

# **INSTITUTE AND FACULTY OF ACTUARIES**

## **AUDIT TRAIL**

April 2017

**CA2: Model Documentation, Analysis and Reporting**

**Paper 1**

## **Student loan repayment model**

### **Objective**

The Dean of the Statistics Faculty (SF) at a university, our client, is concerned about the fees the SF charges students for the two courses on offer. In particular, he is concerned whether the difference in fees fairly reflects the different benefits gained from completing the courses. He would also like to consider an alternative structure for the recovery of the costs of running course B. He would like our assistance projecting students' income net of fees and comparing repayments.

The purpose of this spreadsheet is to complete the following calculations:

- For courses A and B:
  - Project an average student's expected salary over their expected working life time.
  - Generate a loan repayment schedule, which involves projecting the annual increase in the loan, the repayments and the interest applied.
  - Calculate the cumulative discounted net income (accumulated salary net of fees, discounted for the effect of inflation).
- For course B, calculate the total discounted payments under the current structure and an alternative structure.
- For course B, 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.

### **Data**

The following data has been provided by the Dean at the SF, and can be found on the "Parameters" worksheet:

- Details of the courses offered and details of the average student on each course
- The average student's annual salary increases
- Details of how the student loans accrue and are repaid

Where named ranges have been defined, these are detailed in red italics alongside the relevant cells.

The data provided is assumed to be correct but should be independently verified.

## **Assumptions**

- There are no reasons to doubt the accuracy of the data. We assume therefore that the data provided is correct.
- Current levels of inflation are a good guide to future inflation.
- Course details remain the same over the course of our projections, particularly the level of fees charged.
- The structure of the loan repayments will not change over the projection period.
- University fees are payable at the start of each academic year.
- Taxes can be ignored for the purpose of our projections.
- Students are assumed to make the repayments due, no allowance for defaults.
- It is appropriate to allow for level salary increases (post university) of 5% p.a.
- Salary is expected to be paid, on average, half way through the year.
- Students are assumed to continue to repay their loans for all of their future working lifetime. No allowance for withdrawal for any reason including death.
- Students will only complete one course and therefore only have student loans for the fees of that one course.
- Under the alternative structure, students can make payments equal to a given percentage of their salary, without the need for any adjustments.

## **Method**

### **“Loan Schedule A” worksheet**

*In this worksheet the salary projections and loan repayment schedule for an average student on course A are calculated.*

For each year of the projections (years 1 to 40) an “at university?” indicator is determined in column B. If the year (in column A) is less than or equal to the duration of the course the indicator returns yes, else it returns no.

To calculate the student’s salary each year (column C), first we consider whether or not the student is at university:

- If the student is at university the salary is equal to the salary while at university as stated in the “parameters” worksheet.

- If it is the first year after the student has completed the course it returns the average starting salary.
- For all subsequent years it increases the previous year's salary by the annual increase in salary.

To calculate the loan at the beginning of the year, in column D, we first calculate the increase in the loan due to additional fees. If the student is at university the loan increases by an amount equal to the fees for the course. The loan at the beginning of year 1 is equal to the fees, the loan at the beginning of every subsequent year is equal to additional fees, where applicable, plus the loan outstanding at the end of the previous year.

Students only start to repay the student loan when they leave university therefore if they are at university repayments are equal to zero. If the student has left university then the repayment (column F) is equal to:

$$(\text{This year's salary} - \text{income above which the loan is repaid}) \times \text{percentage of income}$$

This is subject to a maximum of the loan outstanding at the beginning of the year and a minimum of zero.

The loan outstanding at the end of the year is found in column G as following:

$$\text{Loan at the beginning of the year} \times (1 + \text{inflation}) - \text{repayment} \times (1 + \text{inflation})^{0.5}$$

However, where the loan outstanding is equal to the repayment amount this is set to zero, as no interest is charged on the loan in the year the loan is repaid

#### *Reasonableness checks*

- The loan increases while the student is at university and decreases once repayments commence. This is reasonable as the interest on the loan is lower than the repayments.

### **“Loan Schedule B” worksheet**

*In this worksheet the salary projections and loan repayment schedule for an average student on course B are calculated.*

This worksheet is a copy of the “Loan Schedule A” worksheet updated as follows:

- The “at university?” indicator is calculated based on the duration of course B
- The salary calculations refer to the salary at university and average salary following the completion of the course, for course B
- The new loan amount is based on the fees for course B.

The remaining calculations are unchanged.

*Reasonableness checks*

- The loan increases while the student is at university and for the first three years after, before it begins to decrease. This is reasonable as on leaving university the loan will be higher than £50,000, and therefore the interest is in excess of £1,000 which is the amount of the first repayment. However the increase in salary and reduction in loan due to repayments being made soon means the repayments outweigh the interest.
- The loan is repaid by the end of year 30. This is later than for course A, which is reasonable given that:
  - total fees for course B are £50,000, compared to £15,000 for course A. This is over three times greater
  - repayments start later in course B due to the longer duration of the course.

