INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2020

Subject CP2 – Modelling Practice
Core Practices

Introduction

The Examiners' Report is written by the Chief 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
September 2020

© Institute and Faculty of Actuaries

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 analyse data, develop a model, and document the work (including maintaining an audit trail for a fellow candidate and senior actuary). They should be able to 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 candidates 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.

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

6. 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.

7. 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 candidates can still earn marks for accurate and clear communication of what was done.

 @Institute and Faculty of Actuaries

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

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

PAPER ONE

Modelling

In this section the candidates could gain 31 marks by carrying out the required modelling steps and completing automatic checks on the data and results.

Most candidates managed to check the data, and find two of the three errors. Not many checked that all the policies were still active (that is, that start date + term > valuation date). The validation of the current fund value was not handled well by the majority of candidates. At heart, this was a relatively simple exercise of accumulating premiums to the valuation date, and the exam paper specifically allowed candidates a lot of leeway to make assumptions and determine their own approach. While a lot of candidates managed to present an answer, there were a significant proportion that completely misunderstood what was expected. Candidates should have consideration of the number of marks allocated to an activity and undertake work that is at a level reflective of those marks.

The calculation of the guaranteed value was generally handled better. The most common error was to calculate the guaranteed value as at the maturity date, rather than the valuation date.

There was a typographical error in the additional guidance section of the paper, where a -1 was missed out in the interest rate formula provided. Candidates in the exam generally either correct the formula themselves or use the formula given. Marks were awarded for any reasonable approach. (In addition, reasonableness checks marks were awarded for those who recognised that the results output using the incorrect formula were of an unreasonable magnitude.)

When it came to calculating the uplift required varying by three data fields, most candidates could get some of the way through this, but very few correctly calculated the uplift as the average cost of guarantee for policies that had a cost of guarantee.

This paper represented a slight change in approach, in that usually the initial sections are simpler, with a harder task at the end to challenge the stronger candidates. Whereas in this scenario part of the data checking requested was one of the more complex activities. This is why it was specifically stated that this part could be left undone and the remainder of the paper completed first. Not many candidates took this option, and as a result, the final section suffered. Candidates should read the paper carefully to ensure that they understand exactly what they are being asked for, and plan their time appropriately to maximise their chances of passing.

Audit trail

Most audit trails were formatted clearly and were easy to follow.

A number of candidates 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. Candidates should prioritise their time appropriately to ensure that their audit trails provide maximum coverage of all elements of what they've done in the model. However the importance of adequately checking the data tests should not be overlooked as it often has been in the past.

Most candidates 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 or deal with situations that aren't used. For example, a number of candidates made assumptions about policyholder behaviour and returns in the future, but the calculations only required information up to the valuation date, which was all known.

Most candidates 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. This was exacerbated by most candidates not managing to calculate the final answers. A lot of 'checks' produced are essentially just confirming that Excel is working correctly, such as doing exactly the same calculation in two different ways. A reasonableness check should be an explanation of *why* a result makes sense.

In general, audit trails were fairly well written, but often there was not enough detail for full marks. Descriptions of steps taken should cover both *what* is being done and *how* it is done.

PAPER TWO

Modelling

The modelling required involved two goal seeks – one for premium, and another for excess. The premium was handled well by the vast majority of candidates. The policy excess, however, required a change to the calculation of reserves, net claims, and claims expenses. Not many candidates managed to pick up on all of these and get full marks.

There were also a significant number of candidates who targeted the sum of accumulated profit over the year, which is a number that makes no sense at all, and delivers incorrect results. These candidates struggled to draw sensible conclusions.

Most candidates produced good charts, and scored highly in this section. As a minor point, it should be noted that good graphing style is to use line graphs for elements that change over time (such as the accumulation of profit), and bar graphs for discrete elements (such as net cashflows in each month).

Summary

The methodology was set out well by better candidates, with generally clear explanations covering most of the main steps. There is a tendency to use less detail than is expected, but this is still an area that is generally well handled.

