Lecture 2

IAQS | INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Class: TY BSc

Subject : Model Documentation Analysis and Reporting

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Chapter: Unit 2

Chapter Name: Model development and documentation

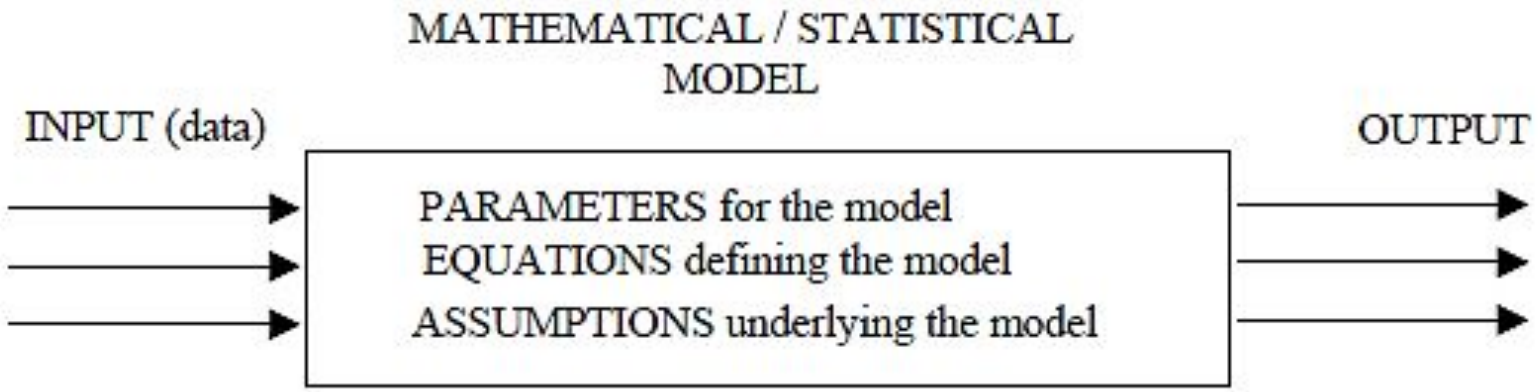
Today's Agenda

1. Model Development
    1. Developing a Model
    2. Setting up the Model

2. Audit Trail
    1. Why do an Audit Trail
    2. Contents of an Audit Trail
    3. Narrative Style
    4. Descriptive Style
    5. Guidelines for an Audit Trail

1.1 Developing a Model

For the purposes of our subject, 'developing a model' just involves formulating a mathematical specification of the situation, as illustrated in the diagram below, and then setting up a spreadsheet to carry out the required calculations.



1.1 Developing a Model

Note:
Note how the word ‘assumption’ is used in. In the office you might hear someone say ‘We need to repeat these calculations using a different assumption’, perhaps referring to a change in the interest rate. Here we would say ‘We need to repeat the calculations using a different parameter value’.

Question

Give an example of a situation where a set of mortality rates might be considered to be:
(a) a parameter of the model
(b) the data for the model

Solution

(a) A life insurer or a pension scheme would normally consider the mortality table used in the calculations to be a parameter of the model. The table is likely to be one of a small number of standard tables that they have used many times.
The data, on the other hand, would relate to the individual policyholders' or members' details, which would require careful checking.

(b) If the model involves an analysis or comparison of the mortality rates themselves, these might be considered to be the 'data' for the model. The rates for each age will be the main focus of the modelling process and there may be no other variables involved.

1.2 Setting up the Model

- It is important at the outset to decide on a suitable approach to use for the calculations and how you are going to structure your spreadsheet.
- You will need to decide the best order in which to do the tasks, how you are going to break the calculations down into separate worksheets and how you are going to accommodate the 'flexible' elements (the data set and the input parameters).
- It is also a good idea to think about ways that you can check your calculations to prevent errors creeping in.
- The aim is to produce a logically-structured flexible spreadsheet that can produce all the required results, but is simple and easy to use, and will give confidence to the user that the answers are correct.