These are not outweighed by the increase in the starting salary. The starting salary is higher by £5,000, which means the repayments are roughly double that on course A.

**“Income comparison” worksheet**

*In this worksheet the net income is found, discounted and accumulated. A graph comparing the cumulative net income for an average student from each course is also plotted.*

For an average student on each course this sheet calculates the following for each of the next 40 years (Course A's calculations, are in columns B to D and course B's calculations are in columns E to G):

- net income: using the data on each course's loan schedule the net income is calculated as total income – repayment of fees
- discounted net income = 
$$\frac{\text{net income}}{(1 + \text{inflation})^{(\text{year} - 0.5)}}$$
- cumulative discounted net income = sum of the discounted net income amounts from year 1 up to and including the current year

The total of both the net income and discounted net income are also found in row 3.

*Checks*

- The total of the discounted net income columns is equal to the cumulative discounted net income in year 40.

*Reasonableness checks*

- Both the total net income and the total discounted net income are higher for course B than course A. This seems reasonable as although the course fees are higher for course B than A (by £35,000), and a student studying course B will not earn anything until year 6, this is outweighed over the 40 years by the higher starting salary for an average student on course B.
- The discounted net income is higher for a student from course B as soon as the student starts earning. This is reasonable as the repayments in the first year for course B are £1,000 and therefore the net income is £29,000. By year 6 the income from course A has not yet reached £29,000.

A line graph is drawn showing the cumulative discounted net income for both courses.

*Reasonableness checks*

- The line for the income from course B is zero for the first 5 years which is reasonable as the student does not earn money while on the course.
- The line for the income from course A starts with a shallow gradient for the first 3 years before it gets steeper, which is reasonable as the student earns £5,000 p.a. while on the course before beginning to earn a salary of at least £20,000 p.a.
- The line for course B is below that of course A up until 30 years, at which point it takes over course A and then they diverge as time passes. It is reasonable for course B's line to start below course A as the students start to earn money at a later date and therefore their cumulative income will be lower. However as a student on course B is earning a higher annual amount then eventually you would expect their cumulative income to overtake that of a student on course A.

## **“Repayment comparisons” worksheet**

*This worksheet calculates the annual discounted payments for an average student on course B under the existing and alternative structures. It also determines the percentage of salary required to be paid under the alternative structure for the present value of all payments to be equal under the two structures.*

The Dean has proposed that as an alternative to the student loan with associated repayment schedule, that after leaving university students pay a percentage of their salary to the university until the end of the year in which they are 40.

This sheet copies in the “at university?” indicator and salary projections from “Loan Schedule B” in columns B and C.

Under the current structure (columns D to F):

- The repayments are copied in from “Loan Schedule B”

- These repayments are discounted and accumulated in the same way as the net income is in the “income comparison” worksheet.
- The total of the discounted repayments is found by summing all amounts in the discounted column.

Under the alternative structure (columns G to I):

- If:
  - the “at university?” indicator is “No” and
  - the average age of the student starting course  $B + \text{year} - 1 < \text{max age}$   
i.e. the student has left university and is less than or equal to 40 years old, then the student will be making a repayment to the university. This repayment is equal to the percentage salary given by the Dean multiplied by the student’s expected salary for that year.
- These repayments are discounted and accumulated as above.
- The total of the discounted repayments is found by summing all amounts in the discounted column.

The Dean would like to know what percentage of salary is required to be paid for the present value of the payments under the alternative structure to equal the present value of the repayments under the current structure. This has been found by copying the set up for the alternative structure but referring to the “target percentage” rather than the one proposed by the Dean (see columns J to L).

The target percentage is found by goal seeking the total of the discounted repayments (cell P7) to be equal to the total under the current structure (cell P5) by changing the target percentage (cell K2). A check in cell R7 highlights whether the goal seek needs re-running.

A line graph is drawn showing the cumulative discounted payments under the current structure and the two alternative structure scenarios.

#### *Reasonableness checks*

- Replacing the target percentage with 8% gives the same results in columns J to L (alternative structure – target) as observed in columns G to I (alternative structure).
- The target percentage is higher than 8% as we are wanting the students to pay back more money than they would under the alternative structure.
- The line for the current structure doesn’t reach its maximum level until later than either of the alternative structures as repayments continue beyond age 40.

- The line for the goal sought scenario is steeper than the original alternative, which is expected as the percentage is higher.
- All three lines first have a value greater than zero at year 5, which is when the students leave university.
- The lines for the goal sought scenario and the current structure scenario reach the same level, which is as expected as the aim is for them to have equal repayments.
- The lines for the percentage salary scenarios are linear whereas the original scenario is curved. This is because the payments grow faster than the salary growth (due to the minimum level of salary before payments start).

**END OF AUDIT TRAIL**