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Assignment 1

Q1 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 0.5% chance of liabilities exceeding assets after one year. The company does not have any existing stochastic model, 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 We are required to make a cash flow projection model that has both assets and liabilities. Thus determine the capital required (mandatory). The steps that I would take in development of the model are as follows:-

- ① Define a set of objective - The objective for the same would be that a change in the regulatory capital requirement would have a sufficient capital that there is less than 0.5% chance of liabilities exceeding assets (or 99.5% probability that the assets are exceeding liabilities).
- ② The data collected should be collected and analyzed properly - The data will be available from internal sources so there is a less chance of the data being invalid. The assets and liabilities can be seen from the books to be projected in the model. (Asset Example $\rightarrow$ premiums due, land, building etc. Liabilities $\rightarrow$ claims due, commission, debt etc).
- ③ For the validity of the model we will have to set certain assumptions including the ones involving the discount rate and inflation rate. The inflation rate can be assumed to be 6-7% (range) (according to the current inflation rate). These cannot be ignored while making the model. $\rightarrow$ The end is taken at a higher rate because of the post COVID time.
- ④ The parameters that can be considered for the model are the demand for the products (help in determining the revenue), The expenses involved (commission, underwriting costs, salaries etc), The loan and debt the company owes, the pre-existing book value of assets, the interest rate of the debt, ^{warrant liability} inflation rate and which factors would affect the assets and the liabilities most (change in which factors) should also be

determined → they could include one of a event (such as a pandemic) or certain crisis in which the no. of claims would increase drastically. The inflation rate and the interest rate could also become one of the parameters for the same.

- ⑤ The model will incorporate that to incorporate real-world system with can be used on a later stage. The value of the assets and liabilities will be taken at a value including the inflation rate. Past scenarios are also required to be taken into consideration.
- ⑥ The experts ~~are~~ will also be involved in making the model. The ones who are expert in this field. For the ~~cash~~^{flow} model the advice of the CA could also be taken into consideration.
- ⑦ Random number generator will not be required for the same as the numbers (past data) will be available. The model will be made as less complex as possible. There would not be many parameters to be taken into consideration.
- ⑧ The program would be written on R or on Excel (software that could be used for the program).
- ⑨ There will be many tests and trials performed on each step (changing the rates — to check if the program is working as intended or not). The program will be debugged perfectly.
- ⑩ Extreme scenarios (if come as an output) would be rechecked and questioned. In this case we will find the worst case scenario from the scenarios available.
- ⑪ The input parameters will be changed to check the appropriateness of the model.
- ⑫ The output will be ~~analyse~~ analysed to check that it ^{meets} the object that ^{there is 99.5% probability} assets ~~don't~~ exceed liabilities to be saved from any ^{bankruptcy} ~~bank~~ the company would face.
- ⑬ The final output will be properly documented step by step and the results for the same will be properly communicated with in main incharge (i.e. the insurer).

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 options 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} ~~payments~~ under the policy policies.

A Board member has asked where ^{there} ~~the~~ are any factors which could cause the probability to be inaccurate.

Outline the items you would mention in your response.

There could be a few factors which could affect the probability to be inaccurate as follows:-

- ① The parameters that are taken into ^{many} may be incorrect or inadequate. (too many parameters taken into consideration)
 $\rightarrow$ Making a complex model.
- ② The parameters may be too sensitive.
- ③ The output ^{would} ~~could~~ not match the objective of the model. Thus making the probability inaccurate.
- ④ The random numbers taken may be inaccurate. (Problems in the modeling would lead to inaccuracy). (Sampling error).
 $\rightarrow$ (stochastic model).
- ⑤ The project options and guarantee cost taken by the policyholders may not follow the same trend as ~~it~~ it used to.
- ⑥ If there is a sudden change which is not accounted for in the model shows up then there could be a problem like the future changes such as tax laws, inflation, government rules, pandemics.
- ⑦ There may be error in the model coding and it may be difficult to identify because the model is so complex.
- ⑧ The policies are accounted for together as groups rather than individual policies so any input error may also pose a big question.
- ⑨ Some internal changes or external changes (like competitors) which are not accounted for could make the probability inaccurate.

Thus these are the factors which could cause the probability to be inaccurate.

