Lecture 3: Development Triangles

AS 8360: Insurance Ratemaking

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Overview

- Loss aggregation methods
  - Calendar Year
  - Accident Year
  - Policy Year
  - Report Year
- Common ratios involving losses
- The loss development triangle
- Diagnostics using triangles

Loss aggregation methods

Calendar year: All loss transactions that occur during the twelve-month calendar year without regard to the date of policy issuance, the accident date, or the report date of the claim. At the end of the calendar year, all paid and reported losses are fixed.

Accident year: All loss transactions for claims that have an occurrence date during the year being evaluated, regardless of when the policy was issued or the claim was reported.

Unlike CY losses, AY losses change after the end of the year as additional claims are reported, claims are paid, or reserves are changed. Since AY is not closed (fixed) at the end of the year, future development of losses needs to be estimated.

Policy year: All loss transactions on policies that were written during the year, regardless of when the claim occurred, reported, reserved, or paid.

Like AY losses, PY losses change as additional claims occur, claims are paid, or reserves are changed. Since a PY extends until the last policy expires, PY claims associated with annual policies arise from a two year time period, a longer period than CY and AY losses.

Report year: Similar to AY except the losses are aggregated according to when the claim is reported, as opposed to when the claim occurs. Common in claims-made policies for lines of business where there is a significant lag between the date of the occurrence and the reporting of the claim.

By design, this type of aggregation results in no IBNR but IBNER is possible.

Example

Aggregate the following claims reported:

6.1 Claim Transaction History

Policy Effective Date	Date of Loss	Report Date	Transaction Date	Incremental Payment	Case Reserve*
07/01/09	11/01/09	11/19/09	11/19/09	$0	$10,000
			02/01/10	$1,000	$9,000
			09/01/10	$7,000	$2,500
			01/15/11	$3,000	$0
09/10/09	02/14/10	02/14/10	02/14/10	$5,000	$10,000
			11/01/10	$8,000	$4,000
			03/01/11	$1,000	$0

*Case reserve evaluated as of transaction date.

Aggregation	Valuation Date Dec 31, 2009	Dec 31, 2010	Dec 31, 2011
CY 2009			
AY 2009			
PY 2009			

Common ratios involving losses

Recall the following fundamental ratios:

- Claim frequency: Number of claims (reported, paid, closed) over number of earned exposures.
- Claim severity: Losses (paid, reported, ultimate) over number of claims.
- Pure premium: Losses over number of earned exposures.
- Loss ratio: Usually, reported losses over earned premium.

These will be used when performing loss development.

The loss development triangle

The loss development triangle is a way to tabulate existing loss data so that we can get insight about the business and be able to forecast ultimate losses.

Most loss development triangles are by AY:

Accident Year	Development Year 0	1	2	3	4	Ultimate Losses
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					

We will focus on various methods of *developing losses*, i.e. forecasting what the ultimate losses will be, in the next few lectures.

From there on, information about earned premiums and exposure units is included to perform a thorough analysis:

Accident Year	Earned Exposure Units	Ultimate Losses	Number of Incurred Claims
2012	1,085,644	129,620,410	55,810
2013	1,096,235	146,865,366	58,706
2014	1,126,283	146,290,566	59,822
2015	1,144,318	181,457,324	64,636
2016	1,205,142	227,430,574	69,474

It is then easy to compute the afore-mentioned loss ratios and proceed to compute loss trends before deciding on premium rate indications.

