

INSTITUTE AND FACULTY OF ACTUARIES

April 2017

CA2: Model Documentation, Analysis and Reporting

Paper 1

Time allowed: 3 hours + 15 minutes reading time

INSTRUCTIONS TO THE CANDIDATE

1. You have 15 minutes reading time at the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have 3 hours to complete the paper.
2. You must build your model from the beginning and not use an imported e-template.

This paper contains all of the information required to complete the exam. No other files are supplied.

Your file names must include your ARN, the name of the document and the paper sat (e.g. 9000000-Summary-Paper1) and each file should contain your ARN as a header or footer.

Please note that the content of this booklet is confidential and students are not to discuss or reveal the contents under any circumstances nor are they to be used in a further attempt at the exam.

If you encounter any issues during the examination please contact the Online Education team at online_exams@actuaries.org.uk T. 0044 (0) 1865 268 255

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Exam requirements

1. Read the background document, which describes the scenarios that need to be modelled and documented for this project.
2. 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 robust reasonableness checks at each stage of your calculations.
 - (i) Produce a loan repayment schedule for an average student on course A as follows:
 - (a) Calculate their expected salary for every year of their expected future working lifetime.
 - (b) Calculate the outstanding loan at the start and end of each year, and the amount of the loan repaid during each year. [7]
 - (ii) Repeat part (i) for an average student on course B. [4]
 - (iii) Calculate the present value of each year's income net of any loan repayment (to give the discounted net income) for both an average student undertaking course A and an average student undertaking course B. [2]
 - (iv) For each year of the student's expected future working lifetime, calculate what they will have earned up to that point, in present value terms. [2]
 - (v) Produce a chart that compares the cumulative discounted net income of an average student on courses A and B, for each year of their future working lifetime. [3]
 - (vi) Produce a summary of the repayments, for an average student on course B, under both the current and alternative structures, which includes:
 - (a) the annual repayments,
 - (b) discounted annual repayments, and
 - (c) cumulative discounted annual repayments. [6]
 - (vii) Determine the percentage of salary required under the alternative structure for the total discounted repayments to equal the total discounted repayments under the current structure. [3]
 - (viii) Illustrate the cumulative repayment results from parts (vi)(c) and (vii) using a suitable chart. [3]

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

Marks available for spreadsheet model and checks:

Accurate completion of above modelling steps	[30]
Demonstration of good modelling technique and practice	[7]
Checks	[8]

[Sub-total 45]

3. Produce an audit trail for your spreadsheet model which 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 the 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

- | | |
|---|------------|
| • Fellow student can review and check methods used in the model | [8] |
| • Senior actuary can scrutinise and understand what has been done | [8] |
| • Written in clear English | [4] |
| • Written in a logical order | [3] |

Audit content

- | | |
|---|-------------|
| • All steps clearly explained | [7] |
| • Clear signposting included throughout | [5] |
| • Statement of assumptions made | [5] |
| • All model steps accurately covered | [15] |

[Sub-total 55]

[Total 100]

Background

The Dean of the Statistics Faculty (SF) at a university is considering the fees the university charges students for the two courses it offers. In particular, the Dean is concerned whether the difference in the fees fairly reflects the difference in the potential financial benefits gained after completing the courses. In addition, the Dean is considering altering the structure in which the costs of running courses are recovered.

The SF offers two courses, course A and course B. The courses require a different number of years studying and charge different fees. Research undertaken by the Dean indicates that students from each course have, on average, a different starting salary when they gain a job following completion of the courses. In addition, due to the different demands on the students during the courses, those students undertaking course A can have a part time job during their years at the university, whereas those undertaking course B cannot.

You are an actuarial student working at Statistical Analysis Ltd, an actuarial consultancy firm. The Dean has approached your boss, a qualified actuary, and asked him to provide assistance in modelling the expected income, net of fees, for an average student who has completed each of the two courses.

Course details

The Dean has provided the following course details:

- The university courses run in line with calendar years i.e. they run from 1 January to 31 December each year.
- It is expected to take 3 years to complete course A, and 5 years to complete course B.
- Annual university fees and salaries for next year are:

<i>COURSE</i>	<i>A</i>	<i>B</i>
University fees	£5,000	£10,000
Salary while at university	£5,000	-
Average starting salary on course completion*	£20,000	£25,000

** these amounts are as at the start of the students' post university job. No allowance for inflation/salary growth is required for the time the students are at university.*

- Annual university fees are not expected to change for the foreseeable future.
- Research indicates that expected annual salary growth will be 0% whilst a student is at university and 5% once they leave university.

Student loans

To fund the annual university fees, students are provided with a student loan. This loan commences at the start of the course, with the loan increasing at the beginning of each year of the course by an amount equal to the annual university fees. The outstanding loan accrues interest annually at a rate equal to price inflation.

The Dean has provided the following details of the repayment of the student loans:

- Students are expected to start a full-time job on the 1 January following the date they leave their course, and will start to repay their loans from this date.
- The repayment amount is 10% of the excess of the students' annual income above £15,000.
- Repayments are deducted from salary before making any allowance for taxes or other charges on income.
- Repayments are assumed to occur on average half way through the year.
- No interest is charged in the year in which the loan is repaid.

Your boss has asked you to model a loan repayment schedule for each of the courses the SF offers, for an average student, over their expected future working lifetime (which can be assumed to be 40 years from the date at which they start the course). The loan repayment schedule should project the amount of loan outstanding and how much should be paid off each year.

Your boss has told you that in recent years price inflation has been 2.5% p.a.

In addition your boss has asked you to compare, for the two courses, the cumulative discounted net income (i.e. the accumulated salary minus loan repayments, discounted for the effect of inflation) that an average student could expect to earn, over their expected working lifetime. These net income projections should start from the day on which a student commences a course, and the cumulative discounted net income should be expressed in today's value.

Repayment of course fees

The Dean is responsible for the SF's finances. He would like to consider changing the structure for recovering the costs of running course B.

The Dean has proposed an alternative structure under which students do not receive a loan, but instead they pay off the student loan by paying a flat percentage of their salary each year after they finish university. These payments would continue until the end of the year in which they reach 40 years old. This would replace the current loan structure.

The details of the average student who studies course B remain as outlined above, with the average age of a student starting course B being 19 years old.

Your boss has asked you to compare the present value (i.e. discounted for the effect of inflation) of the repayments made under the current loan repayment structure with those that would be received were the average student to make annual payments of 8% of their salary after they leave university.

Finally, your boss would like you to determine the percentage of salary which the average student would need to pay for the present value of the repayments under this alternative structure to be equal to the present value of repayments under the current loan repayment structure.

Unfortunately, your boss is out of the office visiting a client and cannot be contacted for the next three hours. He would like the above calculations finished and documented in the audit trail ready for his return.

END OF PAPER