Institute and Faculty of Actuaries

EXAMINERS' REPORT

CP2 Modelling Practice

Core Practices

Paper Two

April 2023

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.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

For some candidates, this may be their first attempt at answering an examination using open books and online. The Examiners expect all candidates to have a good level of knowledge and understanding of the topics and therefore candidates should not be overly dependent on open book materials. In our experience, candidates that spend too long researching answers in their materials will not be successful either because of time management issues or because they do not properly answer the questions.

Many candidates rely on past exam papers and examiner reports. Great caution must be exercised in doing so because each exam question is unique. As with all professional examinations, it is insufficient to repeat points of principle, formula or other text book works. The examinations are designed to test "higher order" thinking including candidates' ability to apply their knowledge to the facts presented in detail, synthesise and analyse their findings, and present conclusions or advice. Successful candidates concentrate on answering the questions asked rather than repeating their knowledge without application.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

Sarah Hutchinson
Chair of the Board of Examiners
July 2023

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

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 student 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.

The subject is split into two papers. The second, dealt with in this report, covers the objectives:

- 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.

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 be taken into consideration once and candidates can still earn marks for accurate and clear communication of what was done.

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

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

The overall difficulty of the paper was in line with the average CP2 diet.

Modelling
The modelling was well handled by most candidates.

The chart's less so. The instructions in the exam for how to structure the charts were less prescriptive than usual, and as a result, candidates needed to consider how best to present the results. This produced a wider range of quality than usual, with better candidates producing charts that told a clear story of how the profits and costs were affected by the scenarios.

Summary
The methodology was well set out by better prepared 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 well handled.

The number of candidates that copy the provided audit trail into the summary paper is thankfully low. There were still a notable number that write the summary in the style of an audit trail (with numerous references to the spreadsheet). We have repeatedly stressed that this is not the right approach, and these candidates score poorly. 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 and commenting on results.

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Conclusions were well handled, with this definitely becoming more of a focus for candidates.

Next steps struggled to get past the obvious 'check-list' items, and only the better prepared candidates branched out into items that would genuinely make a notable difference as a continuation of this assignment.

More detailed commentary is contained alongside each section of the marking schedule below.

It is strongly recommended that prospective candidates do a number of past papers and look closely at both the model solutions and the marking schedule to get a better idea of the range of conclusions and next steps which could be submitted.

C. Pass Mark

The Pass Mark for this exam was 60
1107 presented themselves and 708 passed.

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Solutions for Subject CP2-2 - April 2023

Q1
(i)
Spreadsheet Additional Scenario:
Calculation of expense and profit margin (% of revenue) for a scenario where the weather is colder:
Adjusting the survival rates [2]
Adjusting growth rates [2]
Expected profits formula to refer the adjusted survival rates & adjusted growth rates [1]

(ii)
Calculation of the level to which the monthly cost needs to come down to in order to secure the same profit margins as per the normal weather:
Create a separate monthly cost from the one used in base model [1]
Relink the expected profits to the new monthly cost [1]
Successfully run a goal seek (or other alternative) to solve for the lower expense (including suitable check) [2]
[Total 9]

*The required modelling was reasonably straightforward for this exam, and most candidates scored well, completing all the required work correctly. There were some candidates that made errors in the implementation of the 10% reduction in growth rates by applying it to growth factors (i.e. 1+ (growth rate * (1 - 10%)) instead of (1 + growth rate * (1 - 10%)). Most candidates also managed to perform the goal seek for the reduced level of expenses required.*

Q2
(i)
Chart Production:
Construction of chart showing the distribution of the natural logarithm of birth weights for suitable ln(weights) buckets. [2]

(ii)
Construction of chart showing the amounts of cost components and profit amounts under normal weather against the values under the adverse weather scenarios before and after expense reduction. [3]

(iii)
Construction of chart showing the cost components as proportions of revenue and profit margin under normal weather against the values under the adverse weather scenarios before and after expense reduction. [3]

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The charts section was less well handled as compared to the modelling. While the graph of the distribution of birth weights was generally presented well, a lot of candidates put the data into too few buckets to make a reasonable assessment of the shape of the distribution. It should also be noted that Excel's Histogram chart only includes the data from one column, and can't be used unless the data is transformed into a single column first. Candidates using this feature produced a graph that was clearly incorrect, but few picked up on this or commented on it.