2 Audit Trail

A good audit trail is one that allows the model to be followed by a senior actuary and to be corrected and worked on by a fellow student.

Preparing an audit trail is often referred to as ‘documenting your work’. It involves:

- describing how the spreadsheet model has been set
- explaining any important decisions and assumptions you have made
- describing how you handled any tricky issues.

2.1 Why do an Audit Trail?

- The idea is that, if you have to come back to the project at a later date, or if you are ill and a colleague has to finish off what you started or use your spreadsheet for a similar project, you/they will be able to work out very easily what was done previously, and can amend it or continue it.

- The audit trail also needs to be suitable for a senior actuary to be able to sign off the project without having to take the trouble to look at each formula in the spreadsheet to check what has been done.

- This process is particularly important in computer-based projects or programming exercises because it can be difficult to deconstruct a computer program placed in front of you if the program includes no explanation of what the various sections of the program actually do and what each variable represents.

- The financial regulators also expect companies to have effective systems and controls throughout their work. These should include detailed (and correct) documentation of any software.

2.2 Content of an Audit Trail

What should I include in the audit trail?

BACKGROUND

– a brief introduction, covering the purpose of the project, the data provided, the model used and the outputs produced

– an explanation of any special conventions used in the spreadsheet

DATA

– a description of the data provided

– a detailed description of the data preparation process

– a description of the checks / adjustments applied to the data

PARAMETERS

– a brief description of the parameters used in the model

ASSUMPTIONS

– a list of the assumptions on which the model is based

CALCULATION WORKSHEETS

– a detailed description of each calculation step in the model

RESULTS WORKSHEETS

– a description of how the results of the model were obtained

GRAPHS WORKSHEETS

– a description of any charts requested and how they were produced

2.2 Content of an Audit Trail

- For each worksheet, you need to explain what you did (including any checks you applied) and highlight any aspects that might not be obvious to another user.

- You should also describe all the reasonableness checks you applied to the data, parameter values, intermediate calculations or final results. Include these in your audit trail at the points where you applied these checks.

- A good way to describe in the audit trail what the model does is to write out and explain the key equations *in words* rather than in symbols. Imagine what you would say if you were explaining how your spreadsheet works to a colleague who was sitting next to you.

- In general, you should not include in the audit trail any detailed items that are specific to this particular project, *eg* the particular numerical values used for the parameters or copies of summary statistics or actual results, as the model needs to be flexible for future use.

- Similarly, specific observations and conclusions should not be included in your audit trail. (These would go in a separate summary report.)

2.3 Narrative Style

One possible style for an audit trail is the traditional 'school science experiment' approach, illustrated in the box below. This gives a chronological 'diary' for the project and could be described as a *narrative* style.

Example:

Audit trail (narrative style)

Step 1:	I checked the data for errors.
Step 2:	I calculated some summary statistics and the annual returns.
Step 3:	I fitted a normal distribution.
Step 4:	I carried out a chi-square goodness-of-fit test.
Step 5:	I produced a graph comparing the fitted distribution with the original data values.

2.4 Descriptive Style

Here the audit trail takes the form of a ‘user guide’ containing explanatory notes on how the spreadsheet has been used to carry out the project. Instruction manuals and official documents such as tax returns, passport application forms and insurance proposal forms, are often designed in this way.

The descriptive version of the audit trail for this example (again missing out the details) might look like this:

Audit trail (descriptive style)

Sheet 1:	The historical values of the FTSE 100 index are shown in column A.
	These are used to calculate the annual returns in column B.
Sheet 2:	The summary statistics shown on this worksheet have been calculated using standard Excel functions.
	These can be used to check for any anomalies in the data.
Sheet 3:	The sample mean and variance have been used to fit the normal distribution plotted in the graph.
Sheet 4:	This worksheet shows a comparison of actual and expected returns (derived from the normal distribution), together with the results of a chi-square goodness-of-fit test.

