

Actuarial Model Assignment

1. You have been commissioned to develop a model to project the assets and liabilities of an insurer after one year. This has been requested following a change in the regulatory capital requirement. Sufficient capital must now be held such that there is less than a 0.5% chance of liabilities exceeding assets after one year. The company does not have any existing stochastic models, but estimates have been made in the planning process of "worst case" scenarios.

Set out the steps you would take in the development of the model.

Ans :

- ▶ Examine the change in regulatory requirement
- ▶ Define the scope of the model, for example which factors need to be modelled stochastically.
- ▶ Plan the development of the model, including how the model will be tested and validated.
- ▶ Check diff forms of model, document the chosen approach.
- ▶ Conduct Turing tests

2. An insurance company has a block of in-force business under which policyholders have been given options and investment-related guarantees. A stochastic model has been developed which projects option and guarantee costs. You have used the model to estimate, for the Company Board, the probability of the insurance company having insufficient assets to honour the payouts under the policies. A Board member has asked whether there are any factors which could cause this probability to be inaccurate.

Outline the items you would mention in your response.

Ans : The probability for this to be inaccurate :

- 🔊 Due to pandemic/natural disasters : In case of there for example being a nipah virus outbreak since the probability of deaths is very high and the disease is very contagious a large number of people will be affected causing a sudden rise in health and life insurance claims.

Similar in case of natural disasters

- 🔊 There may be future events, such as legislative changes which affect the interpretation of the policy conditions, which have not been anticipated in the modelling.
- 🔊 There may be errors in the coding of the model or in the input data
- 🔊 **Frauds:** Due to paying many inflated claims or some major fraud scheme looting the insurance company like Haryana insurance scam

3. The government of a small country has asked you to construct a model for forecasting future mortality.
Outline the stages you would go through in identifying an appropriate model.

Ans :

- The process that would be followed to carry out the analysis is as follows:
 1. Develop a well-defined set of objectives that need to be met for forecasting future mortality. Basis on which we analyse mortality like on the basis on regions, gender, age.
 2. Plan the process and run diagnostic test to ensure model meets objectives
 3. Collect and analyse the necessary data for the model. We can collect data from death rates, GBD, past mortality rates data
 4. Define the parameters for the model and consider appropriate parameter values.
We can consider death rates, age, gender for past 20 years
 5. Define the model firstly by capturing the essence of the real-world system. Refining the level of detail in the model can come at a later stage. For this model, we can consider probability of surviving past a particular year of age, remaining life expectancy for people at different ages, proportion of the original birth cohort still living

6. Involve people with expert knowledge of the real-world system you are trying to imitate so as to get feedback on the validity of the conceptual model. Take help from national census office or government department
7. Decide on whether a simulation package or a general-purpose language is appropriate for the implementation of the model.
8. Write the computer program for the model.
9. Debug the program to make sure it performs the intended operations defined in the initial modelling process.
10. Test the reasonableness of the output from the model. We could check that it is a good fit to the actual mortality experience of the country over subsets of the last 50 years.
11. Review and carefully consider the appropriateness of the model in the light of small changes in input parameters.
12. Analyse the output from the model.
13. Ensure that any relevant professional guidance has been complied with. This may include standards on data, modelling and reporting.
14. Document the results of the model and communicate these to the government.

4. You work for a consultancy which has created an actuarial model and is now preparing documentation for the client.
List the key items you would include in the documentation on the model.

Ans:

- Instructions on how to run the model
- Diagnostic tests performed to validate the output of the model.
- Definition of input data.
- Any limitations of the model identified
- Basis on which the form of the model chosen (e.g. deterministic or stochastic)

- References to any research papers or discussions with appropriate experts.
- Summary of model results.
- Purpose or objectives of the model.
- Assumptions underlying the model.
- How the model might be adapted or extended.

5. Ten years ago, a confectionery manufacturer launched a new product, the Scrummy Bar. The product has been successful, with a rapid increase in consumption since the product was first sold. In order to plan future investment in production capacity, the manufacturer wishes to forecast the future demand for Scrummy Bars. It has data on age-specific consumption rates for the past ten years, together with projections of the population by age over the next twenty years. It proposes the following modelling strategy:

- extrapolate past age-specific consumption rates to forecast age-specific consumption rates for the next 20 years
- apply the forecast age-specific consumption rates to the projected population by age to obtain estimated total consumption of the product by age for each of the next 20 years
- sum the results to obtain the total demand for each year.

Describe the advantages and disadvantages of this strategy.

Ans :

☒ Advantages:

- The model is easy and cheap to implement.
- The model is very flexible towards different possible scenarios or can take into account future changes in the population
- The model is simple to understand and to communicate.
- The model takes account of one major source of variation in consumption rates, specifically age.

☒ Disadvantages

- This model may be suitable in the short run but the parameter being age may not be suitable in the long run
- Extrapolation of past age-specific consumption rates may be complex or difficult and can be done in different ways.
- Consumption of chocolate may be affected by the state of the economy.
- Unforeseen events such as competitors launching new products, or the nation becoming increasingly health-aware, may affect future consumption.

- It will be sensitive to price changes in the future

6. Following a review of the results of a stochastic model run, an actuary requests that a parameter is changed. The change is not expected to alter the results significantly, but results on the final basis are required in order to complete a report. Unfortunately, the actuarial student who produced the original model run is away on study leave, and so the revised run is assigned to a different student. When the revised results are produced, they are significantly different from the original results. Discuss possible reasons why the results are different.

Ans: The results may differ:

- * Maybe the assumption that the parameter would not alter the result was wrong and the parameter did affect the result a lot
- * The second trainee may not have been completely aware of maybe some minute change which the original trainee had in mind or might not have followed the procedure correct or may have used different assumptions
- * There may have been some new data between this time that second training was not aware of (so he ran the model on truncated data)
- * The difference between the two runs may not have only been the parameter change, the second run may have had fewer simulations.

7. A new town is planned in a currently rural area, A model is to be developed to recommend the number and size of schools required in the new town. The proposed modelling approach is as follows:
The current age distribution of the population in the area is multiplied by the planned population of the new town to produce an initial population distribution.
Current national fertility and mortality rates by age are used to estimate births and deaths,
The births and deaths are applied to the initial population distribution to generate a projected distribution of the town's population by age for each future year, and hence the number of school age children.
Discuss the appropriateness of the proposed modelling approach.

Ans :

- ☑ The population of the village may not remain consistent ,with the development of a new town many people from nearby rural areas may come here.The migration factor hasn't been considered
- ☑ The fertility and mortality rates vary from area to area ,in a developed country the rates may be low but may be high in under developed countries with lack of basic facilities
- ☑ The model may not be appropriate in the long term because it doesn't take into account the increasing/decreasing population which will depend on the employment opportunities there, and also willingness of parents to send their children to schools should also be taken into considerations by conducting direct surveys
- ☑ There could be sudden changes to government education policy that may require more number of schools or if children may not go to schools if due to lockdowns or some sudden events parents prefer their kids doing odd jobs than studying (from low income groups)
- ☑ The model is explained in a simple way and can be easily communicated

8. A large company wishes to construct a model of sickness rates among its employees to use in evaluating the present and future financial health of its sick pay scheme. Outline factors which the company should take into consideration when developing the model.

Ans: Factors company will take into consideration :

○ Age of employees:

Employees who are older will face higher medical expenses than the younger one

○ Departments employees work in :

Employees who work on the field like with complex dangerous machinery can have an allowance for accidental disability along with dental or hospital charges

○ Index:

look at health indices to estimate probability of various diseases affecting people

○ Minimum working days to qualify for sick pay scheme