

INTRODUCTION TO ACTUARIAL MODELS ASSIGNMENT 1

DIV: A, ROLL NO. 50

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.

The following are the steps to build the model:

- i. To begin with we would first layout the objectives we aim to achieve from this model, i.e., to change the regulatory capital requirement such that there is a 0.5% chance of the liabilities exceeding the assets in the following year.
- ii. We would then plan out how we would go about making the model and set up validation parameters for the same.
- iii. We define the inputs which are meant to be stochastic and which are not.
- iv. Collecting relevant data, referring to pre-existing models, and consulting other actuaries make up another step.
- v. We account for the sensitivity of each input of the model.
- vi. We examine the current workings of the firm and then give estimations for the worst-case scenario.
- vii. A software to build the model on is decided and the code is written and debugged.
- viii. The results that best satisfy our objectives are then presented to the clients.

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 pay-outs 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.

We can mention the following factors:

- i. The assumed scenarios could highly vary from the real-world scenarios.
- ii. There could be a possibility of extreme situation such as a global pandemic.
- iii. Changes in government policy could not have been accounted for. E.g., Demonetization.
- iv. Changes in management of the company could result in change in efficiency of the daily operations.
- v. Bad/unreliable data input could produce skewed outputs.

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.

To construct an appropriate model, we would go about the following steps:

- i. Starting off, we need to clarify the purpose of the model i.e., What is the period for which the forecast is wanted? Why does the government want a model for mortality rates? Etc.
- ii. Moving forward, we would study pre-existing models and gather past data i.e., previous mortality trends classified by gender, age and cause of death. We would then analyse the living conditions, health facilities provided to the citizens of that country, and other factors that affect the mortality of humans.
- iii. After analysing, we would start developing a model based on all the above stated factors i.e., broadly speaking, diet, living conditions, climatic conditions, etc.
- iv. Deciding on a software for building the model then jotting down the code and debugging the same.
- v. Running the code under various possible scenarios and communicating the best suited results to the clients.

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.

Steps to be followed in the documentation process:

- i. Purpose and objectives of the model.
- ii. Defining the input data.
- iii. Stating the limitations of the model.

- iv. Assumptions.
- v. References to any research papers and/or sources used.
- vi. Summary of the results.
- vii. Performing tests to validate the results.
- viii. How the model can be adapted.

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.

Advantages

- i. Since most of the data is available, this model is cost effective.
- ii. It is easy to interpret and communicate.
- iii. The past data has a high probability of being accurate and thus we don't have to spend time and energy on rectifying the data.
- iv. It accounts for the future changes in the population.

Disadvantages

- i. Preferences of people might change overtime and the model might not have accounted for it.
- ii. The proposed model has no checks for sensitivity involved.
- iii. Consumption is highly dependent on pricing, so if the pricing of the product changes, then so will the consumption.
- iv. Extrapolation might be complex.

- v. Consumption of confectioneries is elastic in nature and thus, in case of recession, consumption would decrease significantly.

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.

The results could be different because –

- i. The previous student might not have properly documented the whole procedure, leading to the new student using a completely different approach.
- ii. The documentation might have been tough to interpret.
- iii. It might be a complex model and hence the new student might not have been able to live up to the previous standards.
- iv. There might have been an error in the original model.
- v. The assumed sensitivity of the parameters could have been wrong

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.

- i. This approach is simple and easily comprehensible.

- ii. Relatively straightforward and easy to explain to developers.
- iii. Unforeseen events like a global pandemic should be accounted for.
- iv. The data provided is likely to be gathered from reliable sources.
- v. Other such towns built, should be studied and developers should be consulted.
- vi. Town developers should also account for migration.

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.

The company can account for the following in their model:

- i. Studying the past data on sick leaves taken by the employees. classified by age, gender and cause.
- ii. They can divide the employees into age bands and then calculate the probability of getting sick for each band or on the basis of positions so as to get a better view of the pay-outs required.
- iii. Severity of the diseases.
- iv. Cause of origin.
- v. Medical history of the employees.
- vi. If there is a rise in sick leaves in a specific season, e.g., monsoon, they will have to pay-out more than expected.