Institute and Faculty of Actuaries

EXAMINERS' REPORT

CP2 Modelling Practice

Core Practices

Paper Two

September 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
November 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 penalised once and students 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.

It is recommended that prospective candidates attempt a number of past papers and look closely at both the model solutions and the marking schedule to get a better idea of the types of conclusions and next steps that the examiners are looking for.

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

The overall difficulty of the paper turned out to be slightly more challenging than the average CP2 diet. This was not the intention of the examiners when setting the paper. This paper asks for more charts than usually. The examiners were hoping this would give students more opportunities to explain the results. This, however, did not materialise.

Modelling
The modelling and the construction of charts were well handled by most candidates.

Not an insignificant proportion of the candidates missed the question on analysing the risk metrics split by different scenarios. Candidates who answered this question generally answered it well. The examiners would like to remind students to read the exam paper carefully.

Summary
There is a tendency to use less detail than is expected in the methodology, but this is still an area that was reasonably well handled. Better prepared candidates were able to describe what is being done at a level appropriate for the senior actuary audience.

A small number of candidates either referred to the spreadsheet (in the style of an audit trail) or copied the audit trail into the summary report. As we have repeatedly stressed in the past, this approach is heavily penalised.

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Conclusions were disappointing and less well-handled than in the previous sessions. Less prepared candidates tended to display a lack of understanding of the assignment and merely pointed out what is observed in the charts and offered little or no explanation as to what the outputs meant and communicated this appropriately.

The next steps section is an area where better prepared candidates differentiated themselves. They were able to tailor the next steps to be relevant to the scenario at hand and offer a wide range of different ideas. Less prepared candidates tended to offer the usual "check-list" such as brief statements about tax, stress scenarios or updating the model as time progresses without making any effort to make it relevant for the situation in the exam.

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

C. Pass Mark

The Pass Mark for this exam was 58.
1250 presented themselves and 714 passed.

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Solutions for Subject CP2 Paper 2 September 2023

Q1

(i)

Spreadsheet Additional Scenario :

Calculation of the nightly room rates such that Risk Metric 1 in the post-renovation scenario equals that of pre-renovation scenario:

Create a separate "Updated calc" sheet to perform goal seek [½]

Introduce new parameter for revised nightly room rates and link to new profit calculation sheet [½]

Successfully run goal seek (or other alternative) to solve for new nightly (including goal seek check worth 0.5 mark) [2]

(ii)

Calculation of the nightly room rates such that Risk Metric 2 in the post-renovation scenario equals that of pre-renovation scenario:

Create a separate "Updated calc" sheet to perform goal seek [½]

Introduce new parameter for revised nightly room rates and link to new profit calculation sheet [½]

Successfully run goal seek (or other alternative) to solve for new nightly (including goal seek check worth 0.5 mark) [1]

[Total 5]

The required additional modelling was reasonably straightforward, and this section is generally well answered.

A small number of candidates were not awarded marks by overriding the goal seek conditions for the two different goal seek scenarios in the same worksheet.

Q2

(i)

Chart Production:

Construction of chart showing the relationship between the average profits in the renovation analysis and the number of premium rooms converted [3]

(1 mark for collating data, 2 marks for graph)

(ii)

Construction of the ranked day 1 profit simulations of the post-renovation scenario [3]

(1½ mark for collating data, 1½ marks for graph)

(iii)

Construction of chart showing the utilisation rate over the course of a month for the pre-renovation and post-renovation scenarios, split by standard and premium rooms [2]

(1 mark for collating data, 1 mark for graph)

(iv)

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Construction of chart showing the monthly profits for the pre-renovation, post-renovation and post-renovation updated scenarios, split by standard and premium [3]
(1½ mark for collating data, 1½ marks for graph)

[Total 11]

This section was generally well attempted.

Most candidates were able to produce the charts as required.

Less prepared candidates might lose partial marks by using inappropriate chart types or not having clear labelling.

Whilst there is not a definitive answer to the chart type used (and any appropriate chart types would receive full credit), it is important to use charts that present the data in a clear and readable format.

Q3
(i)
Analysis:
Chart or table showing Risk Metric 1 and Risk Metric 2, split by the pre-renovation, post-renovation and the two post-renovation updated scenarios [3]

Not an insignificant number of candidates missed this question. Those who attempted this question generally answered it well. It is important to read the exam paper carefully.

