Chapter 2 - Projecting Ultimate Claims

Introduction to Ratemaking and Reserving

Outline

Claim Development Triangle

- Consider the following cumulative claims paid data:

Transaction Year	Acc. Year	Amount (RM)
2006	2006	100
2007	2006	50
2007	2007	110
2008	2006	20
2008	2007	51
2008	2008	115

- We need to group the data by accident year and by transaction year as well.

Claim Development Triangle

- We can arrange the data in previous slides using table:

Accident Year	1	2	3
2006	100	150	170
2007		110	161
2008			115

- We can rearrange these number in another way of presentation, which is known as "Claim Developmment Triangle"
- It is easier to look at AGE of claims rather than accounting date

Accident Year	12 Months	24 Months	36 Months
2006	100	150	170
2007	110	161	
2008	115		

Rows, Diagonals and Columns

- Three important dimensions in a development triangle - rows, diagonals and columns
- Rows - Represent each accident year
- Columns - Age of the claims
- Diagonals - Each diagonal represents a successive valuation date
- In example earlier, first diagonal represents CY2006 and second, third diagonal represents CY2007 & CY2008, respectively
- From the claim dev. triangle, we can see that the cumulative paid claims for AY2006, as of Dec 31, 2007 is 150 and as of Dec 31, 2008 is 170. That is, a total of 20 was paid in 2008

Some Common Triangles

- Besides paid claims, there are also some commonly used triangles for analysis of ultimate claims:
  1. Reported claims, or Inccurred claims
  2. Closed count
  3. Reported count
- These triangles are usually using cumulative numbers instead of incremental numbers as cumulative numbers are generally more stable compare to incremental

Claim Development Triangle - Example

You are given the following data

- Claims paid data:

Acc. Year	2012	2013	2014	2015
2012	75,000	137,500	75,500	49,000
2013		50,000	115,000	145,000
2014			115,000	123,000
2015				85,000

- End of year case reserves:

Acc. Year	2012	2013	2014	2015
2012	188,000	115,000	74,000	35,000
2013		175,000	94,000	45,000
2014			115,000	68,000
2015				208,000

Claim Development Triangle - Example (cont.)

1. Construct the Cumulative Claims Paid Triangle

2. Construct the Cumulative Reported Claims Triangle

Claim Development Triangle - Example (cont.)

3. Calculate paid claims for calender year 2015

4. Calculate the change in case reserves for calender year 2015

Development Method

- Also known as Chain Ladder Method or Link Ratio Method
- One of the most frequently used techniques used in projecting ultimate claims
- Can be applied to most type of data - claims, indemnity, ALAE, recoveries, count, premiums, average values and ratios
- Regardless of the type of data used, development method has the following two key assumptions:
    1. Historical experience is predictive of future experience, and
    2. Activity observed to date is relevant for projecting future activity

Assumptions

- With the two assumptions above, we have some implicit assumptions when we are using this technique on projecting future value, for example:
- If we are using development data on CLAIMS, then we are in fact assuming that the claims process remains the same throughout the period of study. That is, there is no speeding up in claim payments and etc.
- If we are using development data on PREMIUMS, then we are assuming that there is no change in mixture of portfolio, exposure and etc.

Steps in Development Method

- Display data in development triangle
- Calculate age-to-age factors
- Calculate average age-to-age factors
- Select age-to-age factors for each maturity age interval
- Select a tail factor
- Calculate cumulative development factors
- Project ultimate value

Display Data in Development Triangle

- We shall use the cumulative reported claims triangle that we constructed earlier
- The reported claims are

Acc. Year	12m	24m	36m	48m
2012	263,000	327,500	362,000	372,000
2013	225,000	259,000	355,000	
2014	230,000	306,000		
2015	293,000			

Calculate Age-to-Age Factors

- The reported claims age-to-age factor for AY2012 from 12-to-24 months is $\frac{327{,}500}{263{,}000} = 1.2452$
- Repeat this for all numbers and we obtain the following age-to-age factor triangle:

Acc. Year	12-24	24-36	36-48	48-Ult
2012	1.2452	1.1053	1.0276	
2013	1.1511	1.3707		
2014	1.3304			

Calculate average age-to-age factors

- Some commonly used averages are:
  1. Simple average
  2. Weighted average
  3. Medial average, also known as truncated average (simple average excluding high and low values)
  4. Geometric average
- For the above examples, we have:

Select Age-to-Age Factor

- Consider all the averages that we have computed:

Acc. Year	12-24	24-36	36-48	48-Ult
Simple Ave.	1.2423	1.2380	1.0276	
Weighted Ave.	1.2430	1.2225	1.0276	
Geometric Ave.	1.2401	1.2309	1.0276	

- All averages for 12-24 are close
- For 24-36 age-to-age factors, AY2013 is much higher than AY2012, by looking at the numbers in reported claims triangle, we can see that 259,000 is much lower than other two numbers. While other numbers are looking fine

Select Age-to-Age Factor (cont.)