 @Institute and Faculty of Actuaries

Despite clear instructions, there are still some candidates that simply copied the audit trail into the summary paper. These submissions were heavily penalised. There are also some candidates that write the summary in the style of an audit trail, with numerous references to the spreadsheet, although these are still on a reducing trend, which is good to see. 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.

Most candidates managed to pick out the most obvious conclusions from the results. 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. Candidates should aim to explain what they see, and find a reason for it. As an example, the drop in profit due to the reserve being introduced is easy to observe, but only the better candidates linked this to the loss of investment return on that reserve, and only a select few showed a quick calculation to prove this (roughly a £10,000 drop = a reserve of £101,000 at 10% p.a.).

Most candidates produced plenty of next steps, but only the better candidates 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 limited credit. In particular, the use of a template list of next steps can often be noticed, either by not making these relevant to the assignment, or including steps which are patently out of place. Candidates should ensure that their suggestions are relevant to the situation, and make sense as an additional area of investigation. They should also try think a bit deeper and explain the benefit one would achieve from doing this – which will ensure that they get maximum credit for each idea.

C. Pass Mark

The Pass Mark for this exam was 58.
1252 candidates presented themselves and 797 passed.

Marking Schedule

PAPER 1

Q1

i) Check policy data
   a. Premium [1]
   b. start date [1]
   c. term [1]

ii) Appropriate calculation of estimated fund value, with effort and accuracy built into the approach reflective of the marks available. Consideration should be given to:
   a. Amount and timing of premiums in the first year and hence the interest applicable to these premiums
   b. Timing of premiums in subsequent years
   c. The number of premiums to date
   d. The returns due [6]

iii) Comparison to provided value [1]
Use of tolerance to decide value to use for analysis [1]
and update [0.5]
Update of data for 3 errors found in (i) [1.5]

iv) a. Calculation of guaranteed value [2]
b. Calculate cost of guarantee per policy [1]
c. Calculate total cost of guarantee (x80 for sample impact) [1]

v) Correct allocation of fund size band [1]
Group policies by the three grouping options, and sum cost of guarantee for each subgroup [3]

vi) Calculate average cost of guarantee % for each subgroup (using averageifs) [2]
Calculate cost to company of each of the three grouping options [3]

vii) Bar chart to illustrate cost of guarantee for three grouping options compared to actual cost [3]

[Total 29]

Q2

i) Auto checks [2]

ii) Good spreadsheet practice
No hard-coding (use of parameters and no copy and paste values) [1]
Flagging rows/columns that don't copy down [1]

Easy to follow (inputs, checks and outputs easy to find) [1]
Logical order (left to right, top to bottom, within and between sheets) [1]
Clear and accurate labelling within the spreadsheet - rows, columns, worksheets [1]
Use of simple techniques (but not oversimplified) - formulae not overly complex/steps split out and calculations built up [2]

iii) Other Checks

Reasonableness checks:

- Small differences in fund value due to assuming returns apply evenly across year. [1]
- Incorrect fund values are from years 1995 and earlier [1]
- Grouping by year of issue:
  - aligns with returns, and should have lowest cost of guarantee [2]
  - years with highest cost are years with high return followed by negative [1]
  - years following large negative return have no cost [1]
- Grouping by fund value: largest funds will have longest durations in force, less likely to have cost of guarantee [1]
- Term to maturity has no bearing on current fund level: highest overall cost, all policies are uplifted [1]
- Any other sensible reasonableness check [2]

[Maximum 4]

[Total 13]

Q3 Audit Approach

i) Communication skills

- HOW the steps have been executed is clear, rather than just WHAT has been done being stated [2]
- There is sufficient technical detail and does not include excessive use of Excel formulae to describe steps [1]
- Sufficient detail is providing in the audit trail as a standalone document - does not refer references in the model [1]

[Maximum 4]

ii) 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]
- The workbook is well labelled and is easy to navigate through [1]
- Where there are, or could be errors, the audit trail would enable the student to identify and correct errors [2]
- Danger areas in the spreadsheet are appropriately flagged (e.g. goal seek) [1]