The charts showing 'different types of cost and profits' gave candidates a bit of leeway to determine for themselves what elements were important. Some chose to group expenses into a single figure, leaving them with fewer conclusions to draw from the graphs.

A significant number of candidates constructed charts which showed profit elements at cohort level, despite the exam paper specifically instructing them not to do so.

Q3

(i)

Summary:

Methodology (including purpose, data, approach and assumptions)

Statement of purpose	[1]
Data used, including 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. Award 1 mark for any valid assumption not included in the audit)

Calculation of growth factors and survival probabilities	[1]
Calculation of Maturity weight (birth weight X product of growth factors)	[1]
Calculation of Expected Survival weight (maturity weight X survival probability)	[1]
Calculation of revenue (eligible weight X price per KG)	[1]
Exclusion of chinchillas with weights falling outside marketing range	[½]
Calculation of expenses (Birthing cost = No. births X cost per chinchilla)	[½]
Calculation of expenses (Feeding cost = maturity weight X cost per kg) allowing for reduction in cost for chinchillas that die)	[1½]
Calculation of expenses (Monthly cost - no. months X expense per month)	[½]
Calculation of the Profit as Revenue less all Expenses	[½]
Calculation of the Profit margin	[½]

Adverse weather scenario adjustments

survival probabilities (multiplying all survival probabilities by 92.5%)	[1]
growth factors (multiplying all growth factors by 90%)	[1]
Determination of lower monthly cost under adverse weather	[1½]

Senior actuary can understand what has been done *(maximum 7 marks)*

The level of detail included is appropriate for a senior actuary	[2½]
All methodology steps are set out clearly	[2½]
The senior actuary would be able to understand the approach taken without having to refer to other documentation	[2]

[Total 26]

(ii)

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Results, including charts:
Chart showing the distribution of the natural logarithm of birth weights for suitable ln(weights) buckets [½]
Chart showing the amounts of cost components and profit amounts under normal weather against the values under the adverse weather scenarios before and after cost reduction [½]
Chart showing the cost components as proportions of revenue and profit margin under normal weather against the values under the adverse weather scenarios before and after expense reduction [½]
Statement of the profit margin under fair weather; adverse weather before expense adjustment and; under adverse weather but after expense adjustment [1½]
Inclusion of the nominal profits under all scenarios [1]
An indication of how the monthly expense level changes under adverse weather in order to maintain the same level of profit margin as under fair weather [1]
[Total 5]

(iii)
Conclusions:
(Where results are observed but not explained only ½ mark should be awarded, unless the mark is specifically stated to be for an observation)
The distribution of natural logarithm of birth weights forms a bell shape with highest frequency around 1.15 and 1.2 [1]
This suggests a normal distribution is appropriate for the log of birth weights and therefore validating the assumption that weights follow lognormal distribution. [1]
Revenue decreased under adverse weather due to [1]
Lower growth rate and lower survival probability which results in lower maturity weights and fewer chinchillas surviving to maturity [2]
Feeding costs lower under adverse weather as this is a function of [1]
maturity weight which is lower as growth rates are expected to be lower in this scenario and the feeding costs will also be lowered as fewer chinchillas survive to maturity under adverse scenario [2]
Monthly costs remain unchanged between scenarios as these are fixed and are not impacted by weights or survival rate of chinchillas [2]
Birthing costs are unchanged as this is a based on the number of chinchillas born at the start of the season and the chinchillas born does not vary between scenarios [2]
The project makes a profit of $443 under normal weather which deteriorates to two thirds of that under adverse weather if the monthly costs remain unchanged [1]
The reduction in profit under adverse scenario shows that the reduction in feeding expenses under adverse weather is not adequate to offset the lower revenue under this scenario [2]
The profit margin under the adverse weather scenario has also reduced. The proportionate reduction of the profit and the profit margin is not the same [2]
In order for the project under adverse weather conditions to make the same profit margin as that under normal weather conditions, the monthly cost needs to reduce from $30 per month to $28.91 per month. This expense reduction together with the reduction in feeding cost will offset the impact of lower revenue in the profit margin calculation [2]
The revenue under the "adverse weather and lower expenses" scenario is the same as the adverse weather scenario. This is appropriate as there is no change to