- Thus, we can choose weighted average as our age-to-age factor for all three years
- So we have

Acc. Year	12-24	24-36	36-48	48-Ult
Simple Ave.	1.2423	1.2380	1.0276	
Weighted Ave.	1.2430	1.2225	1.0276	
Geometric Ave.	1.2401	1.2309	1.0276	
Selected	1.2430	1.2225	1.0276	?

Selecting Tail Factor

- There are 4 commonly used techniques in determining tail factor:
  1. Bondy method
  2. Algebraic methods
  3. Benchmark data
  4. Curve fitting method
- We shall only focus on Original Bondy method here (students who are interested to know more about modified Bondy and other methods, you can check on the section 14.4.5 of "Fundamentals of General Insurance Actuarial Analysis")

Selecting Tail Factor (cont.)

- Original Bondy Method - Tail factor is set to be the last observed age-to-age factor
- The main drawback of this method is the potential to greatly underestimate the remaining development for long-tail lines
- Thus, we choose tail factor to be 1.0276 in our earlier example

Acc. Year	12-24	24-36	36-48	48-Ult
Simple Ave.	1.2423	1.2380	1.0276	
Weighted Ave.	1.2430	1.2225	1.0276	
Geometric Ave.	1.2401	1.2309	1.0276	
Selected	1.2430	1.2225	1.0276	1.0276

Calculating Cumulative Development Factors

- To calculate the development factors, we start from tail factor and successively multiply each selected age-to-age factor from right to left hand side

- Each cumulative factor also represents the expected development that remains at a particular maturity age

Calculating Cumulative Development Factors (cont.)

- The expected developement (development pattern) can be calculated by
  Development Pattern $= \frac{1}{cumulative\ \ factor}$
- In our exammple, we can have

Projecting Ultimate Value

- Before we project the ultimate value, we first look at the triangle with all information needed (Call this as Table A):

Acc. Year	12m	24m	36m	48m
2012	263,000	327,500	362,000	372,000
2013	225,000	259,000	355,000	
2014	230,000	306,000		
2015	293,000			
Selected	1.2430	1.2225	1.0276	1.0276
Cumulative	1.6047	1.2910	1.0560	1.0276
% Reported	62%	77%	95%	97%

Projecting Ultimate Value (cont.)

- And what we want to do now is "Completing The Square"
- Completing Square?

$$
\begin{aligned}
x^2 + x - 1 &= x^2 + x + \frac{1}{4} - \frac{1}{4} - 1 \\
&= \left[x + \frac{1}{2}\right]^2 - \frac{5}{4}
\end{aligned}
$$

Projecting Ultimate Value (cont.)

- We are trying to fill in the blank cells in Table A
- First, add a new column to the right of last column and name it as "Ult"

Acc. Year	12m	24m	36m	48m	Ult
2012	263,000	327,500	362,000	372,000	
2013	225,000	259,000	355,000		
2014	230,000	306,000			
2015	293,000				
Selected	1.2430	1.2225	1.0276	1.0276	

Projecting Ultimate Value (cont.)

- We then use the selected age-to-age factor (also known as selected Claim Development Factor), to project each AY claims to ultimate value
- For example, the ultimate claim for AY2012 equals

$$\text{Ult Claims}_{AY2012} = 372,000 \times 1.0276 = 382,267.20$$

- Continue the calculation to fill up all blank cells in Table A.

Acc. Year	12m	24m	36m	48m	Ult
2012	263,000	327,500	362,000	372,000	382,267
2013	225,000	259,000	355,000	364,798	374,866
2014	230,000	306,000	374,085	384,410	395,019
2015	293,000	364,199	445,233	457,522	470,149
Selected	1.2430	1.2225	1.0276	1.0276	

Projecting Ultimate Value (cont.)

