

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

13 September 2021 (am)

Subject CP2 – Modelling Practice Core Practices

Paper One

Time allowed: Three hours and twenty minutes

In addition to this paper you should have available the 2002 edition of the
Formulae and Tables and your own electronic calculator.

If you encounter any issues during the examination please contact the Assessment team on
T. 0044 (0) 1865 268 873.

Exam requirements

1 Modelling steps and data checks

Read the background document, which describes the scenarios that need to be modelled and documented for this project.

Construct a spreadsheet model that produces the following calculations and charts. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed (and documented in the audit trail) reasonableness checks at each stage of your calculations.

Modelling steps:

- (i) Carry out checks on the data provided to confirm that the data is complete and fit for use. This should include analysis of the data provided to give reassurance that the data is accurate, correct and consistent with the instructions provided. [8]
- (ii) Calculate the profit for each individual flight over the year, under the current situation (base scenario) by:
- (a) calculating the income from the business class tickets and economy tickets.
 - (b) calculating the following costs:
 - fuel
 - crew salaries
 - airport fee
 - leasing of the aircraft
 - environmental tax
 - overheads.
 - (c) calculating the profit for each individual flight overall as well as split by business and economy class. [12]
- (iii) Calculate the following key profit metrics for the year:
- (a) The percentage of flights that produce a profit
 - (b) For business class and economy class separately:
 - the overall average profit per occupied seat
 - the overall profit margin as defined by JIT. [4]
- (iv) Repeat parts (ii) and (iii) for the alternative scenario. [5]
- [Sub-total 29]**

[Note: all scenarios outlined above should be modelled separately in your spreadsheet. The user should not need to change the parameters to see the results.]

2 Modelling technique and practice

Demonstration of good modelling technique and practice. [7]
[Sub-total 7]

3 Audit trail

Produce an audit trail for your spreadsheet model that includes the following aspects:

- purpose of the model
- data and assumptions used
- methodology, i.e. description of how each calculation stage in the model has been produced
- explanation of any checks performed.

You should ensure that your audit trail is suitable for both a senior actuary, who has been asked to approve your work, and a fellow student, who has been asked to peer review and correct your model, or to continue work on it, or to use it again for a similar purpose in the future.

Marks available for audit trail:

Audit approach

- | | | |
|-------|--|-----|
| (i) | Communication skills. | [4] |
| (ii) | Fellow student can review and check methods used in the model. | [7] |
| (iii) | Senior actuary can scrutinise and understand what has been done. | [7] |
| (iv) | Written in clear English. | [4] |
| (v) | Written in a logical order. | [3] |

Audit content

- | | | |
|--------|--|------|
| (vi) | All steps clearly explained. | [8] |
| (vii) | Reasonableness checks included. | [5] |
| (viii) | Clear signposting included throughout. | [4] |
| (ix) | Statement of assumptions made. | [5] |
| (x) | All model steps accurately covered. | [17] |

[Sub-total 64]
[Total 100]

Background

Just-In-Time (JIT) is an airline company. It is currently carrying out a profit review for the route between London and New York (NY) across travel classes. The airline operates this route 360 days a year with 90 days in each quarter. There are two flights per day: one flight departing from London and one departing from NY.

The airline offers two travel classes: business and economy. During the non-peak season, the business class fare is \$2,000 and the economy class fare \$500. The peak season fares are 15% and 35% higher than the equivalent non-peak business and economy class fares, respectively.

JIT defines the peak season to be the second and third quarter of each year and the non-peak season to be the first and fourth quarter. Other than the seasonal adjustment, ticket prices are fixed and do not depend on supply and demand or direction of travel.

The aircraft are configured to take 30 business class passengers and 240 economy class passengers. From past experience, JIT expects the occupancy rate for economy class to be higher than business class across all quarters.