Accident Year	Average Claim Frequency	Average Claim Severity	Pure Premium per Unit Exposure
2012	0.05141	2,323	119.39
2013	0.05355	2,502	133.97
2014	0.05311	2,445	129.89
2015	0.05648	2,807	158.57
2016	0.05765	3,274	188.72

Diagnostics using triangles

Even before loss development is performed, actuaries can glean useful information from loss development triangles. That's because a variety of data, such as:

- Reported claims
- Case outstanding
- Cumulative total paid claims
- Cumulative paid claims on closed claim counts
- Incremental paid claims
- Reported claim counts
- Claim counts on closed with payment
- Claim counts on closed with no payment
- Total closed claim counts

can be made into triangles and compared against one another. In addition, triangles of ratios and average claim values can also be created. Examples of such triangles include:

- Ratio of paid-to-reported claims
- Ratio of total closed claim counts-to-reported claim counts
- Ratio of claim counts on closed with payment-to-total closed claim counts
- Ratio of claim counts on closed without payment-to-total closed claim counts
- Average paid on closed claims (cumulative paid claims on closed claims divided by claim counts closed with payment)

etc.

Example

We will use the loss development triangles as a tool to further understand how changes in an insurer's operations and the external environment can influence the claims data.

The following data represents the historical claims experience for automobile bodily injury liability over the 2002 to 2008 experience period.

Additional info: Major tort reforms were implemented in 2006 resulting in caps on awards as well as pricing restrictions and mandated rate level changes for all insurers operating in the region. As a result of these reforms, management decided to reduce its presence in this market.

Table 1 – Summary of Earned Premium and Rate Changes				
Calendar Year	Earned Premiums ($000)	Rate Changes	Cumulative Average Rate Level	Annual Exposure Change
2002	61,183		0.0%	
2003	69,175	+5.0%	5.0%	7.7%
2004	99,322	+7.5%	12.9%	33.6%
2005	138,151	+15.0%	29.8%	21.0%
2006	107,578	+10.0%	42.8%	-29.2%
2007	62,438	-20.0%	14.2%	-27.5%
2008	47,797	-20.0%	-8.6%	-4.3%

Table 2 – Reported Claim Development Triangle							
Accident	Reported Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	12,811	20,370	26,656	37,667	44,414	48,701	48,169
2003	9,651	16,995	30,354	40,594	44,231	44,373	
2004	16,995	40,180	58,866	71,707	70,288		
2005	28,674	47,432	70,340	70,655			
2006	27,066	46,783	48,804				
2007	19,477	31,732					
2008	18,632						

Table 3 – Paid Claim Development Triangle							
Accident	Paid Claims ($000) as of (months)						
Year	12	24	36	48	60	72	84
2002	2,318	7,932	13,822	22,095	31,945	40,629	44,437
2003	1,743	6,240	12,683	22,892	34,505	39,320	
2004	2,221	9,898	25,950	43,439	52,811		
2005	3,043	12,219	27,073	40,026			
2006	3,531	11,778	22,819				
2007	3,529	11,865					
2008	3,409						

Table 4 – Ratio of Reported Claims to Earned Premium							
Accident	Ratio of Reported Claims to Earned Premium as of (months)						
Year	12	24	36	48	60	72	84
2002	0.209	0.333	0.436	0.616	0.726	0.796	0.787
2003	0.140	0.246	0.439	0.587	0.639	0.641	
2004	0.171	0.405	0.593	0.722	0.708		
2005	0.208	0.343	0.509	0.511			
2006	0.252	0.435	0.454				
2007	0.312	0.508					
2008	0.390						

Table 5 – Ratio of Reported Claims to On-Level Earned Premium							
Accident	**Ratio of Reported Claims to On-Level Earned Premium as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.229	0.364	0.477	0.674	0.794	0.871	0.862
2003	0.160	0.282	0.504	0.674	0.735	0.737	
2004	0.211	0.500	0.732	0.892	0.874		
2005	0.295	0.488	0.723	0.726			
2006	0.393	0.679	0.709				
2007	0.390	0.635					
2008	0.390						

Table 6 – Ratio of Paid Claims-to-Reported Claims							
Accident	**Ratio of Paid Claims-to-Reported Claims as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.181	0.389	0.519	0.587	0.719	0.834	0.923
2003	0.181	0.367	0.418	0.564	0.780	0.886	
2004	0.131	0.246	0.441	0.606	0.751		
2005	0.106	0.258	0.385	0.567			
2006	0.130	0.252	0.468				
2007	0.181	0.374					
2008	0.183						