[Maximum 7]

iii) 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 i.e. concise list of value added assumptions, not long list with many not adding value [1]
- Data sources are clearly described [1]
- It is easy for a senior actuary to pick up the high level detail of the modelling - can pick up the high level without having to read all the detail [2]
- The level of detail is appropriate for a senior actuary - explanations are clear and concise [1]
- Reasonableness checks are clearly stated and their results explained [1]

[Maximum 7]

iv) 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]

v) 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

vi) 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 [2]

[Maximum 8]

vii) Signposting / labelling CLEAR:

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

[Maximum 4]

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

[Maximum 5]

ix) Steps CORRECTLY described

- Overview [1]
- Data used, including source [1]
- Data checks - checking for errors in the data (1) and Adjustment of Data (1) [2]
- Investment return for term of policy [1]
- Value of premiums in first year [1]
- Accumulation of premiums in remaining years [1]
- Current policy value [1]
- Application of tolerance (1), and choosing correct fund value (1) [2]
- Calculate Guaranteed value (1) and cost of guarantee (1) [2]
- Application of grouping options (1 for each option) [3]
- Calculation of cost of uplift for three options [2]
- Construction of charts [1]
- Any other distinct, valid step [1]

[Maximum 16]

[Total 58]
[Paper Total 100]

PAPER 2 (Analysis and Summary)

Marking Guide

1. Spreadsheet Additional Scenario **[7]**

Calculation of mitigation options

i) Correct calculation of increased policy premium:
Use of correct new premium in the formulae [1]
Calculation of the correct premium [1]

ii) Correct calculation of increase policy excess:
Update number of claims [1]
Update net claims [1]
Update claim expenses [1]
Correct calculation of new excess [1]

Inclusion of check on results [1]

[Total 7]

2. Chart Production **[11]**

i) Construction of chart showing the distribution of the claims incurred for the other insurer [2]

ii) Construction of chart for the monthly cashflows and the monthly accumulation of profit for the 2021 policy year. [4]

iii) Construction of chart showing a comparison of the monthly cashflows for the 2021 policy year before and after the allowance for the reserve requirement [2]

iv) Construction of chart showing the monthly accumulation of profit under the base scenario, allowing for the reserve requirement and each option identified. [3]

[Total 11]

3. i) Methodology (including purpose, data, approach and assumptions)
[max 25 marks]

Statement of purpose. [1]

Data provided from Never Worry insurance company (quoting source) [1]

Data provided by internal teams (quoting source) [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. Award 1 mark for any valid assumption not included in the audit.

Analyse of claims data

Analysis of minimum and maximum [1]

Average claim incurred amount is reasonable given distribution and excess [1]

Summary of Chi-squared test [1]

Cashflow analysis

Determination of various cashflows which occur in each month [2]

Projection of accumulated profit including interest [2]

Additional Reserve Requirement

Additional monthly cashflows added to projections [1]

Calculation of quantum of reserve requirement (1 mark for expected claim and 1 mark for expected number of claims) [2]

Projection of accumulated profit [1]

Mitigation options

Update cashflow analysis for new policy premium and use of goal seek [1]

Update reserve and cashflow analysis for new policy excess [2]

Determination of new policy excess using goal seek [1]

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]

ii) Results, including charts **[6 marks]**

Chart showing the distribution of the claims incurred for the other insurer [0.5]

Statement of accumulated profit at policy year end [1]

Chart showing annual cashflows and the accumulated profit for the policy year [0.5]

Chart showing comparison of the annual cashflows for the policy year [0.5]

Statement of the reduction in the accumulated profit following reserve requirement [1]

Statement of the change in policy premium [1]

Statement of change in policy excess [1]

Chart showing the accumulated profit projection under all scenarios [0.5]

iii) Conclusions **[max 22 marks]**

Where results are observed but not explained only ½ mark should be awarded, unless the mark is specifically stated to be for an observation.

