

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

24th March 2021

Subject CP2B – Actuarial Modelling (Paper B)

Time allowed: 3 Hour 30 Minutes (14.30 – 18.00 Hours)

Total Marks: 100

Exam Requirements

Read the background document that describes the scenarios that have been modelled and documented for this project, and the work that remains outstanding.

Read the audit trail that 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.

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

Background

Insurance regulator in the country of Indiana is considering to change the solvency regime from Factor based to Risk based approach. The regulator has engaged an actuarial firm, you work for, in assessment of the solvency capital requirements under different solvency regimes / approaches.

The regulator has asked your firm to produce required capital at time 0 (i.e. just before issuance of the policy) under three different approaches listed below:

1. Factor based approach – sum of the below
 - a. 0.2% of the sum assured
 - b. 5% of the Best Estimate Liability (BEL)
2. Sum of difference between BEL under stressed individual parameter and base scenario.
3. Difference between BEL under stressed combined parameters and base scenario.

The BEL is calculated by discounting the net cash-flows over the future lifetime of the contract, where net-cashflow is income less outgo.

Your colleague has worked on the model to calculate the capital requirement under Approach 1 and 2 above, your colleague is away on long leave and hence your manager has asked you to take the project forward. You have been provided with the model and audit trail of the work done by your colleague. You should assume that your colleague's calculations have been reviewed and are correct.

The regulator has asked to test below levels of shocks on different parameters / assumptions:

Parameter / Assumption	Level of shock
Mortality	+100% of best estimate mortality rate
Surrender	-25% of best estimate lapse rate
Interest Rate	-1% from best estimate interest rate

The regulator has asked to use below set of model point and assumptions for assessment of the capital requirement:

Age	35	Years
Gender	Male	
Number of Policies	1,000	
Annual Premium	25,000	

Initial Commission Rate	10%	of premium
Renewal Commission Rate	5%	of premium
Initial Expenses	2,000	per policy
Renewal expenses	500	per policy per annum
Annual Mortality rate	2	Per mille
Death Benefit	150,000	
Policy Term	5	Years
Premium Paying Term	5	Years
Expense inflation rate	5%	per annum from 2nd year
Surrender rate	10%	per year
Surrender Value	30%	Of total premium paid
Maturity Benefit	150,000	
Best estimate interest rate	6%	Per annum

You are required to perform the following assignments:

- Q. 1)** Determine the capital requirement under Approach 3. **[10]**
- Q. 2)** Make suitable charts to illustrate the capital requirement under three different approaches. **[5]**
- Q. 3)** Prepare a Summary document capturing the main features and the results of the work done by you and your colleague. You can assume that the summary is being prepared for your boss, who is the chief actuary of the firm.

Your Summary document should include the following:

- Purpose of the project, data, method and assumptions used by you and your colleague
- Results, including charts, if any
- Commentary on the results and the next step

The Summary should cover the full scope of the project, including the approaches that were modelled in the spreadsheet.

The Audit trail is provided below for your reference and you are not required to add or amend the Audit trail.

Marks available for the Summary:

- Methodology (including purpose, data, method and assumptions) (30)
 - Results, including charts (10)
 - Commentary on results and conclusions (20)
 - Next step (15)
 - Drafting (10)
- [85]**

Audit Trail:

Objective

The regulator in the country of Indiana is considering to bring change in the solvency regime from Factor based to Risk based approach. The capital requirement under Factor based solvency regime is calculated by applying factors over Sum assured and Best Estimate Liability (BEL). However, under Risk based approach, the capital is calculated by assessing difference in best estimate liability and liability under stressed scenario.

The spreadsheet focus on the calculation of capital requirement for the two approaches as prescribed by the regulator. The cash flows for the policy under the base and stressed scenario are projected monthly to determine the net cash-flows till the end of the policy term. The net cash flows are discounted for each of the base and stressed scenarios to determine the corresponding BEL. The difference in BEL over the base and individual stressed parameters scenarios gives rise to capital requirement that an insurance company needs to hold under Risk based approach.

Data

The Input worksheet contains all the data related to Policy parameters, Factors for solvency calculation and Shock parameters for stressed scenarios.