Q4
(i)
Summary:
Methodology (including purpose, data, approach and assumptions)
Statement of purpose. [1]
Data used and source [1]
Data validation/review [1]
Assumptions: up to 4 marks for a good list of "added value" assumptions. [4]
(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 trail)

Description of steps:
Pre-renovation
Calculation of the capped number of rooms when demand > supply [½]
Calculation of the utilisation rate [½]
Calculation of standard rooms profits [2]
Calculation of summary statistics [½]
Calculation of Risk Metric 1 and Risk Metric 2 [1]

Renovation analysis:

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Calculations of the premium room conversion [½] for stating step size and [½] for stating constraint: # of standard room units + 2 x # of premium room units = 100 [1½]
Calculation of profits for standard and premium rooms [2]
Calculation of number of rooms available for upgrade [1] for stating demand (excess demand from standard rooms) [1] for stating supply (number of premium rooms available for upgrade) [2]

Profits from upgrades (standard room rate and premium room cost) [½]
Renovation cost [½]
Overall profit& summary statistics [½]

Post-renovation:
Calculation of profits from standard and premium rooms and upgrades [1]
Summary statistics [½]

Post-renovation (additional scenarios):
Description of goal seek goal and constraint [1 for each of the scenario] [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]

(ii)
Results, including charts:
Chart showing the relationship between average profits and the number of premium rooms converted [1]
Chart showing the utilisation rate [½]
Chart, statement or table of the standard and premium rooms rates in each of the four scenarios [1]
Chart showing the ranked day 1 profit by simulation in the post-renovation scenario [½]
Chart showing the monthly profits for the pre-renovation, post-renovation and post-renovation updated scenarios, split by standard and premium rooms [1]
Chart or table showing Risk Metric 1 and Risk Metric 2 for the four scenarios [1]
Statement that having 20 premium and 60 standard rooms is optimal [1]

(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.)
Renovation analysis:
Observation that the first part of the profit profile is upward sloping [1]
because adding premium rooms (up to a certain number) increases profit [1]
given the standard room utilisation rate has been low [1]
Observation that the second part of the profit profile is downward sloping [1]
because of diminishing marginal return [1]
When the standard rooms demand outstrips that of supply, more upgrades from standard room will be available at no extra cost, reducing profit [1]
Having 60 standard rooms and 20 premium rooms is optimal [1]

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Utilisation rate:
The utilisation rate profile is flat and fluctuates within a narrow range [1]
indicates demand doesn't fluctuate within the month [1]
Would typically expect demand to surge over the weekend but this is not observed in the chart [1]
because average is taken across each day of the month which will average weekends out over a year [1]
The utilisation rate pre-renovation is c50% [½]
which means overheads, which is a fixed cost, will eat into profits [1]
The utilisation rate post-renovation has improved [½]
implies better matching between supply and demand for both standard and premium rooms [1]
Upgrade has further improved utilisation rate of premium rooms by c2%-3% [1]
improving profit further albeit at a lower rate [1]

Profits by simulation:
Observation that the distribution is fat-tailed as few losses are significant [1]
losses happen when there is a very low demand for rooms and the hotel will incur overheads [1]
Observation that rest of the curve follows a steady upward sloping patter [1]
given the utilisation rate is broadly steady and that profits are ranked [1]
Observation that the curve eventually levels and the profit is capped [1]
this happens when the hotel is at fully capacity [1]

Analysis of monthly profits:
Pre-renovation: the hotel can meet demand most of the time [1]
thought utilisation rate remains low, limiting profits [1]
Post-renovation: standard room profit has gone down slightly [1]
even though there is no change in standard room demand [1]
This is because some guests may now be turned away given there are not as many standard rooms as before [1]
renovation cost will need to be accounted for [1]
though renovation cost is partially offset by reducing overheads wastage (the hotel needs to pay overheads on unoccupied room) [1]
Premium rooms bring in sizeable profits [1]
even though the demand for premium rooms is lower than that of standard rooms [1]
the higher premium room rate makes up for it [1]
Profits from upgrades are small but positive [1]
reflecting the fact that the occurrence of an upgrade is not very high [1]
An upgrade always make a profit, as the cost of cleaning a premium room is lower than the rate paid for a standard room [1]
Since Risk Metric 1 and Risk Metric 2 are higher than those in the pre-renovation scenario, higher prices needed to be charged in the post-renovation scenario to compensate such that the two loss metrics are no worse than before. [1]
Profits from both the RM1 and RM2 scenarios are higher than the post-renovation scenario [½]
because of the high nightly rates they are able to charge [1]

Analysis of profits and losses:

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Observation that RM2 are lower (more negative) than RM1 in all scenarios [1]
reasonable given expect RM1 only captures the 5th worst loss (VaR) whereas RM2 captures the average of the 5 worst losses (TVaR) [1]
The loss metrics are lower in pre-renovation than the post-renovation scenarios [1]
as the hotel is very unlikely to have to turn away guests and incur fixed overheads for unoccupied rooms [1]
Losses mainly come from overheads when the hotel is not sufficiently occupied [1]
Post-renovation: need to account for renovation cost, resulting in higher losses [1]
The loss metrics in the two additional scenarios are the same as those in pre-renovation as required. [1]