Table 7 – Ratio of Cumulative Paid Claims to On-Level Earned Premium							
Accident	**Ratio of Cumulative Paid Claims to On-Level Earned Premium as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	0.041	0.142	0.247	0.395	0.571	0.727	0.795
2003	0.029	0.104	0.211	0.380	0.573	0.653	
2004	0.028	0.123	0.323	0.540	0.657		
2005	0.031	0.126	0.278	0.412			
2006	0.051	0.171	0.331				
2007	0.071	0.238					
2008	0.071						

Table 8 – Reported Claim Count Development Triangle							
Accident	**Reported Claim Counts as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	1,342	1,514	1,548	1,557	1,549	1,552	1,554
2003	1,373	1,616	1,630	1,626	1,629	1,629	
2004	1,932	2,168	2,234	2,249	2,258		
2005	2,067	2,293	2,367	2,390			
2006	1,473	1,645	1,657				
2007	1,192	1,264					
2008	1,036						

Table 9 – Closed Claim Count Development Triangle							
Accident	Closed Claim Counts as of (months)						
Year	12	24	36	48	60	72	84
2002	203	607	841	1,089	1,327	1,464	1,523
2003	181	614	941	1,263	1,507	1,568	
2004	235	848	1,442	1,852	2,029		
2005	295	1,119	1,664	1,946			
2006	307	906	1,201				
2007	329	791					
2008	276						

Table 10 – Ratio of Closed-to-Reported Claim Counts							
Accident	Ratio of Closed-to-Reported Claim Counts as of (months)						
Year	12	24	36	48	60	72	84
2002	0.151	0.401	0.543	0.699	0.857	0.943	0.980
2003	0.132	0.380	0.577	0.777	0.925	0.963	
2004	0.122	0.391	0.645	0.823	0.899		
2005	0.143	0.488	0.703	0.814			
2006	0.208	0.551	0.725				
2007	0.276	0.626					
2008	0.266						

Table 11 – Definitions of Average Values	
Average Value	**Definition**
Average reported claim	Reported claim triangle / reported claim count triangle
Average paid claim	Paid claim triangle / closed claim count triangle
Average case outstanding	$\frac{\text{Reported claim triangle} - \text{paid claim triangle}}{\text{Reported claim count triangle} - \text{closed claim count triangle}}$

Table 12 – Average Reported Claim Development Triangle

Accident	Average Reported Claims as of (months)						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	9,546	13,455	17,219	24,192	28,673	31,379	30,997
2003	7,029	10,517	18,622	24,966	27,152	27,239	
2004	8,796	18,533	26,350	31,884	31,129		
2005	13,872	20,686	29,717	29,563			
2006	18,375	28,440	29,453				
2007	16,340	25,104					
2008	17,985						

Table 13 – Average Paid Claim Development Triangle							
Accident	**Average Paid Claims as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	11,417	13,067	16,436	20,290	24,073	27,752	29,178
2003	9,631	10,163	13,478	18,125	22,896	25,077	
2004	9,452	11,673	17,996	23,455	26,028		
2005	10,315	10,920	16,270	20,569			
2006	11,502	13,000	19,000				
2007	10,726	15,000					
2008	12,351						

Table 14 – Average Case Outstanding Development Triangle							
Accident	**Average Case Outstanding as of (months)**						
Year	**12**	**24**	**36**	**48**	**60**	**72**	**84**
2002	9,213	13,714	18,151	33,273	56,167	91,729	120,366
2003	6,634	10,733	25,647	48,766	79,718	82,826	
2004	8,706	22,941	41,561	71,204	76,320		
2005	14,464	29,994	61,547	68,983			
2006	20,185	47,368	56,984				
2007	18,480	42,002					
2008	20,031						