

INTRODUCTION TO ACTUARIAL MODELS

ASSIGNMENT 1

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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.

Since the company does not have any existing stochastic models the key steps for the development of a model are as follows

- i) Develop a well-defined set of objectives that need to be met by the modelling process. The objective in this case is to develop a model to project the assets and liabilities of an insurer after one with a change in the regulatory capital requirement such that there is less than 0.5% chance of liabilities exceeding assets after one year.
- ii) Plan the modelling process and how the model will be validated
- iii) Collect and analyze the necessary data for model. This can include the various assets and liabilities, expenses, premiums collected and various such data of the insurer.
- iv) Define the parameters for the model and consider appropriate parameter values. The parameters in this case could be the discounting rates.

- v) Define the model initially by capturing the essence of the real-world system. Refining the level of detail in the model can come at a later stage. The company can browse through various past models of different companies as a reference.
- vi) Involve the experts on the real-world system you are trying to model in order to get feedback on the validity of the conceptual model
- vii) Decide on whether a stimulation package or general purpose language is appropriate for the implementation of the model.
- viii) Write the computer program for the model
- ix) Debug the program to make sure it performs the intended operations in the model definition.
- x) Test the reasonableness of the output from the model
- xi) Review and carefully consider the appropriateness of the model in the light of small changes to the input parameters
- xii) Analyse the output from the model
- xiii) Ensure that any relevant professional guidance has been complied
- xiv) Communicate and document the results and the model.

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.

The following factors can be mentioned:

- i) There could be a possibility of outliers or extreme situations
- ii) The assumed scenarios could be vary from real world scenarios
- iii) Changes in government policies cannot be predicted
- iv) Data inputs could be skewed

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.

The stages to go through in identifying an appropriate model for forecasting future mortality are:

- i) The objectives of the modelling exercise. The objective behind the creation of the model should be clear in order to avoid confusion.
- ii) The validity of the model for the purpose to which it is to be put.
- iii) The validity of the data to be used. The data needs to be collected from a reliable and unbiased source
- iv) The validity of the assumptions taken into account like death rates
- v) The current relevance of models written and used in the past. For example, the hospital facilities in the past were not as advanced as the current times hence the death rates were much higher then

- vi) The credibility of the data input and results output
- vii) The ease with which the model and its results can be communicated
- viii) Regulatory requirements

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.

The key items to be included in the documentation of the model are as follows:

- i) Model inputs
- ii) Calculations
- iii) Assumptions
- iv) Limitations
- v) Outputs
- vi) Application of the model
- vii) Code conventions such as comments

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) The model is cost effective due to the the availability of most of the data
- ii) The past data has a higher accuracy hence we don't have to spend time rectifying the data
- iii) Easy to interpret and communicate

Disadvantages:

- i) Preference of people might change overtime and the model might not have accounted for it
- ii) Extrapolation might be complex
- iii) Consumption of such a product is highly elastic in nature. In case of recession the demand might 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 reasons why the results produced were significantly different from the original result are as follow:

- i) The original student might have made an error in the model
- ii) The documentation might have been too complex for the student to follow
- iii) The original student might not have properly documented the whole procedure causing the new student to use a different procedure
- iv) 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) The approach is simple and easy to follow
- ii) The data collected is likely to be from a reliable source like government records
- iii) The process is easy to explain to the builders and other non technical staff involved in the construction of the city
- iv) Similar past projects should be studied
- v) Real world experts should be consulted

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 factors the company should take into consideration when developing the model are:

- i) Studying the past data on sick leaves taken by employees
- ii) The probability of a person to fall sick
- iii) The employees should be divided into different age groups as older people tend to fall sick more often
- iv) Medical history of the employees
- v) Severity of the disease
- vi) If there is a rise in sick leaves during a specific season like monsoon, then the company would have to pay out more during that time
- vii) An upper limit should be set by the company for the number of paid sick leaves with an exception of critical accidents and illness