

# **INSTITUTE OF ACTUARIES OF INDIA**

## **EXAMINATIONS**

**10<sup>th</sup> December 2022**

**Subject CP2B – Actuarial Modelling (Paper B)**

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

**Total Marks: 100**

### **INSTRUCTIONS TO THE CANDIDATES**

- 1. Mark allocations are shown in brackets.*
- 2. Do save your work in solution template on a regular basis.*
- 3. All the detailed guidelines are available on exam screen.*
- 4. If Any, Data set file(s) accompanying the question paper is available for download on the exam screen.*
- 5. 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.*

#### **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.**

### Exam requirements

Read the background document, which describes the approach that has been used to model and documented for this project and the work that remains outstanding.

Read the audit trail, which has been written by your colleague, another actuarial student, for the calculations performed by him. This will assist you in following and understanding the calculations performed in the Excel model provided.

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

You should assume that your colleague's calculations have been checked and are correct. Expand the spreadsheet model to produce the following additional calculations. You should ensure that the additional work you undertake on the spreadsheet contains appropriate self-checks and you should not overwrite the existing calculations.

#### Q. 1) Additional information and modelling steps

- Expand the model to calculate the premium rates for two categories: for ages  $\leq 45$  and for ages  $> 45$ , based on the additional information received and all other assumptions remaining the same.  
[Hint : You can use Excel function SUMIFS to sub-total based on multiple criteria] (5)
  - Apply a deductible on INR 15000 on the inflated claim amount in the data received and recalculate the premium based on the revised claim experience. Other assumptions remain same. Calculate it independent of the changes made above. (5)
  - Recalculate the premium rate provided in the model developed by your colleague with average claim rate lower by 10% to that calculated from the data and expense loading assumption would increase from 5% to 8%, on higher underwriting costs. (2)
  - Compare the results under these additional approaches. (3)
- [15]**

- Q. 2) Prepare a summary document capturing the main features and results of the work completed by you and your colleague. You can assume that the summary is being prepared for a Senior Actuary, who will in turn present the work to the senior management of your company.

#### Your summary should include the following:

- Purpose of the project, data, methodology and assumptions used by you and your colleague
- Results, including relevant tables and charts
- Commentary on the results
- Key conclusions
- Suggested next steps

#### Commentary on the results should cover, but not be limited to:

- Comparison of the different approaches
- How the rating factors impact the premium calculation
- An explanation on the movement of the results with increased underwriting

- Next steps specific to the project with underlying rationale

The summary should cover the full scope of the project, including the additional approaches, which was modelled in the spreadsheet provided to you.

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

**Marks available for the summary:**

- Purpose data and assumptions (10)
  - Methodology (20)
  - Data Checks and reasonableness checks (5)
  - Results, including charts (5)
  - Commentary on results and conclusions (20)
  - Next steps (15)
  - Drafting (10)
- [85]**

### **Overview of the model / project**

With the recent rising awareness of the importance of health insurance products under the pandemic, a new insurance company wants to explore the opportunity of launching a health insurance cover where the coverage would be indemnity based. It wants to calculate the premium rates and understand the market feasibility. For the same, it has obtained claims information for similar product for last 5 years from an external agent. The sum assured of these claims was defined. The insurer wants to use the same sum assured for its product.

It has also received information regarding the number of active policies at the start of each year, from which the claim was made. The plan is to launch the product in year 2023.

The insurer has decided that it will calculate the average claim amount from the data and average claim rate (average of the claim rate in last 5 years) and use the two to price its product. The following assumptions and additional adjustments also need to be made.

- Additional 10% margin needs to be applied to the price calculated from the information as per the data.
- The claim amount needs to be adjusted for inflation. The product will be issued in year 2023 so all the past claim records need to be inflated and adjusted till 2023. The medical inflation rate to be used is as under.

Year	Inflation rate
2023	8%
2022	8%
2021	9.5%
2020	9%
2019	8%
2018	8.50%
2017	8.75%

- The net premium calculated needs to be further loaded with 5% for expenses.
- The coverage period will be only 1 year, post which the policy is subject to premium review.

The objective is to calculate the premium rate based on the data and assumptions.

### **Further information to offer more competitive premium**

The insurer thinks that if he can vary the prices by age, it may be able to offer better and competitive rates. It has been able to obtain information on inforce data count divided into policyholders aged  $\leq 45$  and  $> 45$  years. It wants to use this information with the claims data information and see if it makes sense to offer two prices: for ages  $\leq 45$  and for ages  $> 45$ .

Year	Number of policies (Total)	Age $\leq 45$	Age $> 45$
2021	9,76,589	3,51,572	6,25,017
2020	7,77,598	3,18,815	4,58,783
2019	8,96,898	3,31,852	5,65,046
2018	8,97,179	3,49,900	5,47,279
2017	8,99,001	3,77,580	5,21,421

The second alternative is that the insurer is thinking to allow a flat deductible under the policy of INR 15000. In this case, only if the claim amount is greater than the value of the deductible, the policyholder will make claim. Further, the amount of claim will also reduce by the value of the deductible.

As an alternative, the insurer is thinking if it makes sense to spend more on underwriting and improve the claim experience. It estimates that if it can increase the level of underwriting, the average number of claims would go down by 10%. However, the expense cost will also go up and the expense loading assumption would also have to be increased from 5% to 8%. This method must be applied independently of the above additional rating factor (i.e., on the base case already modelled and not divided by ages).