- Alternatively, you can also compute the ultimate claims for each calender year using cumulative link ratio
- Ult $\text{Claims}_{2013} = 355,000 \times 1.0560 = 374,880$. Number is different due to rounding error
- Compute all ultimate values using this method:

Expected Method

- Most frequently used in:
  1. Immature experience periods, particularly long-tail LOB
  2. New GI products with limited/no historical experience
  3. Entry into a new geographical area
  4. Wide-ranging of changes, either internally or external environments
- Key assumption - Unpaid claims can better be estimated based on an priori estimate than using experience observed to date
- Ult Claims $=$ Selected Expected Loss Ratio $\times$ Earned Premium

Expected Method - Example (cont.)

Given the following reported claims information:

AY	12 Months	24 Months	36 Months	Earned Premium
2006	5,630	7,106	8,282	12,380
2007	6,380	8,051		13,430
2008	7,348			14,280
CDF	1.570	1.250	1.070	

- The annual loss ratio trend is 7.0% (Meaning increasing by 7% per year)
- Use the expected method to find what is the ultimate claims for each accident year

Expected Method - Example (cont.)

- First estimate the ultimate claim using the cumulative LDF
- Then apply the trend to each accident year's ultimate claims
- Compute the loss ratio for each accident year

- Choose the expected loss ratio. We can use simple average in this case.
- Selected Expected Loss Ratio $= 80.97\%$
- Projected Ult Claims $= 80.97\% \times 14,280 = 11,563$

Bornhuetter-Ferguson Method - Introduction

- Blend of development and expected claims method
- Splits ultimate claims into two components - Actual reported and expected unreported claims
- Credibility weighting between the development and expected claims method
  1. Credibility, $Z = \frac{1}{CDF}$
  2. Less weight is given to expected claims in older (accident) years
- Ult Claims $=$ Actual Reported Claims $+$ Expected Unreported Claims

Bornhuetter-Ferguson Method - Introduction (cont.)

- Mainly used (but not limited to) for reported and paid claims
- Advantages of BF methods:
  1. Random fluctuation early in life of an (accident) year do not significantly distort the projections
  2. Could be useful if the data is extremely thin and/or volatile

Bornhuetter-Ferguson Method - Mechanics (cont.)

- Formula below is being used to compute the ultimate claims

$$\begin{aligned}\text{Ult Claims} &= \text{Actual Reported} + \text{Expected Unreported} \\ &= \text{Actual Reported} + \text{Expected Claims} \times \text{\% Unreported}\end{aligned}$$

  where % unreported = 1 - % Reported = 1 - $\frac{1}{CDF}$
- Expected claims are calculated using previous method (Expected Claims Method)
- We can also use paid claims data instead of reported claims data

BF Method - Example

- Using the same data and LDF with earlier example:

AY	12 Months	24 Months	36 Months	Earned Premium
2006	5,630	7,106	8,282	12,380
2007	6,380	8,051		13,430
2008	7,348			14,280
CDF	1.570	1.250	1.070	

- Use the ELR that we calculated in earlier section, which is 80.97%
- In this example, assume that there is no trend factor

BF Method - Example (cont.)

- Compute the ultimate claim:

The 5 Categories

- There are more methods on estimating ultimate claims which will not be covered here
- Each method is dependent on specific underlying conditions
- There are 5 major categories that we should conisder when conducting any projection of ultimate claims
  1. Claims Settlement Pattern
  2. Mix of Business
  3. Data Constraints
  4. Exogenous Influences
  5. Outwards Reinsurance

Change in Claims Settlement Pattern

- We consider 5 different scenarios:
  1. Scenario A - Steady state (This is our base scenario)
  2. Scenario B - Steady-state volume and deteriorating claims ratios
  3. Scenario C - Increasing volume and steady-state claim ratios
  4. Scenario D - Steady-state volume and claim experience, strengthening in adequacy of case reserves
  5. Scenario E - Increasing volume, steady-state claim experience and strengthening in adequacy of case reserves
- We look at how the three methods we learned earlier behave under each of these scenarios

Summary of Claims Settlement Pattern

- The following table summarizes how the projection of ultiamte value behaves under different scenarios:

Scenario	Expected	Dev. (Rpt)	Dev. (Paid)	BF (Rpt)	BF (Paid)
A	-	-	-	-	-
B	Underestimate	-	-	Underestimate	Underestimate
C	-	-	-	-	-
D	-	Overestimate	-	Overestimate	-
E	-	Overestimate	-	Overestimate	-

Selecting Best Estimates

- Using different methods, will give different ultimate claims and we will need to determine what is the best estimate of ultimate claims
- It is not sufficient to simply take averages of the results of all methods
- We should know what is the factors that lead to the differences
- Once we understand the factors and which methods are appropriate, we can make the selection based on our experience
- One common way is to take the average of the results of appropriate methods