INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2018

Subject CA2 – Model Documentation, Analysis and Reporting

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

Possible models with an audit trail or summary are posted on the website. It should be noted that these include more detail than would ordinarily be possible within the time allowed for the examination.

The specimen solutions are based on one possible approach to modelling the assignment set but the examiners gave credit for any alternative approach or interpretation which they considered to be reasonable.

Mike Hammer
Chair of the Board of Examiners
December 2018

A.   General comments on the *aims of this subject and how it is marked*

1. The aim of this subject is to ensure that the successful candidate can model data, document the work (including maintaining an audit trail for a fellow student and senior actuary), analyse the methods used and outputs generated and communicate to a senior actuary the approach, results and conclusions.

2. The subject is split into two papers, the first covers the objectives:

   - analysis of data.
   - development of a model with clear documentation.

   The second paper covers:

   - ability to analyse the methods used and the model's outputs.
   - ability to apply and interpret the results.
   - communication of the approach, results and conclusions to a senior actuary.

3. As the focus of the subject is on communication the majority of the marks are for the documentation and outputs generated rather than for technical modelling skills. For example, a technical mistake is only penalised once and students can still earn marks for accurate and clear communication of what was done.

4. Candidates who give well-reasoned points not in the marking schedule, are awarded marks for doing so.

B.   Comments on *student performance in this diet of the examination*

GENERAL COMMENTS

Possibly due to the change in syllabus for 2019, there were a higher number of students entering this exam than usual. However, there was a notable decrease in the quality of submissions, which may be due to students taking the exam before they have sufficient experience.

PAPER ONE

Modelling
- Most students managed to project the age progression of children correctly, and generally the cashflows were well modelled.
- There were some students who misunderstood the charge and income aspects of the use of diapers, including only one or the other in the calculations.
- Other common errors were using annual instead of monthly interest and inflation rates, or applying inflation every month instead of just once a year. Similarly, converting charges and costs from daily or weekly to monthly caused a lot of problems.

- Not many students completed the second required graph of daily fees. However, more students than usual managed to complete the modelling exercise.

Audit trail
- Most audit trails were formatted clearly and were easy to follow.
- A number of students put a lot of effort into elaborate introductions and commentary on the data provided, and then ran out of time to describe the workings of the model.
- Most students included as assumptions a lot of information provided in the background information, which didn't earn them any marks. Assumptions need to add value, and not just repeat what has been given.
- Most students included only very basic reasonableness checks, with little attempt to check that the final output was reasonable or that the scenario calculations were working properly. There were a number of checks that could be made comparing the level of income for children under and over three years old, and very few students picked up any of these.
- In general, audit trails were fairly well written, but often there was not enough detail for full marks. The description of the age progression, and how the fees for Scenario 2 maintained the ratio from Scenario 1 were two areas that were particularly lacking in detail.

PAPER TWO

Modelling
- Most students had no issue with making the required changes to the provided spreadsheet. There were two interpretations of where the boundary between a 1% charge and a zero charge, and both of these were given credit.
- Most students produced good charts, although there were some who struggled with the accumulated profit chart, using discounted profit instead.

Summary
- The methodology was generally set out well by better students, with clear explanations but sometimes lacking detail. However, a much greater proportion than usual simply copied the audit trail provided and edited out a few references to the spreadsheet. While partial credit was given in some circumstances, this is, as a rule, not appropriate, and the exam wording will make clear in future that this will not be tolerated.
- Similarly, there were a higher proportion of students who wrote the methodology section of the Summary as though it were an Audit trail. The Summary should be a standalone document that doesn't make any reference to the spreadsheet. Similarly, inserting 'reasonableness checks' which belong in the audit trail should be replaced by explaining results.
- The conclusions students drew from the charts were, on average, a little better than usual. However, they were still often rather brief and basic, focussing on the 'what' but not the 'why'. This area remains the clearest distinction between good candidates and the rest, as it shows an understanding of the assignment and an ability to communicate this.

- Most students produced plenty of next steps, but only the better students linked these clearly to the scenario in the question and explained how each step would help. Those who produced a 'scattergun' list of short one-liners earned very limited credit. The better students understood the scope of the model (a simplified pricing model for a new product) and tailored the next steps appropriately.