Conclusions:
To make sure that the losses are not worse off after renovation, the nightly room rates will have to be increased [1]
Our analysis assumed that the demand for the hotel rooms is inelastic [1]
Conclusion that the actual outcome will depend on experience, particularly of the demand assumption and whether the parameters and models used are borne out in practice. [1]
If any of these assumptions change, we would need to redo the conversion analysis to see if having 20 premium rooms in the hotel is still the optimal option. [1]
Any other valid conclusion

[Marks available 51½, maximum 21]

(iv)
Next steps:
Check that the data provided is correct and fit for purpose [1]
Verify the simulation data from an independent source [1]
Carry out a more realistic modelling of demand assumption such as modelling demand as a price-demand curve as guests demand will be price sensitive in reality [2]
Consider other factors that might affect demand, e.g. seasonality, weekends, sporting events, conferences [1]
Within the modelling, we have assumed demand is independent - in practice demand will be correlated as guests are likely to stay for more than one night and group travelling together will also affect demand in a dependent way [2]
Repeat the renovation projection in a smaller step size to find the most optimal premium to standard room split [1]
Consider if other conversion ratio for premium/standard room split is possible [1]
Consider impact to hotel during renovation, e.g., would the hotel be able to operate at normal capacity during the renovation [1]
Allow for cost of funding in modelling, e.g., allowance for debt servicing cost or cost of capital [1]
Extend the analysis for a longer time horizon. This will more likely bring out the impact of seasonality. [1]
Consider converting the rooms based on optimising the Risk Metrics or some form of risk-adjusted profits measure if risk of large potential losses is a concern [1]
Perform cashflow analysis to see if the hotel has sufficient liquidity to absorb the worst 5 average largest losses [1]
Check if modelling the average or worst five largest daily losses is a reasonable approach [1]
as largest losses tend to be fat tailed [1]

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Explore if lowering the room rates will increase profit from increased demand	[1]
Consider dynamic pricing to increase utilisation rate and profits	[1]
Check if the renovation costs cover the cost of new furniture which may need to be purchased for the bigger premium rooms after renovation	[1]
Check if the renovation costs cover the cost of labour needed for renovation	[1]
Check that such scale of renovation is allowed at the hotel premises	[1]
Model the renovation as a one-off cost rather than a per-night cost.	[1]
Check how the nightly room rates compare with similar hotels in the area and if there is any scope to increase them - it could be that by just raising the room rates, profits can be increased without the need for renovation	[1]
Stress testing - consider shock events such as wars or pandemic on occupancy and profitability	[1]
Appropriately positioned examples of sensitivity testing	[1]
Update the model with actual demand experience as it emerges	[1]
Allow for tax in the modelling of profit [½], e.g. renovation cost may be tax deductible [½]	[1]
Obtain a peer review of the model	[½]
Any other valid next steps	

(The above list is not a definitive list of next steps but represents a good range of example next steps. Each next step should be specific to the project being considered and in most cases should explain the rationale for completing the next step. More simple next steps are awarded up to 1 mark (for suggesting the next step specific to the project) whereas more complicated next steps are awarded up to 2 marks (1 mark for stating the next step specific to the project and 1 mark for stating the rationale for completing the next step).

[Marks available 27½, maximum 18]

(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 81]

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Methodology

Less well-prepared candidates tended to either copy the audit trail directly or write this section in the style of an audit trail with cell referencing to the model which is not appropriate for a summary report. Candidates need to be careful adapting the audit trail to the summary report as it serves a different purpose and audience. A summary report gives a high-level overview of the methodology for a senior actuary whilst an audit trail provides details on the actual modelling and checks primarily for a fellow student to review and a senior actuary to scrutinise.

For example, the audit trail uses symbol such as D(x,y) to denote the capped number of rooms occupied whereas it is sufficient to say "if the demand in a particular simulation is over 100, the number of standard rooms occupied will be capped at 100" in the summary report. Better prepared candidates understood these differences and were able to give clear explanations covering most of the main steps.

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'. For example, they would mention that the most optimal split of premium and standard rooms is 20/60 but would not explain why it would be less optimal to have fewer or more premium rooms (occupancy rate vs overheads trade off). Better prepared candidates really shined through by giving explanation to what is observed whilst less prepared candidates tended to do poorly by just describing the observation.

Next steps

Most candidates produced plenty of next steps, but only the better prepared candidates made them relevant to the scenario and added value. Less prepared candidates tended to come up with a template list of next steps that were either generic, repetitive, or not relevant.

Often suggested next steps will be areas that are already covered by the assignment. For example, candidates could revisit the assumptions or limitations they listed earlier in the report and consider if they could improve on or remove them by suggesting relevant next steps. Thinking deeper and explain the benefit one would achieve from doing this will ensure they get maximum credit for each idea.

[Paper Total 100]

END OF EXAMINERS' REPORT

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