

# CAA GLOBAL

## EXAMINATION

20 October 2021 (am)

### Module 5 – Models and Audit Trails

Time allowed: Three hours and fifteen minutes

#### INSTRUCTIONS TO THE CANDIDATE

1. You are given this question paper and an Excel file.
2. Mark allocations are shown in brackets.
3. Attempt all questions. Questions are to be answered as per 'exam requirements'.

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

## Background

U-Invest is an insurance company that sells single premium investment products. The company is currently reviewing its business plan to understand better the impact of economic changes on the expected future income from its products.

You are an actuarial analyst working for CAA Consult, an actuarial consultancy firm. U-Invest has approached your boss, a qualified actuary, and asked them to perform some modelling in order to help U-Invest understand how lower investment returns, due to an economic downturn, impact the income received from management charges on its products.

## Business Planning Projections Approach

U-Invest uses a simulation approach to analyse the range of possible outcomes when assessing the expected future cashflows on their products.

For the purpose of this analysis, the portfolio of single premium investment products is modelled as a single bond. Interest is added to the portfolio value at the end of each year. The rate of interest that is added at the end of each year is determined by means of random selection, reflecting the current view of the future economic environment.

An annual management charge of 0.75% p.a. is deducted from the portfolio at the end of each year immediately after any investment return has been added.

For each simulation, the portfolio is randomly assigned a number between 0 and 1, to 4 decimal places, at the end of each year. The random number allocated will then determine the investment return that will be added to the portfolio value at the end of each year.

The current investment return assumptions are:

<i>Allocated random number</i>		<i>Investment return p.a. (% of portfolio value)</i>
<i>From</i>	<i>To</i>	
0.0000	0.1999	-2
0.2000	0.3999	-1
0.4000	0.5999	0
0.6000	0.7999	2
0.8000	1.0000	4

The Risk Director of U-Invest believes an alternative distribution of investment returns would better reflect the likely distribution of investment returns in light of the current economic uncertainty. In particular, they believe that for the next 5 years investment returns will be more volatile before returning to the current investment return assumptions.

The proposed investment return assumptions for the next 5 years are:

<i>Allocated random number</i>		<i>Investment return p.a. for the first 5 years of the projection. (% of portfolio value)</i>
<i>From</i>	<i>To</i>	
0.0000	0.1999	-4
0.2000	0.3999	0
0.4000	0.5999	2
0.6000	0.7999	4
0.8000	1.0000	10

### **Additional information**

U-Invest has provided the following additional information to allow you to produce the required analysis:

- The current portfolio value is \$2,500,000.
- For the purpose of this analysis the portfolio should be modelled over a 20-year period.
- An annual management charge of 0.75% p.a. of the portfolio value is applied. This is deducted from the portfolio value at the end of each year immediately after any investment return has been added.
- The only factors that impact on the value of the portfolio are the investment return applied and the annual management charges deducted.
- You may assume that there is no new business and no withdrawals or surrenders allowed prior to the end of the projection period.
- An Excel model that sets out 4,000 random simulations from a uniform  $U[0,1]$  distribution has been provided. These represent the random numbers to be used to determine the investment returns for 200 simulated portfolios over the next 20 years. Each row of data represents the simulations for each of the 200 model portfolios. Each column represents a projection year, from 1 to 20.

### **Part 1**

- (i) Construct a spreadsheet model to include separate worksheets for the data, parameters, projected portfolio values based on current investment returns, projected fund values based on proposed investment returns, charts and any other worksheets as required. [2]
- (ii) Carry out a range of checks on the simulated probability data provided and comment on whether the data appears to be sensible, given the information that has been provided. You are NOT required to make any alterations to the data. [5]

- (iii) Produce a table of the simulated investment return rates at the end of each of the 20 years for the 200 simulated portfolios using the simulated probability data and current investment return rates provided, in the current investment returns worksheet. [3]
- (iv) Produce 200 sets of projections to determine the expected value of each simulated portfolio at the end of each of the 20 years using the expected investment returns determined in part (iii) and the annual management charge information provided. [3]
- [**Note:** See the additional guidance on how to calculate the expected portfolio value.]
- (v) Rank the 200 simulated portfolio values in ascending order, from 1 to 200, based on the projected values of each portfolio at the end of the 20-year period. [2]
- (vi) Identify the simulations ranked 50th, 100th and 150th. Construct, in a separate worksheet, a suitable chart to illustrate the projected portfolio value at the end of each year over the term of the projection for each of these three simulations. [4]
- (vii) Calculate, in the current investment return worksheet, for each of the 200 projections, the effective annualised returns after the management charges over the 20-year period. [2]
- (viii) Calculate the total management charge income, for each of the 200 projections over the 20-year period. [1]
- (ix) Determine, over all 200 projections:
- (a) the minimum total management charge income.
  - (b) the maximum total management charge income.
  - (c) the mean total management charge income. [3]
- (x) Repeat the calculations in steps (iii) to (viii) using the proposed investment return assumptions, in the proposed investment returns worksheet. [8]
- (xi) Determine, using Goal Seek or otherwise, the level of annual management charge using the proposed investment returns that produces a mean total management charge income equal to the mean total management charge income using the current investment returns. [2]
- (xii) Construct a suitable chart to illustrate the maximum, minimum and mean total management charge income for both the current and proposed investment return projections. [3]

***Marks available for spreadsheet model:***

- Model accuracy, completeness and good modelling techniques and data validation of initial data (part (ii)) [38]
  - Reasonableness and automated checks, other than in part (ii) [4]
- [Sub-total 42]**

## Part 2

You need to document all your work in an audit trail so that a fellow analyst student (with similar experience to yourself) could:

- peer review and check your model.
- continue to work on your model.
- run your model on different assumptions or extend your model to allow for extra data fields or scenarios.

Your audit trail should include the following aspects:

- the purpose of the model
- a description of the data used
- any assumptions you have made
- any limitations of your assumptions or of the model
- your methodology, i.e. a description of what you have done to calculate the required values, and how and where in the model you have done it
- an explanation of all the checks you have performed
- your key results
- a description of the charts you have produced.

The audit trail should be in a separate Word document.

### ***Marks available for audit trail:***

#### *Audit approach*

- Fellow analyst student can review, check and modify the model [8]
- Written in clear English [4]
- Written in a logical order. [3]

#### *Audit content*

- All model steps accurately included [21]
- All checks clearly recorded [8]
- All steps clearly explained [8]
- Clear signposting and labelling. [6]

**[Sub-total 58]**

**[Total 100]**

## **Additional guidance**

### ***Expected Portfolio Value***

The Expected Portfolio Value ( $f(t)$ ) at the end of the year  $t$  can be calculated using the following relationship:

$$f(t) = f(t-1) \times (1 + i) \times (1 - amc)$$

where:

$f(t-1)$  is the expected portfolio value at the end of year  $t-1$ .

$i$  is the investment return p.a. (% of portfolio value).

$amc$  is the annual management charge p.a. (% of portfolio value).

### ***Useful Excel functions***

The RANK() function in Excel can be used to return the ranking of a cell in an unsorted array of numbers. For example, RANK(cell, array, 0) will return the ranking that the number in the given cell would have if the (unsorted) array was sorted into descending order. RANK(cell, array, 1) will take a similar approach but assuming it was sorted into ascending order.

The GOALSEEK function in Excel can be used to determine the input values needed to achieve a specific goal. In the Data Tools group of the Data menu tab, GOALSEEK may be found in the What-If Analysis menu. It allows you to set a chosen cell to a specified value by altering a given input value.

**END OF PAPER**