C.   Pass Mark

The Pass Mark for this exam was 60.

PAPER 1

Marking Guide
Q2 (i)-(vii)

(i) Correct calculation of age progression	[2]
(i) Correct calculation of the number of children in each age (by year); (1 mark) for age zero (2 marks) ages 1-4	[3]
(i) Correct calculation of the income from daily fees (1 mark) for under 3s (2 marks) for over 3s	[3]
(i) Correct calculation of the income from diapers	[1]
(i) Correct calculation of the cost of diapers	[1]
(i) Correct calculation of the cost of food	[1]
(i) Correct calculation of the cost of employees (allowing for inflation)	[2]
(i) Correct calculation of the monthly net income	[1]
(i) Correct calculation of the monthly discounted net income	[1]
(i) Correct calculation of the total discounted net income	[1]
(ii) Correct copy and update of scenario for additional childcare hours	[2]
(ii) Correct goal seek for new costs	[2]
(iv) Correct copy and update of scenario for activity charges scenario: new split of ages (1) addition of activity costs (1 for cost; 2 for updating other affected columns)	[4]
(iv) Correct goal seek for activity costs	[1]
(iii) Appropriate chart for the comparison of net income under 15 hour free childcare and 30 hour free childcare scenarios	[2]
(v) Appropriate chart to compare the total charge per day for each scenario	[3]

[Maximum 30]

Other Marks
Good spreadsheet practice (up to 7 marks)

Use of cell references rather than copy & paste	[1]
Use of parameters rather than hard-coding in formula	[1]
Flagging rows/columns that don't copy down	[1]
Use of simple techniques	[2]
Clear and accurate labelling within the spreadsheet	[2]

[Maximum 7]

Other Checks

Auto checks

Suitable auto check on children moving age bracket	[1]
Check on Goal seek under 30 hours scenario	[1]
Check on Goal seek under activities scenario	[1]

Reasonableness checks on the base and alternative scenarios (max 5):

Price charged per day under 15 hour scenario for 3year olds and over is less than original price quoted (i.e. price per week does not equal 5 days x unadjusted daily price)	[1]
Adjusted' price charged per day under 30 hour scenario for 3 year olds and over is less than 15 hour scenario/weekly fees have reduced for over 3s	[1]

Price charged per day under 30 hour scenario for under 3s is higher than 15 hour scenario	[1]
Reason why charges are different under 30 hour scenario (under 3s are compensating for 3+s)	[2]
Reason why net income higher in 30 hours versus 15 hours for early months and then lower	[1]
Reason why net income decreases over time	[1]
Reason why step in income on chart	[2]
Charges for additional activities for under 1s are the highest	[1]
Reason why charges are more expensive for younger children in additional activities scenario	[2]
Reason why activities scenario looks least favourable option	[2]
Any other sensible reasonableness check	[1]

[Maximum 8]
[Total 45]

Q3 Audit Approach

Fellow student can review & check the methods used in model:

For a newcomer, the audit trail is easy to follow i.e. the marker does not have to look at the model directly to understand what has been done	[2]
All the steps are correctly and clearly described	[1]
There is sufficient technical detail	[1]
The workbook is well labelled and is easy to navigate through	[2]
Where there are, or could be errors, the audit trail would enable the student to identify and correct errors	[1]
Danger areas in the spreadsheet are appropriately flagged (e.g. goal seek)	[1]

[Maximum 8]

Senior actuary can scrutinise & understand what has been done

A reasonable overview of the model is included	[1]
There are clear statements of the assumptions made, and justification of the values chosen	[2]
There is sufficient technical detail and does not include excessive use of Excel formulae to describe steps	[1]
Data sources are clearly described	[1]
It is easy for a senior actuary to pick up the high level detail of the modelling	[1]
Reasonableness checks are clearly stated and their results explained	[2]

[Maximum 8]

Written in clear English

The audit trail is written in clear, crisp and flowing English	[2]
Accurate spelling	[1]
The audit trail is laid out well, with good formatting to aid clarity	[1]

[Maximum 4]

Logical order:

Data is introduced before referring to it	[1]

