

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

29th November 2019

Subject CP2B – Actuarial Modelling (Paper B)

Time allowed: 3 Hour 15 Minutes (14.45 – 18.00 Hours)

Total Marks: 100

AT THE END OF THE EXAMINATION

Please return this question paper to the supervisor separately. You are not allowed to carry the question paper in any form with you. You are requested to save and submit the work before leaving the examination premises.

Examination instructions

1. *Mark allocations are shown in brackets.*
2. *Do save your work in Excel files on a regular basis.*
3. *Please check if you have received complete Question Paper and no page is missing. If so, kindly get new set of Question Paper from the Invigilator.*
4. *Please note that you should use your Roll Number and NOT your name on all of the material you submit for marking.*
5. *You would be provided with a digital platform for the examination which will show the time remaining for the examination at all times, once the exam starts. Once the exam duration is over, any work done on MS Excel will automatically get submitted and the platform will get frozen.*
6. *There will however be a 'Submit' button available. Ensure that you click the "Submit" button only when you have answered all questions including sub-parts and then final submission is made. If done erroneously at any point earlier, this step can't be un-done.*
7. *Students are required to submit all their work i.e. model, audit and summary using MS excel only.*

Exam Requirements

- 1) Read the background document, which describes the scenarios that have been modelled and documented for this project and the work which remains outstanding.
- 2) Read the audit trail which has been written by your colleague, another actuarial student, for the calculations that they performed. This will assist you in following and understanding the calculations performed in the Excel model provided.

You are not required to add to or amend the audit trail.

- 3) Build on the model provided to produce the following additional calculations and comment on the claim development patterns under each method comparing them. You should ensure that the additional spreadsheet work which you perform contains appropriate self-checks.

i) Calculate the claims reserves using the inflation adjusted chain ladder method. (4)

ii) Calculate the claims reserves using Bornhuetter Ferguson method. (5)

You should assume that your colleague's calculations have been checked and are correct.

- 4) Illustrate in your model the following using suitable charts:

i) Claims development summed over all accident years for Basic Chain ladder method.

ii) Claims development summed over all accident years inflation adjusted chain ladder method combined with (i).

iii) Claims development summed over all accident years for Bornhuetter Ferguson method combined with (i) and (ii).

(6)
[15]

- 5) Prepare a summary document of around five to seven pages, capturing the main features and results of the work done by you and your colleague. You can assume that the summary is being prepared for your boss, a senior actuary, who will present the work to the Chief Executive Officer.

Your summary should include the following:

- Purpose of the project, data, method and assumptions used by you and your colleague.
- Results, including charts.
- Commentary on the results, key conclusions and suggested next steps.

The summary should cover the full scope of the project, including the modelling already done by your colleague in the spreadsheet provided.

You are not required to add to or amend the audit trail.

Marks available for the summary:

Methodology (including purpose, data, method and assumptions): (20)

Results, including charts (10)

Commentary on results and conclusions (20)

Next steps (25)

Drafting (10)

[85]

Background

In the country of Inland, the Grand Insurance Company (GIC) offers motor insurance products. Their portfolio consists of motor insurance policies ranging from low to high value contracts.

For the claims that are reported, claims reserve is required to pay the claims over the years. These reserves are to settle the claims that have been reported but have not yet been closed.

The company uses basic chain ladder method frequently to estimate these outstanding claims and set up reserves needed for those.

One of your colleagues has already built a model to calculate the projected claims amounts and reserves required to pay off the reported claims using the basic chain ladder method.

It was realized that inflation has not been considered in the model and country has been experiencing high inflation. The chief actuary would like to see the impact of inflation on these reserves.

Your boss has asked you to refine the calculations and calculate the outstanding claims and reserves with inflation adjusted chain ladder method. Inflation rates to be used for this calculation are given below

❖ 2020	10.00%
❖ 2021	11.00%
❖ 2022	9.70%
❖ 2023	9.50%
❖ 2024	11.50%
❖ 2025	10.50%
❖ 2026	10.20%

Your boss also wants to see the claims reserves if Bornhuetter Ferguson method is used to estimate these.

Your boss would like your additional modelling to include appropriate checks wherever necessary.

Your boss would also like you to prepare a summary document covering both the Basic Chain ladder method (performed by your colleague, including the inflation adjustment done by you) and the calculations for Bornhuetter Ferguson method performed by you.

Your boss is out of the office and cannot be contacted for the next three hours. He would like the additional calculations finished and the summary document written up ready for his return, when he will review them and present your findings to the Chief Actuary.

Your colleague has produced an audit trail of his model, which is provided below. An electronic copy of the model is also provided.

You are not expected to include the additional modelling request in the audit trail, but your results should be included in the summary. There is an additional guidance provided below for you to apply the inflation adjustment and the Bornhuetter-Ferguson method.