2.5 Guidelines for audit trails

When writing your audit trail **you should aim to:**

- start with an overview, stating the purpose the way through the project
- state the assumptions you have made and, if appropriate, why
- explain all key steps and decisions
- write one sentence, short paragraph or annotation for each item (brevity is good, but you should make certain that you get your message across)
- give a sufficiently detailed description of your spreadsheet to prevent someone who is using your audit trail (eg the examiner!) from having to 'hunt around' or 'reinvent the wheel'.

You should avoid:

- being too brief or being too detailed (eg quoting Excel formulae verbatim)
- simply repeating instructions or information from the question
- quoting 'hard-coded' question-specific details, eg parameter values or results
- including irrelevant details or 'meta-comments' (eg comments about software issues or the assessment arrangements).

Question

Criticise the audit trail below, which a student has submitted (in narrative style). How could it be improved?

Note that, if an audit trail is good, you shouldn't need to refer to the original instructions for the project – the audit trail should be self-explanatory

Audit trail

1. I checked the data.
2. Then I did the graphs. I didn't like the original colours on the graph, so I changed them a few times.
3. My computer crashed while I was working out the geometric returns and I had to reboot it twice.
4. I calculated the summary statistics using the Excel functions from the Notes.
5. The answer was 0.669.
6. I started writing a macro to count the claims, but couldn't get it to work. So I decided to write the numbers down on paper instead.
7. I assumed that a 'histogram' was the same as a bar chart. I couldn't work out how to get the normal distribution on the same graph, so I've done two seperate ones.
8. I worked out the simulated values.
9. I looked up the percentiles on page 162 of the actuarial tables.
10. I finished by typing up what I had done.

Solution

This student does not appear to have understood the purpose of an audit trail. This audit trail reads like a 'How was your day?' narrative, rather than providing a step-by-step outline of the investigations carried out. It would have been better if a descriptive style had been used.

As a result, the audit trail is far too vague. For example:

- point (1) doesn't say what data was provided or what checks were applied
- point (3) doesn't say how the geometric returns were calculated
- point (5) doesn't make it clear what the 'answer' of 0.669 relates to
- point (6) doesn't say where the paper calculations are.

The student has also 'documented' a number of irrelevant details, such as personal colour preferences in point (2) or the computer problems experienced in point (3).

Solution contd...

Solution

Point (4) simply repeats a general instruction from the question, without adding any extra information. This wouldn't help you next time if you couldn't remember the Excel functions for calculating the mean or the standard deviation.

Point (5) quotes a specific result (which was not used as a reasonableness check). This shouldn't be included in the audit trail.

In point (6) an unnecessarily complicated method has been attempted. However, the student has at least stated what was actually done.

In point (7) the word 'separate' is misspelt. There are some marks on the marking schedule for accurate presentation, so if there is consistent misspelling (*ie* mistakes that would not be acceptable in the office), this could lead to lost marks.

Point (8) doesn't say *how* the simulated values were calculated.

Point 10 is a general 'meta-comment' that doesn't add anything useful.

This audit trail does not include an explanation of the methodology used. Other important details have also been omitted, such as an overview of what the spreadsheet does or a description of any reasonableness checks applied to the results.

Question

A project involves calculating new term assurance premiums for a range of ages and terms for men and women. Suggest some reasonableness checks you could apply.

Solution

Assuming that these are annual premium contracts, you could base reasonableness checks on the following observations:

- If local legislation permits different premiums to be charged for men and women, you would expect the premium rates for the same age and term to be higher for men than for women. If not, the two sets of rates should be the same.
- You would expect the rates for a given term to increase with age.
- You would expect the rates for a given initial age to increase with the term.
- You would expect the rates to be similar to approximations calculated assuming that any deaths during the term occur halfway through the term. (This is a much simpler calculation, as it involves just one age and no summations.)
- You would expect the new rates to be broadly similar to the old rates they are replacing.

If mortality has improved over time, the new rates would be expected to be slightly lower, although other effects such as higher expenses, lower interest rate assumptions, stricter capital requirements or changes to underwriting procedures could offset this.

- The rates calculated on your spreadsheet should match any illustrated values you have been given.