

# **INSTITUTE OF ACTUARIES OF INDIA**

## **EXAMINATIONS**

**24<sup>th</sup> November 2020**

**Subject CP2A – Actuarial Modelling (Paper A)**

**Time allowed: 3 Hour 30 Minutes (09.30 – 13.00 Hours)**

**Total Marks: 100**

## Exam requirements

- 1) Read the background document, which describes the scenarios that need to be modelled and documented for this project.
- 2) Construct a spreadsheet model that produces the following calculations and charts for different scenarios. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed reasonableness checks on your calculations.
  - i) Scenario A: Project the sales by numbers of policies for each of the four classes up to and including the calendar year 2028, using each of the three projection methods and ignoring any adjustment for the AROGYA-19 policies.
  - ii) Illustrate these projections using suitable chart for each of the projection methods.
  - iii) Demonstrate that your results support the decision to use projection method 3, other than for offline RP channel where method 1 has been chosen.
  - iv) Scenario B: Repeat step (i) using the chosen method (Method 1 for offline RP and Method 3 for the other classes) after removing sales of the AROGYA-19 from the data provided. [You are not required to repeat steps (ii) and (iii).]
  - v) Project the expected annual sales revenue under these chosen methods (Method 1 for offline RP and Method 3 for the other classes), both ignoring and allowing for the **AROGYA-19** policies.
  - vi) Determine the year in which annual revenue from online sale channel is first expected to exceed that from offline for each scenario.
  - vii) Illustrate the following sales revenue projections using suitable charts:
    - Projected total off-line and on-line annual sales revenue in each year to 2028, with no adjustment for the AROGYA-19 policies.
    - Projected total overall annual sales revenue in each year to 2028, without and with adjustment for the AROGYA-19 policies.

Marks available for spreadsheet model and checks:

- |  |             |
|--|-------------|
| ➤ Accurate completion of above modelling steps and data checks | (33)        |
| ➤ Demonstration of good modelling technique and practice       | (7)         |
| ➤ Other (non-data) checks                                      | (7)         |
|  | <b>[47]</b> |

- 3) Produce an audit trail for your spreadsheet model which includes the following aspects:
  - Purpose of the model
  - Data and assumptions used
  - Methodology, i.e. description of how each calculation stage in the model has been produced

- Explanation of the checks performed

You should ensure that your audit trail is suitable for both a senior actuary, who has been asked to approve your work, and a fellow colleague, who has been asked to peer review and correct your model, or to continue work on it, or to use it again for a similar purpose in the future.

**4) Marks available for audit trail:**

**a. Audit approach**

- Fellow colleague can review and check methods used in the model (8)
- Senior actuary can scrutinise and understand what has been done (8)
- Written in clear English (4)
- Written in a logical order (3)

**b. Audit content**

- All steps clearly explained (7)
- Clear signposting included throughout (5)
- Statement of assumptions made (5)
- All model steps accurately covered (13)

**[53]**

## **Background**

You are a modelling actuary of a Actuarial Insurance Company. The CEO of the company has approached your boss and asked to construct a model which can project industry wide sales volume by count of policies and premium amount for both on-line and off-line distribution channel for each calendar year up to year 2028. In particular, the CEO is interested in understanding when revenue from the on-line sales channel might overtake that from off-line sales channel for his business plan purposes.

Insurance Companies sell policies in the form of Regular Premium (RP) and Single Premium (SP). RP and SP policies both are available through off-line and on-line channels.

In order to perform these projections and analysis, the CEO has provided you with industry wide data on the numbers of SP and RP policies sold by each of the two distribution channels (on-line and off-line) in the calendar years 2014 to 2019 both inclusive.

The CEO has also pointed out that there was an unusual situation in the country due to a virus (Covid-19) infection in the year 2019 which may need to be taken into account in the sales projection. One particular policy, by the Government insurance company called Arogya Insurance Co., accounted for high proportion of the overall industry wide sales. The policy (“AROGYA-19”, a RP policy, providing only death cover at nominal cost to mass market) was launched on 1st of March 2019. In its first twelve months of availability, it had sold a total of 7.0 million policies across the two distribution channels. The sales numbers provided below are inclusive of Arogya 19 policies.

## **Projection Methods**

There are three different methods suggested by your boss to project the sales numbers. You have to construct a model projecting future sales by policy count and premium amount.

For each of the four classes of data (off-line RP, off-line SP, on-line RP and on-line SP), you first need to calculate the % change (year on year) of number of policies for past years.

Each class should then be projected forward assuming that:

**Method 1:** the future year on year % change is constant, and at the same level as it was from 2018 to 2019.

**Method 2:** the future year on year % change is constant, and at the same level as the simple average of the year on year % changes over the 2014–2019 period.

**Method 3:** the future year on year % change varies, in line with patterns in the historic % changes, as follows:

- Let  $n_i$  represent the number of policies sales in year  $i$  (for  $i = 2014$  to  $2019$ ) as per the data provided. Start from the first order % change ratios  $z_i$  (for  $i = 2015$  to  $2019$ ). These should be calculated as  $z_i = n_i / n_{i-1} - 1$ .
- Calculate the second order % change ratios  $y_i$  (for relevant  $i$ ), where  $y_i = z_i / z_{i-1}$ .
- Calculate the constant  $M$ , the arithmetic mean of these  $\{y_i\}$ .

- The required number of sales  $n_i$  in year  $i$  (for  $i > 2019$ ) can be calculated as:  

$$n_i = n_{i-1} * [M * (n_{i-1} / n_{i-2} - 1) + 1].$$

You have been asked to produce projections of the numbers of sales for each of the four data classes using each of these three methods in turn. Your boss, also wishes you to do this first by ignoring any potential adjustment for the AROGYA(19).

Although he feels that it is useful to present to the CEO with the projections from each of the three methods, having performed some broad analysis, he has decided that the most appropriate method is Method 3 for all classes other than offline RP for which Method 1 appears to be appropriate.

He would like you to use your projections to demonstrate that this decision is appropriate, and then to use these specified methods for the rest of your analysis.

Before starting to consider the amounts of sales revenue, your boss has asked you to repeat the projections of sales numbers using the specified methods. However, this time he wants you to remove the Arogya -19 from the data provided, in order to understand the potential impact of this possible distortion.

## Data Provided

### 1. Number of policies in millions

Type of policies	2014	2015	2016	2017	2018	2019
off-line SP	24.6	14.15	8.09	5.05	3.54	2.7
off-line RP	155	148.35	138.88	127.04	111.26	95.25
on-line SP	55	83.29	118.8	152.43	174.64	184.9
on-line RP	2.8	6.8	11.2	17	23	28

### 2. Average Annual Premium Size

Channel	Average Annual Premium Size in Rs.			
	Offline		Online	
Year	2014	2019	2014	2019
RP	10,000	8,000	10,000	7,000
SP	30,000	24,000	1,000	800

To project the annual sales revenue note the following:

- The reduction in Annual premium size, in the past, continues at the same annual rate due to the improvements in the longevity and reduction in fixed expenses for the same level of risk cover throughout the projection period.
- To perform the sales revenue projections and analysis, ignoring and allowing for the AROGYA -19 policies.

The CEO wants to know the year in which annual revenue from online channel is first expected to exceed that from off line channel.

\*\*\*\*\*