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 that we would go through in indentifying an appropriate model are as follows:

- ① Defining a set of objective - I need to construct a model for forecasting future mortality. why does the government want forecast of morability (Purpose of the model). And the model will be used for how many years.
- ② From where the data will be collected → Check the past trends and patterns from the models available (assumption that this is not a new model). The data will most likely be provided by the government as they have a record. Thus the data is most likely to be perfect.
- ③ For the validity of the model certain assumptions will be made such as past trends, patterns, health conditions etc.
- ④ The parameters to be taken into consideration. Example No. of people, health conditions of that area, External affairs (war), etc. If there are not many parameters available then making a complex model is not justifiable.
- ⑤ The model will be based on the real-world system.
- ⑥ There will be experts involved ~~by~~ while making the model. Advice may be taken from a few Economists.
- ⑦ Identify the computer software will be used from the model.
- ⑧ Debug the program.
- ⑨ Extreme ~~scenaw~~ scenarios will also be taken into consideration.
- ⑩ The sensitivity of the results will be tested by changing the input parameters.
- ⑪ Analyse the output.
- ⑫ The final result will be properly documented and the results for the same will be communicated to the government of the small country.

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 of the model.

The key items that would be involved in the documentation of the model are as follows:-

- ① The objective of the model.
- ② Assumption that were made while making the model.
- ③ The input data.
- ④ On what basis was the model chosen (deterministic/stochastic)
- ⑤ The expert with whom the result was communicate.
- ⑥ Any externalities if taken into consideration.
- ⑦ A summary of the model.
- ⑧ Sensitivity of the model.
- ⑨ Validity of the output of the model.

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 past ten years, together with projections of the population by age over the next twenty years. It proposes the following modeling strategy:-

- extrapolate past age-specific consumption rate to forecast age-specific consumption rate for the next 20-years.
 - apply the forecast age-specific consumption rates to the projected population by age to obtain estimated total consumption of product by age for each of the next 20 years
 - Sum the results obtain the total demand for each year.
- Describe the advantages & disadvantages of this strategy

Advantages

- ① The model is simple to understand and communicate.
- ② The data is available internally thus there are no complexities in the data involved. (correct data used).
- ③ The model takes into account the future change in the population as it forecasts the future consumption rate by ~~the~~ the past age specific consumption rate.
- ④ Since the data is available internally there wouldn't be a lot of resources involved in data collection.
- ⑤ The model will be used as an advantage to the business as it is forecasting the future thus making it easy for the company to set certain reserves.

Disadvantages

- ① The trend may not be the same. (Past consumption trend may not be followed in future).
- ② Consumption may be a sensitive parameter in respect of ~~price~~ pricing the chocolate.
- ③ The company has not taken into scenario the competitors. There may be a new company that may enter into the market.
- ④ There ^{may} also ~~be~~ be other factors that determine the consumption such as taste, price, advertisement, other options available etc.

Thus these are the few advantages and disadvantages of the strategy.

- 6) Following a view of the result 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 the possible reasons why results are different.

The possible reasons for the results being different are as follows:

- ① The other student may not have ~~rep~~ replicated the model correctly or didn't understand the student's objective thus making the model revised result not match the original result.
- ② The student who created the model may have not ~~taken~~ documented the model properly making it difficult for the other student.
- ③ The model being a stochastic model the random numbers taken by the first student may not match the numbers taken by the second student (set data not used).
- ④ The parameter that was expected to bring no change to the output may have been wrong. (The data could be sensitive to the parameter used).
- ⑤ The number of simulations taken by the two students may be different.
- ⑥ The parameter that is changed may be linked to some other parameters in the model. Thus making the revised result change.

7. A new town is planned in a current 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 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 birth and death.

The births and deaths are applied to 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. The appropriateness of the proposed modelling approach can be said or discussed as:

- ① The model is clear (with the explanation it is simple). The parameters given are not too complex.
- ② The starting population number taken into account may be wrong. Thus making the model inappropriate.
- ③ Extreme conditions are not subjected in the model. Such as a war or a pandemic which would cause the lives of many people.
- ④ The data taken would be most likely from a government official website thus it will be reliable.
- ⑤ The model will be easy to communicate with others.
- ⑥ The fertility rate may follow a trend ~~with~~ and the model is only taking the current fertility rate (same with the mortality rate).
- ⑦ The national fertility and mortality rate may not be appropriate for the new town.
- ⑧ All the children ^{living in the new town} may not necessarily go to the school over there.

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

The factors that the company should take into consideration while developing the model are as follows:-

- ① Objective - model of sickness rate (use → evaluating the present and future health of its sick pay scheme).
- ② The salary of the employees.
- ③ The health / living and working conditions they are present throughout in the day.
- ④ Underlying diseases if any of them have a few.
- ⑤ The benefit that the employees will be provided under the scheme.
- ⑥ If there are any previous models made then the company may look into those models as well.
- ⑦ ~~The~~ The company may look into how complex the model is. (This could be determined by the input data and the parameters which are taken into consideration).
- ⑧ The experts that will be involved in the modelling process.
- ⑨ The software used for the model.
- ⑩ The Budget of the model. (and how easily the data is available)

There would be many other factors that would be taken into consideration.