

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

16th September 2021

Subject CP2A – Actuarial Modelling (Paper A)

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

Total Marks: 100

Background

You are an Actuary who has just joined XYZ Insurance Company. XYZ sells a number of different products, but the key features of the top selling product are outlined below.

The product started selling in 2010 and provides hospitalisation benefit and enables policyholders to invest annual premiums over the term of the policy. If policyholders make a claim, they receive a payout equal to 80% of the accumulated fund value based on invested premiums, plus a bonus payment. On any claims paid out so far, the accumulated account value is accordingly reduced. No claims were made on any policies before the year 2020, but a large number of claims have been made in 2020.

The bonus amount is calculated as $20\% \text{ of account value} + \text{bonus rate} \times 20\% \text{ of account value}$. The bonus rate varies by annual cohorts and bonus is only paid to policyholders who make a claim or exercise the option to withdraw. The bonus rates have already been derived based on past investment returns and profitability of the company and have been provided to you for the year 2020. For each cohort, any bonus rate which is declared remains guaranteed.

Other features of this product are as follows:

- Policyholders can pay premiums at the start of each year, and the premium amount is flexible from INR200 to INR10,000.
- The maximum term of the product is 30 years.
- Multiple claims are permitted as long as the total claimed amount is within 150% of annual premium multiplied by policy term.
- The actual investment return on the fund is credited to the policy on an annual basis at the end of the year.

Given the recent situation with COVID-19, the company has observed a significant increase in the number of claims. During a pandemic, the product offers an option to policyholders to claim the full amount equal to the outstanding claim limit. The option can be exercised only at the end of the calendar year. Most of the policyholders have elected this option on 31 December 2020. The profits to the company will be reduced if the claim payout exceeds the current fund value. For e.g. if the account value of a policy is 100 and the claim payout including bonus is 120, the profit of the company is assumed to be reduced by 20 for this policy, and so on.

As a result of the large number of policyholders choosing this option, the overall accumulated profits have reduced significantly.

The CFO of the company has asked you to analyse the claim payments and change in profit position for XYZ as at 31 December 2020, based on data from a sample of policies. You already have the total starting profits position for the company before calculating the impact from these options and do not need to know how the profits are derived. The CFO wants you to estimate exactly how much the profits will reduce as a result of the options being availed.

The CFO has asked you to consider how the bonus amount and total profits for the company will change in the following scenarios:

1. New claim limits: The claim limit is retrospectively reduced for all policies to 90% of annual premium * term.
2. Revised bonus paid in 2020: Keeping the claim limit at the original amount, the company could alternatively request the Board and shareholders for approval on a revised bonus that is calculated as 21% of the accumulated fund value, for all cohorts of business.
3. Surrender option: The company is worried about the large number of policyholders who have availed the option. Instead of this, the company has offered an alternative option for policyholders to surrender their policies and receive 102.5% of the current fund value in all cases, which means that the profit of the company will be reduced by 2.5% of the account value. You are asked to analyse whether this improves the bonus situation if the same policyholders who availed the original option opt to surrender. Surrender value is equal to the current account value.

Information provided

You have obtained an Excel file with the necessary data. It contains a sample of the policies that were active as at the last valuation date (31 December 2020). There are, however, some concerns over the quality of the data.

The data provided is a modified extract from the administration system, and includes the following data for each policy:

- Start date: The company did not maintain the exact date of sale so we can assume for simplicity that all policies were sold at the start of each year based on the data provided
- Annual premium amount
- Policy term
- Current fund value, which is the accumulated value of invested premiums after deduction of all charges: The product specification notes that this value cannot be negative, in case all accumulated value is exhausted due to claims, the value should be set at zero and no further claims shall be paid.
- Data on which policies have elected to claim outstanding amount at end of 2020.
- Data on which policies have made claims in the past. For those policies which have not made a claim in the past, you can perform a validation to see that the accumulated value of premiums equals the provided account value.

Separately, you have sourced a record of annual investment returns per calendar year for the fund. The annual investment return figures are net of all charges in the product.

The following additional information is also provided to you:

- Formula for claim limit which is 150% of annual premium * term
- New formula for claim limit for new policies in Scenario 1: 90% of annual premium * term
- Bonus rates in 2020 for all cohorts of business
- Original profit position prior to options being availed.

The CFO has suggested you to use reasonable estimates instead of the provided data where you believe that there are errors.

Modelling

Your task is to construct a model that produces the following checks, calculations and charts:

- Perform checks on the data provided.
- Validate the current fund value of policy where there was no claim. To do this you should calculate an estimate of the current policy value using the premium, start date and fund returns, making appropriate simplifying assumptions where necessary.
- Calculate the potential payout if the option is availed, which will require working out the claims to date, on the basis of the difference between premiums accumulating based on investment returns versus the current fund value.
- Calculate the revised bonus and total profits for the company in the three additional scenarios.
- Produce a graph that compares the actual profit for all policies in the three scenarios.

Exam requirements

Q. 1) Modelling steps and data checks

Read the background document that describes the scenarios that need to be modelled and documented for this project.

Construct a spreadsheet model that produces the following calculations and charts. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed robust reasonableness checks at each stage of your calculations.

- i) Perform checks on the validity of the following data items provided in the sample policy data:
 - a) start date
 - b) annual premium
 - c) term
 - d) current fund value.

(4)
- ii) Validate the current fund value of the policies by calculating an estimate, using the sample policy data and return information provided. Make appropriate assumptions regarding the timing of returns earned on premiums paid during any given year.

(6)
- iii) Make adjustments to the data using a level of tolerance you consider to be appropriate, where the results of your checks in part (i) and calculations in part (ii) indicate the data may not be correct.

(5)

- iv)
 - a) Calculate the bonus value of each policy in the provided sample.
 - b) Estimate the total bonus for all policies.
- (4)
- v) Produce summary tables that update the results under the three scenarios. (4)
 - vi) Calculate the change in profits for the three scenarios. (6)
 - vii) Produce a suitable chart to illustrate the results in parts (iv)(b) and (vi). (3)

[**Note:** all scenarios outlined above should be modelled separately in your spreadsheet. The user should not need to change the parameters to see the results.]

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Q. 2) Modelling technique and practice

- i) Auto checks on the modelling completed in stages Q.1 (ii) to Q.1 (iv). (3)
 - ii) Demonstration of good modelling techniques and practice. (7)
 - iii) Other checks. (5)
- [15]

Q. 3) Audit trail

Produce an audit trail for your spreadsheet model that includes the following aspects:

1. Purpose of the model
2. Data, including checks, the results of the checks and any action taken as a consequence
3. Assumptions used
4. Methodology, i.e. description of how each calculation stage in the model has been produced
5. Explanation of any further 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 student, who has been asked to peer review and correct your model, to continue work on it or to use it again for a similar purpose in the future.

Marks available for audit trail:

Audit approach

- i) Communication skills (the audit trail provides enough detail to be read as a stand-alone document) (4)
- ii) Fellow student can review and check methods used in the model (6)
- iii) Senior Actuary can scrutinise and understand what has been done (7)

iv) Written in clear English (4)

v) Written in a logical order (3)

Audit content

vi) All steps clearly explained (7)

vii) Clear signposting included throughout (4)

viii) Statement of assumptions made (5)

ix) All model steps accurately covered (13)

[53]