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the growth rates or the survival probabilities [1]
Monthly costs represent a significant proportion of the revenue [1]
If expenses are not adjusted under adverse weather, the profit margins reduce significantly but remain positive [1]
Because the revenue under adverse weather is lower than under normal weather, the proportion of birthing costs is higher even though the nominal amount is the same across all scenarios [1]
The model provides some valuable insights but the actual cashflows would be Based on actual growth experience and prevailing market prices. [1]
The feeding cost as a proportion of revenue show a decrease of about 1% from 15.6% under normal weather to 14.7% under adverse weather [1]
Any other valid conclusion with the reason why

[Marks available 25, maximum 22]

(iv)
Next steps:
Validate breeding data by comparing data with market data from other farms [1]
Validate market prices and weight restriction with other sources e.g. other published sources [1]
Allow for time value of money in the cashflow [1]
Allow for inflation on expenses [1]
Verify suitability of underlying log normal distribution for the chinchillas birth weights and the parameters [1]
Use a different profit measure e.g. IRR [1]
Perform sensitivity analysis on the costs incurred by the farmer to identify how much the profits may vary [1]
Perform sensitivity analysis on the reduction in growth rates and probabilities of survival under the adverse weather conditions scenario i.e. how much will the profit change if the reduction in these rates are higher than 10% [1]
Allow for future costs/revenue from chinchillas that weigh less than 5kg or more than 6.5kgs after the 12-month period [1]
For the adverse weather scenario, investigate other remediation mechanism e.g. investigate the additional costs and impact on profit margins of raising the chinchillas in a heated environment i.e. do the heating costs outweigh benefit of generating the original level of revenue [2]
Check how competitors are dealing with variability of weather to reduce the impact on project cashflow. [1]
Is there a breed that thrives in lower temperature environment that can be kept at the farm to diversify cashflows? [1]
What other risks could affect the project. Morbidity perhaps? Expand the model to investigate how morbidity could affect the project's cashflows and together with mitigating options. [2]
Investigate the use of futures to hedge the risk of poor yield or investing in weather index which pays out in the event of cold weather and therefore smooths out the cashflows from the chinchilla project [2]
The farmer should consider lobbying the market to accept lower weight chinchillas especially when weather is adverse in order to increase the sales revenue [1]
Update the model over time with experience [1]
Can the feeding cost be reduced by growing own feed onsite? [1]

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Consider the impact of extending the breeding period under adverse weather to allow chinchillas more time to grow. [1]
Obtain a peer review of the work performed. [1]
Any other valid next steps

[Marks available 22, maximum 20]

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

[Total 10]
[Sub-Total 82]
[Paper Total 100]

Methodology

The methodology was well set out by better prepared 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 well handled. As mentioned in the Paper 1 report, it would appear that this area of the exam is improving slowly over time. However, there was a tendency to blindly follow the order of steps from the audit trail. In particular, the description of the calculation of feeding weight would have been better grouped together with the rest of the costs. The order that makes sense in the audit trail doesn't necessarily make sense in the summary, and candidates should be aware of how they structure the message of what the model does so that it is as clear as possible.

Conclusions

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 well prepared 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, many candidates noted that there was a reduction in feeding costs in the adverse weather scenario. A lot of candidates linked this to the reduction in growth rates which resulted in a lower feeding weight. Better prepared candidates pointed out that the reduction in survival probabilities had an impact here as well, as the feeding cost depends on both growth and survival. or the claims in the last few years of the data provided (or that there is notable volatility

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Next steps

Most candidates produced plenty of next steps, but only the better prepared 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 very 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. Submissions of this sort tend to score relatively poorly.

Often, suggested next steps will be areas that are already covered by the assignment, such as sensitivity testing a parameter which was changed in one of the scenarios. Mentions of an epidemic being a shock scenario were numerous, but many lacked a clear link with what impact this would have on the task at hand. 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.

END OF EXAMINERS' REPORT

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