

} Represent ultimate losses

Volume-weighted average

0/1	1/2	2/3
1.5	1.13	1

(Age to age)

0/∞	1/∞	2/∞
1.695	1.13	1

(Age to ultimate)

AY	Ultimate Loss	− Paid Loss	= Reserve
1996	17,000	17,000	0
1997	20,475	20,475	0
1998	24,578	21,750	2828
1999	29,603	17,465	12116

14,944

Example

The following data represent cumulative payments made through the development years shown:

Accident Year	0	1	2	3	4	5	6
1993	1780	2673	2874	3094	3157	3166	3166
1994	3226	4219	4532	4881	5144	5199	
1995	3652	4989	5762	6436	6720		
1996	2723	4301	5526	6231			
1997	2923	4666	5349				
1998	2990	5417					
1999	3917						

Volume-weigh
3-year

Estimate the loss reserve as of end-of-1999, using each of the following:

(a) A 3-year average factor model

(b) A 5-year average factor model

(c) A volume-weighted 3-year factor model

(a)

0/1	1/2	2/3	3/4	4/5	5/6
1.663	1.195	1.107	1.039	1.007	1

(b)

0/1	1/2	2/3	3/4	4/5	5/6
1.532	1.147	1.1	1.039	1.007	1

(c)

0/1	1/2	2/3	3/4	4/5	5/6
1.666	1.192	1.109	1.042	1.008	1

Next steps:
- compute Age-to-ultimate factors for (a)-(c)
- then compute ultimate loss based on these factors
- finally, subtract from paid losses to compute reserve.

AY	(a) Ult. Loss	(a) Reserve	(b) Ult. Loss	(b) Reserve	(c) Ult. Loss	(c) Reserve
1993	3166	0	3166	0	3166	0
1994	5199	0	5199	0	5199	0
1995	6767	47	6767	47	6774	54
1996	6519	288	6519	288	6545	314
1997	6195	846	6156	807	6231	882
1998	7498	2081	7151	1734	7521	2104
1999	9016	5099	7922	4005	9061	5144
TOTAL		8361		6881		8498

Example

The following data showing cumulative closed claims through development years (first table), and cumulative paid losses (in thousands) on closed claims through development years (second table) are given.

Closed claim counts

Accident Year	0	1	2	3	4	Estimated Ultimate
1995	400	700	850	930	1000	1000
1996	480	780	1000	1140		1200
1997	500	950	1190			1400
1998	570	1050				1500
1999	600					1500

0.4 0.7 0.85 0.93 1

0.4 0.658 0.833 0.95

0.357 0.679 0.85

0.38 0.7

0.4

Paid losses

Accident Year	0	1	2	3	4
1995	2,000	6,000	9,000	~~11,200~~ 11441	14,000
1996	2,600	~~6,840~~ 7273	~~10,920~~ 11138.4	15,600	
1997	~~2,380~~ 2667	~~8,960~~ 9243	14,400		
1998	~~3,120~~ 3284	10,800			
1999	3,800				

(a) Analyze the *speed of finalization* of closed claims. ✓

(b) Adjust the cumulative paid losses for changing speeds of finalization, by adjusting each paid entry pro rata to what it would have been if the percentage of closed claims had been equal to that in the latest diagonal (i.e in 1999).
Assume no change in average claim size. (see above triangle)

(c) Calculate the estimated loss reserve, using each of (i) the unadjusted data, and (ii) the adjusted data.

Age-to-age factors

0/1	1/2	2/3	3/4
3.214	1.568	1.336	1.25

Age-to-age factors

0/1	1/2	2/3	3/4
3.14	1.53	1.336	1.224

(Then compute age-to-ultimate factors and ultimate losses)

AY	Reserve
1995	0
1996	3900
1997	9648
1998	17480
1999	28184
Total:	59,212

AY	Reserve
1995	0
1996	3494
1997	9141
1998	16213
1999	26044
Total:	54,892

Example

implies consistency ⇒ chain ladder is appropriate

The Bigger Insurance Group has held a constant book of business for many years. They have sent you the following loss payment data (in thousands):

Accident Year	0	1	2	3	4
1998	200	240	260	270	270
1999	165	235	255	265	
2000	205	245	265		
2001	195	235			
2002	203				

replace by best estimate, e.g 195

Link ratios

0/1	1/2	2/3	3/4
1.2	1.083	1.038	1
1.424	1.085	1.039	
1.195	1.082		
1.205			

best guess for error

(a) In the development of your chain ladder link ratios, you discover a highly probable error in the data. What data point is likely incorrect?

(b) How can you continue the analysis safely if this data point is wrong?

(i) Just omit this number
(ii) Replace it with best estimate

(c) Determine your best estimate of the loss reserves as of year-end of 2002.

(d) Determine the discounted value of this loss reserve liability if $i = 5\%$ per annum effective. State all assumptions.

payments are uniformly distributed throughout each year

(c)

AY	0	1	2	3	4	Reserve
1998						0
1999				(0) 265		0
2000				(10.3) 275.3	(0) 275.3	10.3
2001			(19.6) 254.6	(9.9) 264.5	(0) 264.5	29.5
2002	(40.6) 243.6	(20.3) 263.9	(10.3) 274.2	(0) 274.2		71.2
	Discount by ½ year	Discount by 3/2 year	Discount by 5/2 year	Discount by 7/2 year		111

Discounted value of reserve: $(40.6+19.6+10.3)(1.05)^{-\frac{1}{2}} + (20.3+9.9)(1.05)^{-3/2}$

$+(10.3)(1.05)^{-5/2} = 106$

Why do we need multiple techniques?

The loss development technique is just one of several techniques to do loss development.

As we will see in the next lecture, sometimes an alternative computation called the *expected loss ratio* technique has advantages. Other times, we will need to apply more elaborate methods, such as the *Bornhuetter-Ferguson* and *Cape Cod* techniques.

We will study these methods in some detail and identify situations where we would choose one over the other.