Assumptions are stated before using them [1]

The methodology is described in a logical order i.e. nothing is introduced which would require that the reader has read ahead [1]

[Maximum 3]

Audit Content

All steps CLEARLY explained

The level of detail in the audit trail is appropriate for a newcomer to understand what has been done [1]

All the methodology steps are set out clearly [2]

Data provided and any necessary adjustments made are described and justified clearly. [1]

All reasonableness checks applied are adequately documented [1]

Areas where manual intervention or caution is required are well flagged (eg goalseeks or non-standard model areas) [1]

The marker does not need to look directly at the model to understand what has been performed [1]

[Maximum 7]

Signposting / labelling CLEAR (max 5 marks):

The audit trail allows the user to follow the model through [1]

The audit trail allows the user to understand each calculation easily [1]

There is adequate signposting in the audit trail to describe the purpose of each tab [1]

There is adequate signposting in the audit trail to describe the general direction of the model [1]

Model labelling is consistent with the audit trail (data, parameters, scenarios, outputs, charts) [1]

Up to 5 marks for including assumptions (1 for each distinct, reasonable "added value" one listed)

[Maximum 5]

Steps CORRECTLY described (max of 15)

Overview [1]

Data used, including source [1]

Calculation of Age progression [2]

Calculation of number of children in each age bracket [1]

Calculation of income items (including allowance for inflation as appropriate) [2]

Calculation of expense items (including allowance for inflation as appropriate) [2]

Calculation of discounted net income and total discounted net income [1]

Update to calculation for the 30 hours free childcare scenario (1 mark), including goal seek (1 mark) [2]

Goal seek of price to be charged under 30 hours free childcare scenario	[1]
Calculation of charges for activities for each age group	[2]
Goal seek of price to be charged for each activities	[1]
Construction of charts	[1]
Any other distinct, valid step…	[1]

[Maximum 15]
[Total 32]

PAPER 2 (Analysis and Summary)

Marking Guide
Q3 Techniques - Additional Scenario

Update to exit charge to reflect cap	[2]
Update to fund projection to reflect new fund charge	[2]
Update to product projection to reflect new fund charge	[1]
Set up trial and error / goal seek to find revised fund charge	[2]
Solve fund charge to match original profit	[1]
Check on goal seek for fund charge	[1]

[Maximum 9]

Q4 Charts

Construction of chart showing variation in profit for different terms	[2]
Construction of chart showing variation in profit for different premiums	[1]
Construction of chart showing profit and accumulated profit for the medium term medium premium policy	[3]
Construction of chart showing total expected profit before and after the exit charge cap	[2]

[Maximum 8]

Q6 Summary methodology
Purpose, Data, Approach, Assumptions

Statement of purpose	[1]
Data used & source	[1]
Data validation / review	[1]
Assumptions - up to 5 marks for a good list of "added value" assumptions	[5]
Award a total of 1 mark for restating assumptions from the Audit trail, 1 mark for new valid ones	

Projections

Allowance for mortality and exit	[1]
Projection of fund	[1]
Calculation of fund charge	[1]
Calculation of initial and recurring expenses	[1]
Calculation of charges by term (1 for premium and fund; 1 for exit)	[2]
Calculation of profit (1) and discounted profit (1)	[2]
Summary tables and total profit calculation	[1]

Alternative scenarios

Explanation of application of exit charge cap	[1]
Explanation of calculation of fund charge	[2]

Senior actuary can understand what has been done

The level of detail included is appropriate for a senior actuary	[2]
All methodology steps are set out clearly	[2]
The senior actuary would be able to understand the approach taken without having to refer to other documentation	[1]

[Maximum 5]
[Total 25]

Summary Drafting
Clear & concise drafting to give a senior actuary a good Understanding

Clear / concise drafting of the objective, and data summary/description	[1]
Clear / concise drafting of the assumptions and methodology	[1]
Clear / concise drafting of the results and conclusions	[2]
The summary report is written in clear, crisp and flowing English.	[2]
Accurate spelling	[2]
The summary is well laid out, in a reasonable order, with good formatting to aid clarity	[2]

[Maximum 10]