Additional Guidance-

The claim amounts need to be adjusted for future inflation in future development years.

For inflation adjustments, you can follow below steps-

1. Use the similar method as basic chain ladder.
2. Find non-cumulative (individual) claims for each development year.
3. Cumulate the inflation to calculate the rates to apply for a calendar year.
4. Apply inflations in future claims as per the calendar year.
5. Calculate the claim reserves by adding lower triangle numbers.

The Bornhuetter-Ferguson method combines the estimated loss ratio with a projection method.

For Bornhuetter-Ferguson method, follow the below steps-

1. Sum the cumulative claim amounts for each development year in a column.
2. Subtract last number of that column.
3. Calculate ratio of above two numbers from step 1 and 2 for each development year like below-
Ratio= total (t+1)/total-last no. (t)
4. Development factors are then calculated as cumulative factors using above ratios for each development year.

An example has been included below for reference from the core reading.

Cumulative incurred claims data, by years of accident and reporting development

		DY						
		0	1	2	3	4	5	Ult
AY	1	2,866	3,334	3,503	3,624	3,719	3,717	3,717
	2	3,359	3,889	4,033	4,231	4,319		
	3	3,848	4,503	4,779	4,946			
	4	4,673	5,422	5,676				
	5	5,369	6,142					
	6	5,818						
TOTAL		25,933	23,290	17,991	12,801	8,038	3,717	
TOTAL – last no:		20,115	17,148	12,315	7,855	3,719		
RATIO (r)		1.158	1.049	1.039	1.023	0.999	1.000	
DEVELOPMENT FACTOR (f)		1.290	1.114	1.062	1.022	0.999	1.000	

The 'TOTAL' figures have been calculated by summing the entries in each column, *eg* the second TOTAL is:

$$3,334 + 3,889 + 4,503 + 5,422 + 6,142 = 23,290$$

The 'TOTAL – last no' figures have been calculated by summing all but the last entry in each column, *eg* the first TOTAL – last no figure is:

$$25,933 - 5,818 = 20,115$$

The RATIO figures are what we previously referred to as the development factors. These are calculated in the usual way. Note, however, that since we are given the TOTAL and TOTAL – last no for each development year, the calculation can be simplified. For example, the ratio of DY1 to DY0 is given by:

$$\frac{23,290}{20,115} = 1.158$$

What the Core Reading refers to as DEVELOPMENT FACTORS are actually *cumulative* development factors, *ie* they apply from the development year of the column they are in up to Development Year 5. For example, the figure of 1.290 is calculated as:

$$1.158 \times 1.049 \times 1.039 \times 1.023 \times 0.999 \times 1.000 = 1.290$$

So, if we were to use the Basic Chain Ladder method to estimate the cumulative claims incurred by the end of Development Year 5 in respect of Accident Year 6, we would obtain:

$$5,818 \times 1.290 = 7,505$$

Audit Trail

Purpose- The purpose of this model is to be able to calculate the claims reserves required in order to settle the payments for the claims already reported for the motor insurance portfolio of Grand Insurance Company.

Data- Data has been provided for claims reported and paid over the years from year 2012 to 2019.

Assumptions- The following assumptions have been made in order to calculate the claims reserves-

- The claim amounts provided are correctly captured
- The development of claims will follow same pattern over the years
- The inflation is not taken into account for Basic chain ladder method
- The claims for year 2012 are fully developed and there will be no more payments in respect of those claims

Methodology-

A new worksheet is created named “BCL”. The claims data provided in “Data” tab is again reproduced in this worksheet in Table 1 for reference using formulae to refer to data in “Data” tab. Table 1 is from Cell C2 to L11.

The cumulative amounts of claims are calculated in Table 2 using Table 1 by adding these individual claims till any development year. Table 2 is from Cell C15 to L24.

For example, cumulative claims in development year 3 are calculated by summing the individual claims from development year 0 to 3.

Then the development factors for each development year are calculated in row 28 using the ratio of claims for development year t and t-1 and using the developed years only.

For example, in cell F28, the development ratio for development year 1 is calculated using claims reported till 2018 by taking ratio of sum of claims in development year 1 and development year 0 till 2018.

Similarly, in cell G28, the ratio of sum of claims in development year 2 and development year 1 till 2017.

These development ratios for a development year are then used to project the cumulative claims for these development years in Table 3 which is from Cell C30 to L39

For example, development ratio for development year 1 of 1.2196 is used to calculate the amount for development year 1 for claim reported in 2019 as below-

$$24,392 = 20,000 * 1.2196$$

Similarly, corresponding development ratios are used to fill values for each development year.

To calculate the claims reserves, the claims fully developed at end of year 7 are then used.

The fully developed claims in development year 7- claims paid till date will give the claims reserves needed for that reported year.

These are calculated in column M and summed over all reported years in cell M40 to calculate the total claims reserves.