Shape of graph does follow the exponential distribution. [1]

Given this shape and the positive outcome of the chi-squared test, we can conclude that Never Worry's statement that the claims data follows the exponential distribution. [1]

The net cashflows are negative in January because the initial expenses are borne by the insurance company in that month and this results in a greater outgo than the income received for that month. [2]

Subsequent cashflows are positive but quite volatile because the number of claims vary significantly month to month. [2]

Accumulated profit starts off negative due to the initial higher outgo in January but gradually increases and becomes positive as positive net cashflows are expected in subsequent months and interest is received on the fund. [2]

Under the reserve scenario, there is a larger negative cashflow in January. Between February and November, there is no change in the net cashflows as the reserve has no impact on the claims incurred or expenses. The cashflow in December increases as the

reserve is released. [2]

The positive cashflow in December is of a similar magnitude to the negative cashflow in January. [1]

The reduction in the accumulated profit is primarily a result of the interest incurred on the reserve over the year. The reserve under this scenario is $101,035 and given the discount rate of 10%, it is expected that the interest cost will be around $10,000. [2]

The accumulated profit at the end of January is significantly lower for the "with reserve" and "updated policy cost" scenarios due to the high cash outflow in relation to the reserve. [1]

For the "updated policy excess" scenario, the accumulated profit at the end of January is less negative as the reserve requirement is lower. While the expected claim incurred does not increase under this scenario, it is expected that there will be a lower number of claims. [2]

The shape of the "with reserve", "updated policy cost" and "updated policy excess" scenario curves are very similar. [1]

The "update policy cost" curve increases slightly quicker due to the higher income received each month due to the higher policy premium. [1]

As expected the accumulated profit at the end of December is the same for the "base", "updated policy cost" and "updated policy excess" scenarios. [1]

The introduction of the reserve has a significant impact on the profitability of the business. This is expected due to the size of the reserve and the high interest rate assumed. [2]

It may be easier to implement the change in the policy premium as this involves a lower proportional increase and therefore may not impact the marketability of the product significantly. [2]

AH will have to consider whether this change will not make the product competitive in the market. [1]

Any other valid conclusion [3]

iv) Next steps **[max 19 marks]**

Confirm that the data provided is representative of the expected claims that may be incurred if AH introduce this product i.e. are all the terms adopted by NW the same as those proposed by AH. [2]

Source additional data from other sources (e.g. another insurance company offering similar products or a reinsurer, if applicable) that cover a greater number of policies. [2]

Try to obtain data in relation to claims under the policy excess amount. [1]

Confirm that the expenses per policy and per claim are reasonable. [1]

Complete the Chi-squared test to a higher level of confidence. [1]

Allow for inflation between 2019 and 2021 on both the premiums and expected claim costs and expenses. [2]

Confirm that the interest rate of 10% is appropriate for this period of projection. [2]

Consider alternative scenarios such as reduced policy term, limit the number of claims, etc. to assess impact on the accumulated fund amount. [2]

Sensitivity test the results of the analysis to allow for a different interest rate or an alternative reserve formula. [2]

Sensitivity test the impact of the change in the policy premium and the policy reserve to changes to the proportion of reserve required by the Regulator. [2]

Confirm that the formula adopted for the expected claim incurred is appropriate or whether some alternative formula should be used. [2]

Determine the distribution of the number of claims incurred and complete stochastic projections using the exponential distribution for claim amounts. [2]

Project the cashflows over a longer period to consider if the product will be profitable in the longer term. [2]

Consider amending both the policy cost and the policy excess in order to mitigate the impact of the allowance for the reserve requirement. [2]

Assess whether the alternative policies have been offered in the market and investigate if they are profitable. [2]

Consider the impact on the cashflow projections if the premium is paid as an annual amount at the beginning of the year – this may enable to company to reduce premiums and given a lower premium, customers may be willing to make a one-off payment. [2]

Investigate whether the Regulator will permit the reserve to be released gradually over the policy year and update the model. [2]

Obtain a peer review of the model. [1]

Any other valid next steps [3]

v) Drafting **[10 marks]**

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]

[Total 82]
[Paper Total 100]

END OF MARKING SCHEDULE