Results

Appropriate chart showing variation by term	[1]
Appropriate chart showing variation by premium	[1]
Table of profit percentage for nine sample policies	[1]
Statement of total profit expected in the next year	[1]
Statement of expected profit percentage in next year	[1]
Appropriate chart showing progression of profit and accumulated profit for medium term medium premium policy	[1]
Appropriate chart showing impact of capped charge on profit	[1]
Statement of profit (amount and percent) after impact of capped exit charge	[1]
Statement of fund charge required to restore profit	[1]

[Maximum 9]

Conclusions
(where Results are observed but not explained, only award 1/2 mark)

Increase in premium results in increase in profit & why (the discounted value of the charges is less than the discounted value of the costs because the costs is fixed in monetary terms whereas the charges are based on premiums and fund values)	[2]

Increase in term results in increase in profit & why (Initial cost are not term dependent so longer term is proportionately cheaper; compound interest on fund.) [2]

Increasing term increases profit more than increasing premium & why [1]

Explanation that for the high premium policy, the fact that no premium charges is offset by the higher fund charge at later years [2]

Average policy has an annual profit from year 2 onwards - first year is loss because initial charge, subsequent years charges exceed expenses) [1]

Explanation of accumulation of profit (initial expenses, break even, profitable after year 1, etc) [2]

Capping exit charge reduces profit & why a) pricing basis includes an assumption for exit rates, for each exit taking place 2 or more years before retirement, the exit charge will be lower under the government's proposal [2]

b) for exits which occur within 5 years of retirement, no exit charge will be payable (whereas under the existing approach, an exit charge is incurred between years 2 and 5) [1]

c) The lower exit charges will only reduce income for Sunset Life and there is no corresponding reduction in the charges received by Sunset Life [1]

Comment on appropriateness of replacing exit charge with higher fund charge (pushes charge later, results in penalising long-standing policyholders [2]

Comment on timing of charges vs timing of expenses - fund charge results in more back-loading of charges [2]

Change in fund charge is relatively small & why a) the increase in the fund charges received by Sunset Life later in a policy's life will be significant as fund values will be high given the length of time premiums have been received and investment returns [2]

b) the change in exit charges only impacts the policies expected to lapse. Over a 15-year period, it is expected that around 50% of the policies will lapse so the change in exit charges only impacts 50% of policies [2]

Policyholders who remain paying more in charges than those who leave early, which is perhaps an undesirable form of cross-subsidisation [1]

Post change profit for medium/medium case is higher than original & why [2]

Variation in profit is less after increase in fund charge & why [2]

Any other valid conclusion (max 3) [3]

[Maximum 19]

Next Steps

Validate the information provided particularly: [1]

    The parameters for the product [1]

    The details of the new regulation [1]

Verify that the proposed discount rate is appropriate for the Sunset Life's pricing basis	[1]
Model investment return / inflation stochastically to get a range of possible fund growth profiles	[2]
Sensitivity test product pricing basis - expenses	[1]
Sensitivity test product pricing basis - lapse rates	[2]
Validate sales figures for next year	[1]
Sensitivity test sales figures, especially balance of low / high terms & premiums	[2]
Allow for inflation and investment returns that vary over time	[2]
Increase profit by increasing premium charge (or another option which front-loads charges more	[2]
Build a more sophisticated cashflow model…	
… capable of running more model points and building a more accurate picture of the expected profit	[2]
… update the model so that premiums can vary over time or increase in line with inflation	[2]
Take into account reserving requirements to see how they may impact profitability	[2]
Consider capital strain on investments.	[1]
Consider alternative sales channels where initial expenses may be lower.	[2]
Take tax into account	[1]
Find a charging structure which maximises return to the policyholder that doesn't exit	[2]
Do market research on acceptability of increased fund charge	[2]
Consider the impact of an extreme event such as a market crash, resulting in a one off reduction of fund values or a large proportion of policyholders lapsing in any one year	[2]
Determine term at which break-even point is reached for each level of premium	[2]
Update the model as time progresses to allow for actual experience, especially for mix of actual sales	[2]
Obtain a peer review of the work performed	[1]
Any other valid next steps (max 3)	[3]

[Maximum 20]

END OF EXAMINERS' REPORT