

Audit trail – Economic Uncertainty

Objective

Given a set of simulated random draw results, the objective was to analyse the investment returns on 200 simulated portfolios using two different investment return assumptions and determine the level of annual management charge which results in both structures providing the same expected total management charge income.

Investment returns are applied to each portfolio based on the result of a random selection at the end of each year according to a defined investment return structure.

Worksheet - Data

The workbook takes the raw data and performs a range of checks on it. Where any issues have been noticed, a note has been made to check those results although no data changes have been made here.

We have been informed that the simulation data provided is from a U[0,1] distribution. The validity of this assumption has been assessed through a number of checks on the data.

Finally, the results are summarised in tables and charts in the Charts tab at the end of the workbook

The simulated random numbers from a U[0,1] distribution were provided directly by U-Invest in the format given.

There are 200 rows, each representing a single portfolio, with the values for each of the 20 columns representing the outcomes of the random selection at the end of each year for the next 20 years.

Assumptions

The data is assumed to be correct, subject to the potential issues noted in the data checking exercise. No changes have been made to the data for the purposes of this project. Interest is applied at the end of each year

Annual Management Charges are applied at the end of each year immediately after any interest has been applied.

The term of each projection is 20 years, with no new business, withdrawals or early surrenders possible

Data Validation

The data checks have been performed within the Data Validation tab

The following checks have been done:

- that the total number of data items is 4000 (200 x 20)
- mean value equal to 0.5 (expected mean if data from a U[0,1] distribution as expected)
- standard deviation equal to 0.289 (expected standard deviation if data from a U[0,1] distribution as expected)
- the minimum and maximum values (checked no values lower than 0 and none greater than 1)
- simulated values plotted on a chart to verify that values uniformly distributed in the range 0 to 1

As a result of these validations, the data appears to be from a U[0,1] distribution.

Note - any changes that are subsequently made as a result of these checks should only be made once, within the data sheet.

Worksheet - Parameters

This sheet sets out all the parameters used within the calculations, including:

- the initial portfolio value, used to give the value of each simulated portfolio at time 0 (*initial_value*)
- the current annual management charge (*amc*)
- the current investment return assumptions (*original_projection*)
- the alternative investment return assumptions for the initial period of the alternative projection (*alternative_projection*)
- the initial period for which the alternative projection assumptions are used in the alternative projection, prior to reverting back to the current investment return assumptions (*alternative_projection_initial_period*)

Worksheet - Current Investment Returns

The purpose of this worksheet is to simulate the investment returns each year and project portfolio values for 200 simulated portfolios under the original investment return assumptions and determine the total management charge income for each simulation.

This worksheet starts by referencing the data from the data sheet.

The first table (Table 1) calculates the investment return for each portfolio at the end of each year.

For each row and column, a VLOOKUP function is used to return the level of investment return by comparing the random number, representing a random economic outcome each year for each portfolio, to the investment return breakdown given in the named range *original_projection*.

At the bottom of this table a series of checks are included to confirm that the maximum and minimum returns are within the expected range (no smaller than the minimum and no greater than the maximum return as set out in the parameters tab). In each case the returns are within the expected range for each projection year.

A check is also included to check that the average return over all 200 simulations for each year is within 0.5% of the expected return. This check is successful for each projection year.

The second table (Table 2) uses these investment return amounts to project the value of each portfolio.

The value of each portfolio at time 0 is given by the parameter *initial_value*.

At time 1 and all subsequent time periods the value of each portfolio is given by the value at the end of the previous year multiplied by (1+investment return) as calculated in Table 1.

The annual management charge is also deducted from the portfolio value at the end of each year by multiplying this value by (1 - annual management charge), where the annual management charge is given by the parameter with named range *amc*.

In column AV the projected portfolio values at the end of the 20 year period are ranked into ascending order by value from 1 to 200 using the RANK function.

In column AX the total management charge income is over the 20 year period, representing the income received by the company from annual management charges, is calculated for each of the 200 portfolios as $\text{Sum}(\text{Projected Value at } t= 1 \text{ to } 20) \times \text{amc} / (1-\text{amc})$.

Columns AZ:BA provides summary statistics for the total management charge income with the minimum, maximum and mean values provided using the MIN, MAX and AVERAGE functions respectively.

Worksheet – Alternative Investment Returns

The purpose of this worksheet is to simulate the investment return amounts paid at the end of each year and project portfolio values for 200 simulated bonds under the proposed product structure.

Calculations are similar to those in the current investment returns tab however alternative investment return assumptions are used to reflect the current economic uncertainty, reverting back to the current assumptions after a 5 year period. Further calculations are required to determine the annual management charge which produces the same expected total management charge income as the current investment return assumptions.

The first table (Table 3) calculates the investment return each year.

For each row and column, a VLOOKUP function is used to return the level of investment return by comparing the random number, representing a random economic outcome each year for each portfolio, to the investment return breakdown. An IF function is used to determine which investment return assumptions should be used. For the first 5 years of the projection, determined by the parameter *initial_period*, the *alternative_projection* investment return assumptions are used. For the later years in the projection the *original_projection* investment return assumptions are used.

At the bottom of this table a series of checks are included to confirm that the maximum and minimum returns are within the expected range (no smaller than the minimum and no greater than the minimum return as set out in the parameters tab). In each case the returns are within the expected range for each projection year.

A check is also included to check that the average return over all 200 simulations for each year is within 0.5% of the expected return. This check is successful for each projection year.

The second table (Table 4) uses these investment return amounts to project the value of each portfolio.

The value of each portfolio at time 0 is given by the parameter *initial_value*.

At time 1 and all subsequent time periods the value of each portfolio is given by the value at the end of the previous year multiplied by (1+investment return amount) as calculated in Table 3. The annual management charge is also deducted from the portfolio value at the end of each year by multiplying this value by (1 - annual management charge).

Calculations in columns AV to BA to determine the rank of each simulation, the total management charge income and summary statistics including the expected investment return required above are identical to those in the current investment returns tab described above.

The level of the annual management charge is given in cell AA9, determined using GOALSEEK. The GOALSEEK is used to find the level of annual management charge such that the expected total management charge income on the proposed investment returns is the same as that obtained when using the current investment return assumptions.

This is achieved by determining the difference between the total management charge income on each set of projections in cell AA7 and solving for the charge amount for which this difference is zero.

A check is included in cell AB7 to ensure that this condition has been met (difference equal to zero)

Worksheet - Charts

This sheet just brings together the requested portfolio projection charts and summary statistics.

For each of the current and proposed investment returns the value of the 25th, 50th and 75th percentile simulations (50th, 100th and 150th ranked simulations) are shown on line graphs for each of the 20 years of the projection.

A bar chart compares the maximum, minimum and mean simulated total management charge income over the 20 year period on the current and proposed investment return assumptions.