Introduction to Actuarial Models

Assignment – 1

By – Tarush Gupta

Q1.

The key steps I would take in the development of the model are:

i. *Review the regulatory guidance.*
ii. *Define the scope of the model, for example which factors need to be modelled stochastically.*
iii. *Plan the development of the model, including how the model will be tested and validated.*
iv. *Consider alternative forms of model, and decide and document the chosen approach. Where appropriate, this may involve discussion with experts on the underlying stochastic processes.*
v. *Collect any data required, for example historic losses or policy data.*
vi. *Choose parameters. For economic factors should be able to calibrate to market data. For other factors e.g. expenses, claim distributions need to discuss with staff.*
vii. *Existing worst case scenarios. Discuss with staff whom made the estimates ,especially to gauge views on the probability of events occurring.*
viii. *Decide on the software to be used for the model.*
ix. *Write the computer programs.*

x. *Debug the program, for example by checking the model behaves as expected for simple, defined scenarios.*
xi. *Test the sensitivity of the model to small changes in parameters.*
xii. *Calculate the capital requirement.*
xiii. *Communicate findings to management and document them.*

Q2,.

Items to be mentioned include:

i. *Models will be chosen which it is felt give a reasonable reflection of the underlying real world processes, but this may not turn out to be the case. (Model error.)*
ii. *The model may be very sensitive to parameters chosen, and the parameters are estimates because the true underlying parameters cannot be observed. (Parameter error.)*
iii. *Sampling error may result from running insufficient simulations. (It should be possible to give a confidence interval for the error that could result from this source.)*
iv. *The management actions assumed may not match what would happen in extreme circumstances.*
v. *Policyholder behaviour, such as take-up rates for options, may differ in practice.*

vi. 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.
vii. There may be errors in the coding of the model. The model is likely to be complex and difficult to verify completely.
viii. The model relies on input data, which may be grouped rather than being able to run every policy. Any errors in the data could cause the output to be inaccurate.

Q3.

The stages we would go through in identifying an appropriate model are :

i. Clarify the purpose of the exercise. Why does the government want forecasts of mortality? What is the period for which the forecast is wanted?
ii. Consult the existing literature on models for forecasting mortality, and speak to experts in this field of application. Consider using or adapting existing models which are employed in other countries.
iii. Establish what data are available (e.g. on past mortality trends in the country, preferably with deaths classified by age and cause of death).
iv. On the basis of what data are available, define the model you propose to use. If the data are simple and not detailed, then a complex model is

not justified. Will a deterministic or a stochastic model be appropriate in this case?

v. Identify suitable computer software to implement the model, or, if none exists, write a bespoke program.
vi. Debug the program or, if existing software is used, check that it performs the operations you intend it to do.
vii. Test the sensitivity of the results to changes in the input parameters.
viii. Analyse the output.
ix. Write a report documenting the results and the model and communicate the results and the output to the government of the small country.

Q4.

The key items I would include in the documentation on the model are :

i. Tests performed to validate the output of the model.
ii. Definition of input data.
iii. Any limitations of the model identified (e.g. potential unreliability).
iv. Basis on which the form of the model chosen (e.g. deterministic or stochastic)
v. References to any research papers or discussions with appropriate experts.
vi. Summary of model results.
vii. Name and professional qualification.

viii. Purpose or objectives of the model.
ix. Assumptions underlying the model.
x. How the model might be adapted or extended.

Q5.

Advantages of this strategy:

i. The model is simple to understand and to communicate.
ii. The model takes account of one major source of variation in consumption rates, specifically age.
iii. The model is easy and cheap to implement.
iv. The past data on consumption rates by age are likely to be fairly accurate.
v. The model can be adapted easily to different projected populations or takes into account future changes in the population.

Disadvantages of this strategy:

i. Past trends in consumption by age may not be a good guide to future trends.
ii. Extrapolation of past age-specific consumption rates may be complex or difficult and can be done in different ways.
iii. Consumption of chocolate may be affected by the state of the economy, e.g. whether there is a recession.
iv. Factors other than age may be important in determining consumption, e.g. expenditure on advertising.

v. *Consumption may be sensitive to pricing, which may change in the future.*
vi. *A rapid increase in consumption rates is unlikely to be sustained for a long period as there is likely to be an upper limit to the amount of Scrummy Bars a person can eat.*
vii. *The projections of the future population by age may not be accurate, as they depend on future fertility, mortality and migration rates.*
viii. *The proposed strategy does not include any testing of the sensitivity of total demand to changes in the projected population, or variations in future consumption trends from that used in the model.*
ix. *Unforeseen events such as competitors launching new products, or the nation becoming increasingly health-aware, may affect future consumption.*
x. *The consumption of Scrummy Bars may vary with cohort rather than age, and the model does not capture cohort effects.*

Q6.

- *One or both of the runs (the original or the new) may have been incorrect as, for example, the second trainee may not have been fully aware of the set-up (for example he or she may not have followed the procedure correctly, or may have used different assumptions).*

- The difference between the two runs may not have only been the parameter change, for example the two runs may have used different random seeds, or the second run may have had fewer simulations.
- The expectation that the model was not sensitive to this parameter could have been incorrect.

Q7.

The appropriateness of the proposed modelling approach depends on the following:

i. The model should be simple to apply.
ii. The data specified are likely to be available from reliable sources.
iii. Although it is possible that the starting point for the planned population may be wrong
iv. Unforeseen events may take place such as a national epidemic which change the rates.
v. The model is relatively straightforward to explain to the planners/developers.
vi. Should consider whether there are trends in fertility rates, rather than simply using current rates.
vii. Mortality rates unlikely to be significant relative to the uncertainty in the projection, because rates at ages with non-zero fertility rates should be small and child mortality rates should be low.

viii. Current age distribution for the area may not be representative of that for the new town as, for example, rural areas may have different distributions to urban areas

ix. Consider the type of houses being built and how they are marketing e.g. are they family houses?

x. May wish to consider experience of similar new towns.

xi. May wish to consider whether national fertility rates are appropriate for a new town, where many young families may live.

xii. Migration may affect the profile of the population, for example older families moving away and younger families buying their houses may mean the age structure remains relatively constant over time regardless of mortality and fertility rates.

xiii. The approach does not take account of non-state schooling or the possibility of children going to boarding school.

Q8.

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

i. The nature of the existing sickness data the company possesses. The model can only be as complex as the data will allow it to be.

ii. Whether the company has made any previous attempts to model sickness rates among its employees, and how successful they were.
iii. The complexity of the model, e.g. whether it should be stochastic or deterministic. More complex models will be costlier to prepare and run, but eventually there may be diminishing returns to additional complexity.
iv. General trends in sickness at the national level may need to be built in.
v. The definition of sickness and level of benefits payable under the scheme.
vi. Does the company plan to change the characteristics of the employees? For example, does it plan to recruit more mature persons?
vii. The ease of communication of the model.
viii. The budget and resources available for the construction of the model.
ix. Capability of staff. Will outside consultants be required?
x. By whom will the model be used? Will they be capable of understanding and using it?
xi. Does the model need to interface with models of other aspects of the company's business?

The independence of sickness rates should be taken into account e.g. in the event of an epidemic claims cannot be considered in.