The distance between London and NY is 3,470 miles. The planes burn 4 gallons of fuel per mile and each gallon of fuel costs \$1.30. The only other factor affecting fuel usage is wind speed, for which JIT has provided the impact as follows:

<i>Wind speed factor</i>	<i>Impact on fuel (%)</i>
-2	-30
-1	-15
0	0
1	15
2	30

[**Note:** In the 'Impact on fuel' column, negative means there is saving on fuel.]

JIT expects the journey from NY to London to be more fuel efficient, as the prevailing winds are usually from west (i.e. NY) to east (i.e. London) across the Atlantic. This implies the journey from NY to London usually has a negative wind speed factor.

Each flight needs to have a crew of 10 members: two pilots and eight cabin attendants. To comply with the relevant aviation employment law, each crew member can only fly once every 3 days. For example, if a crew member last worked on the Monday morning flight, their next flight would be on the Thursday morning. The airline currently has the minimum number of crew to meet these requirements.

The annual salary for each pilot is \$100,000 and \$20,000 for each cabin attendant.

JIT has assigned two aircraft to the NY to London route, each completing one flight a day for the 360 operational days of the year. Each aircraft costs \$200 million. The airline has a lease agreement with the aircraft manufacturer to pay the full cost of the aircraft over 25 years at a fixed interest rate of 5% p.a. This involves a fixed annual payment (in advance) for 25 years.

Each airport charges a fee every time an aircraft takes off. For London the fee is \$15,000 per take off, while for NY it is \$25,000.

The overheads (which cover the ground crew salaries, maintenance of the aircraft, insurance and other costs) are \$20,000 per flight.

Finally, there is an environmental tax imposed by the government, which is charged at 25% of the total income from tickets for each flight.

The airline has asked your company to determine the profitability of this flight route by calculating the income and costs. They have provided a data file containing reliable flight records for a period of 1 year, detailing the number of passengers in each class on each flight and the wind speed factor. JIT is confident the data provided is a good indicator of future performance.

Your manager would like you to use the information provided by the airline to determine the profit or loss in total for each individual flight over 1 year.

Where costs cannot be clearly assigned to one flight, your manager has asked that you assume that these costs can be split equally between the flights completed over 1 year.

Using these calculations, your manager would like you to calculate profit margins for business class and economy class seats to assess the **overall annual profitability**, by completing the following steps:

- (i) Determine the profit or loss attributed to business class and economy class passengers per flight, respectively.
 - For business class passengers, assume costs for the flights are 20% of the total costs for that flight.
 - For economy class passengers, assume costs for the flight are 80% of the total costs for that flight.
- (ii) Calculate the average profit per occupied seat over all flights for business class and economy class passengers, respectively.
- (iii) Calculate the overall annual profit margin for business and economy class passengers, respectively. The profit margin is defined by JIT as average profit per occupied seat divided by the average price per occupied seat.

Alternative scenario

JIT is considering modifying the route to become a business class only flight:

- Each business class seat takes up the space of three economy class seats.
- Twice as many cabin attendants are required on business class only flights compared to business and economy flights.

For these additional business class seats, JIT has asked your manager to assume the same occupancy rate as currently experienced on each flight for the economy seats (i.e. if 75% of economy seats were occupied, then 75% of the newly created business class seats would also be occupied).

Using the business fare under the original scenario, JIT would like to find out how this alternative scenario would impact the profits.

To assist with presenting the results of your analysis, your manager would like you to recalculate the profit metrics allowing for this proposed modification.

Unfortunately, your manager is currently on a plane, and cannot be contacted for the next 3 hours. They would like the above calculations finished and documented in an audit trail ready for their return.

Additional guidance:

Annuity in advance

$\ddot{a}_{\overline{n}|}$ is the value at the start of any given period of length n of a series of n payments, each of amount 1, to be made **in advance** at unit time intervals over the period.

$$\ddot{a}_{\overline{n}|} = \frac{1-v^n}{d}$$

where $v = \frac{1}{1+i}$ (i is the rate of interest) and $d = 1 - v$.

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