Assumptions

- The mortality rate is constant for all ages.
- Deaths follow constant force of mortality, where monthly mortality rate can be approximated as below:

$$\text{Monthly mortality rate} = (1 - (1 - \text{annual mortality rate})^{(1/12)})$$

- The surrender rate is constant over the term of the policy
- Surrender has been assumed to happen annually and at the end of the year.
- Discount rate is constant over the term of the policy.
- Inflation rate is constant.
- Premiums and commissions are paid annually at start of the month.
- Expenses are deducted at the start of the month.
- Renewal expenses are inflated from 13th month onwards.
- Benefits are paid at the end of the month
- Investment income has been ignored for cash flows at start of the month
- Net cash flows are calculated at the end of the month

Worksheet- Input

This worksheet stores policy details, product features, assumptions and solvency factors and stressed parameters.

Worksheet- Decrement

This worksheet uses the parameters from the Input sheet. Table 1 contains the mortality and surrender rate for the base as well as stressed scenario.

Table 2 shows the Number of Policies (NoP) at the start and end of each month.

Number of deaths (t) = NoP at start of the month (t) * monthly mortality rate (t)

Number of surrenders (t) = (NoP at start of the month (t) – No. of deaths during the month (t)) * surrender rate (t)

NoP at end of month (t) = NoP at start of the month (t) - No. of deaths during the month (t) – No. of surrenders during the month (t)

The above steps are repeated in Table 3 and Table 4 for the stressed scenarios.

Any input in the Table and checks performed in the Sheet are given in Red text.

Worksheet- Per Policy CF

This worksheet uses the parameters from the Input sheet. This worksheet contains the per policy projection till the end of the policy term for the following parameters:

- Premium
- Initial Commission – Initial Commission Rate * Annual Premium
- Renewal Commission – Renewal Commission Rate * Annual Premium
- Initial expenses
- Renewal expenses – (Renewal expenses per policy * $(1 + \text{Expense inflation rate})^{(T - 1)}$)/12 where T is the policy year
- Surrender benefit – 30% of the total premium paid
- Death benefit – 6 times of the Annual Premium
- Maturity benefit – Same as death benefit, payable at the end of the policy term

Any checks performed in the sheet are given in Red text.

Worksheet- Inforce CF

This worksheet contains the projection of in-force cash flows till the end of the policy term. The in-force cash flow is calculated by multiplying the per policy cash flow with the corresponding number of policies.

Premium cash flows are calculated by multiplying the Premium from the Worksheet “Per Policy CF” with the NoP at start of the month from the Worksheet “Decrement”.

Similar calculations have been performed for Commission and Expenses.

Surrender Outgo is calculated by multiplying Surrender Benefit from the Worksheet “Per Policy CF” with the No. of surrenders during the month from the Worksheet “Decrement”.

Death Outgo is calculated by multiplying Death Benefit from the Worksheet “Per Policy CF” with the No. of deaths during the month from the Worksheet “Decrement”.

Maturity Outgo is calculated by multiplying Maturity Benefit from the Worksheet “Per Policy CF” with NoP at the end of the policy term from the Worksheet “Decrement”.

The Net Cash flow is determined at each time step using the following formula:

$(\text{Premium} - \text{Initial Commission} - \text{Renewal Commission} - \text{Initial expense} - \text{Renewal expense} - \text{Surrender Outgo} - \text{Death Outgo} - \text{Maturity Outgo})$

The Net Present Value of the Net Cash flow Vector is determined at time 0 using the interest rate assumption from the Input Sheet to determine the Best Estimate Liability (BEL).

The BEL is determined for the base case as well as for individual stressed parameters.

Any checks performed in the sheet are given in Red text.

Worksheet- Capital Cal

Approach 1:

The capital requirement under the factor based approach is determined as the sum of capital requirement on Sum assured and BEL.

The Capital requirement on Sum assured is determined as Total Sum assured at inception of policy multiplied by the Factor 1 (% of Sum assured).

The Capital requirement on BEL is determined as Total BEL at inception of policy multiplied by the Factor 2 (% of BEL).

Approach 2:

Table -1 contains the value of BEL for Base case as well as for Individual Stressed parameters. The value of BEL has been calculated in the worksheet "Inforce_CF".

Table -2 contains the value for change in BEL under each of the stressed parameters. This is derived by subtracting the BEL between Base and individual Stressed parameters.

The sum of change in BEL will give the total capital requirements under Risk based solvency regime.