The Senior Actuary in your team has provided you with the model and Audit trail written by your colleague. This does not include the calculation based on the additional information. The Senior Actuary wants you to model these additional cases and prepare a summary report which he/she can present to the management showcasing the different pricing approaches and their results.

**You are not expected to include the additional modelling you undertake in the audit trail, but the approach and results of all elements of the scenario (both those completed by your colleague and by you) should be included in the summary.**

## **Audit Trail**

### **Background**

The project calculates premium rates for an indemnity-based health insurance product. The product will be with one year term, post which the premium will be subject to review at the time of renewal. Hence, only 1 year period is considered for setting the premium rate.

The enclosed spreadsheet is used to calculate the premium rate where the following factors are considered:

- Average claim amount
- Average claim probability
- Expense loading
- Additional margin

### **Objective**

The objective of this model is to calculate the premium rate for a defined sum assured using the claims data received for last 5 years. The product is expected to be launched in year 2023.

### **Data**

The following data was received:

- Claims data: This is present in sheet 'Data – claims'. 50000 claim records have been provided containing information on the amount of claim, age and gender of the policyholder and year of claim (between 2017 to 2021).
- Number of inforce policies: This is present in sheet 'Data – inforce'. Inforce count at the start of every year (for years 2017 to 2021) has been provided.

Data check has been done in sheet 'Data check'

The following checks were done:

- All claim records relate to year 2017-2021: The claim counts have been split into year wise and the total of the 5 years matches with the total data size. i.e., 50000. No inconsistencies were observed. This has been shown in rows 2-10.
- Reasonableness of the claim amount: Maximum, minimum, and average claim amount has been taken out from the data. It was observed that the maximum claim amount looks too high. Hence, claim records have been grouped into smaller groups.

From the grouping it was identified that most of the claims are below INR 10 lacs amount. However, 7 records (out of 50000) exceed INR 1 Crore in value. These appear to be incorrect entries and hence these 7 records have been manually deleted.

This is shown in the table present in Row 18-26.

### **Data corrected**

Based on the check done, 7 records which were identified with claim amount above INR 1 Crore has been manually revived from the data present in sheet 'Data - claims'. The other

claims were pasted in sheet 'Data claims – Filtered'. All further calculations have been done using the information present in this sheet.

*Check has been done that the only 7 records have been deleted and those 7 records are the ones with claim amount >1 Cr. This has been shown in column 'F' and rows '31 to 35' of sheet 'Data check'.*

### **Assumptions**

The following assumption provided has been pasted in sheet 'Assumption':

- Medical inflation rate applicable from year 2018 to 2023
- Expense loading on the benefit premium calculated
- Further margin to be loaded on the premium calculated

Besides, the following assumptions have been made while modelling:

- Premium rate has to be calculated using the claims and inforce data provided
- No other loading has to be provided
- The product will be a 1-year term product and hence only 1-year average claim cost must be considered
- No adjustment for discounting and interest rate had to be made
- Sum assured applicable to the policies for which claims data relates is like the sum assured to be offered by the insurance company
- Annual premium will be paid at the start of the policy

### **Calculation**

Sheet: Calculation - inflation adj

The first step is to inflate the claim amount from the data to year 2023 (in which the claims under the new products are expected)

- For the same inflation factors are calculated. This is calculated as the cumulative factor from the claim year to year 2023. For example for claim data 2020, adjustment needs to be done to inflate them from 2021 to 2022 and then from 2022 to 2023. Hence the inflation factor will be  $(1+10\%)*(1+8\%)$ .
- These factors are calculated in column D.
- These are then applied to the claim amount in sheet 'Data claims – Filtered' column F, based on the claim's year. The values now represent the claim amount rolled forward to 2023.

*Check: A check has been done to ensure that the inflation is adjusted correctly in 'Data claims – Filtered'. For this, the inflation factor is applied directly on the total claim amount received in the data (totalled year wise) and then compared against the total inflation adjusted claim amounts (totalled year wise). The checks are 'TRUE' for all years.*

Calculation of the base premium: Sheet 'Calculation - Base premium'

The first step was to calculate average claim amount.

- For this inflated claim amount was grouped year wise. This was then totalled to calculated total claim amount in last 5 years.
- Then the number of claim records in year was calculated from the data using excel function 'Countif'. This was then totalled to calculate the number of claim record data calculated. A check was done to ensure that the total matches from the total policy count post removing the 7 error claim records.
- Average claim amount was calculated as total claim amount / total number of claims.

*Check: A reasonableness check has been done to see that the average claim amount post all the adjustments look reasonable. For this, average claim amount from the data (without any inflation adjustment) was obtained. This was then inflated using an average inflation rate for an average period. This value was calculated to the correct inflated adjusted average claim amount. The ratio was calculated as 94%, showing that the high-level check result is close to the actual average claim amount calculated.*

In order to calculate the probability of claim, the following calculation was done:

- Number of claims data in each year was counted using excel 'Countif' function.
- Number of policies at the start of each year was already provided in the data.
- Average claim rate was calculated using the above two. A graph has been plotted for the same.
- The average over last 5 years was further averaged to calculate an average claim rate probability.
- This is done in cell C13.

Calculation of the premium rate

- This has been calculated as:  

$$\text{Average claim amount} * \text{average claim rate} * (1 + \text{expense loading}) * (1 + \text{margin})$$

*Where;*

- *Average claim amount and average claim rate were calculated as explained above.*
- *Expense loading and margin assumptions were provided.*

## **Results**

The premium amount for the defined sum assured has been calculated in cell C16 of sheet 'Calculation'.

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