

## **Analysis of Profitability of New Unit Linked Product**

This audit trail has been produced by A. N. Actuary on 10<sup>th</sup> October 2021. It relates to the spreadsheet 'UL Product.xlsx'.

### **Objective**

This spreadsheet has been produced for FundCo. The purpose of the spreadsheet is to investigate the profitability of a new unit linked product that FundCo is considering launching. The product has a ten year term and customers can invest either a single premium or regular annual premiums in a single fund. We have been provided with the projected monthly returns on the fund as well as details of the charges, discount rate and expenses to use. The fund management charge is 0.5% per month, paid at the start of the month. The discount rate is 0.3% per month. The expenses are as follows:

- Initial expenses of £300 to be paid immediately at the start of the ten year period.
- Fixed monthly expenses of £18 to be paid at the start of each month.
- Fund-linked monthly expenses of 0.2% of the fund value at the start of the month to be paid at the start of each month.

The spreadsheet first calculates the projected fund value at the end of the ten year period for both a single premium of £5,000 and regular premiums of £500. The monthly fund values are shown on a chart. It then calculates the net present value (NPV) of a regular premium product for a range of premiums. These results are also shown on a chart. Finally it calculates the minimum single premium that would result in a profit for FundCo, given the assumptions around the fund return, charges and expenses.

### **Data Checks and Charts**

Data on projected monthly fund returns for months 1 to 120 (i.e. ten years) have been provided and are shown on the sheet 'Data'. The sheet 'Data Checks and Charts' links to this data.

The following validation checks have been performed on the data:

- The check in column E checks the month numbers. Each month number is equal to the previous month plus one.
- There are 120 month numbers and 120 fund returns, as expected for ten years of data.
- The maximum, median, minimum, mean and standard deviation have been calculated. The maximum and minimum show that there are no extreme outlying values. The minimum is slightly negative but this is not unreasonable, as the value of investment funds can go down as well as up.
- The skewness is close to zero. This suggests the fund returns might follow a symmetrical distribution.

- Visual inspection of the data shows that there are no blank values.

The checks all give satisfactory results and so I have assumed the data is accurate.

The maximum, median and minimum values have been plotted on a column chart on this sheet. The median is between the maximum and minimum as expected.

### **Assumptions**

The following assumptions have been made in the model:

- The fund return data provided is complete and accurate and appropriate to use for this purpose.
- No customers will withdraw their investment before the end of the ten year period.
- No allowance has been made for potential death or illness of policyholders.
- No allowance has been made for overhead expenses.
- No allowance has been made for inflation.
- The expense data provided by FundCo is complete and accurate and appropriate to use for this purpose.
- The product charge (0.5% per month) is constant across the ten year period.
- The discount rate (0.3% per month) is constant across the ten year period.
- Customers can either invest a single premium or ten regular premiums annually – no other options are available.
- The term of the investment can only be ten years.

### **Parameters**

This sheet sets out the parameters used in the model:

- The monthly fund management charge is 0.5% of the fund value at the start of the month.
- The initial expenses are £300.
- The fixed monthly expenses are £18, paid at the start of the month.
- The fund-linked monthly expenses are 0.2% of the fund value at the start of the month.
- The discount rate is 0.3% per month.

Each parameter has been set as a named range, with the name shown in grey next to the parameter. These parameters are used in the other sheets in the model.

Note that there are also user inputs in the sheets 'Fund Values', 'Regular Premium NPV' and 'Single Premium NPV'. These are explained further below. All cells with user inputs are coloured orange.

This sheet also shows the colour coding used in the model.

### **Fund Values**

This sheet calculates the fund value at the end of the ten year period for both a £5,000 single premium investment and a £500 regular premium investment. The calculations are slightly different for the single premium and the regular premium projection.

Cell D4 is a user input for the single premium to be modelled. Columns D to F project the investment as it increases each month. Cell D9 is simply equal to the single premium. Column E links to the monthly fund return data. The value of the fund at the end of the month is then calculated as follows:

$$\text{End of month fund} = \text{Start of month fund} * (1 + \text{monthly fund return}) * (1 - \text{monthly charge})$$

From month 2 onwards the fund at the start of the month is simply equal to the fund value at the end of the previous month. The calculations are then repeated until the end of the ten year period.

Cell J4 is a user input for the regular premium. Columns I to K then project the regular premium investment up to the end of the ten year period. The calculations are the same as those for the single premium except that the regular premium is added to the start of month fund value at the start of each year. This is modelled by using an IF function. If the year of the month is equal to one more than the previous month then the regular premium is added.

This sheet also contains a line chart which shows the end of month fund values for both the single premium and the regular premium product across the ten year period.

The following checks have been performed:

- Column G checks that the end of the month fund value is greater than the start of the fund of the month value if the fund return is greater than the charge applied, and vice versa, for the single premium product.
- Column L applies the same check to the regular premium product.
- Cell F130 calculates what the value at the end of ten years would be if the average fund return was applied to the single premium. The result is fairly close to the projected value, which seems reasonable.
- Visual inspection of the chart shows that the projected fund values are reasonable. Annual jumps can be seen for the regular premium product.
- The final fund value is higher for the single premium product as expected, as the money is invested for longer (and the fund returns are generally positive and higher than the charge).

## Regular Premium NPV

Columns D to F on this sheet simply repeat the calculations from columns I to K of the previous sheet, i.e. they project the fund value for a £500 regular premium investment.

Column I calculates the income for FundCo from this product each month, i.e.  $0.5\% \times \text{start of month fund value}$ .

Column J calculates the total regular expenses for FundCo each month, i.e.  $\text{£}18 + 0.2\% \times \text{start of month fund value}$ .

Column K calculates the monthly cashflow, i.e. charges less expenses.

Column L discounts each cashflow to time 0 using the discount rate of 0.3% per month using the following formula:

$$\text{Discounted cashflow} = \frac{\text{Monthly cashflow}}{(1+0.3\%)^{n-1}}$$

Where n is the month number. Using this formula the cashflow in month 1 is not discounted, which makes sense as it occurs at the start of the month.

Cell L7 calculates the total NPV, i.e. the sum of the discounted cashflows less the initial expenses of £300.

In columns N to AP these calculations are repeated for regular premiums of £1,000, £1,500 and £2,000.

The following checks have been performed:

- Columns G, Q, AA and AK check that the end of the month fund value is greater than the start of the fund of the month value if the fund return is greater than the charge applied, and vice versa.
- Cell F132 checks that the projected fund value after ten years for the £500 regular premium product is the same as that calculated on the previous sheet.
- Cell L8 checks that the result can be reproduced using the Excel NPV formula.
- Cells V8, AF8 and AP8 check that as the premium increases the NPV increases.

## Regular Premium Results

This sheet summarises the results from the previous sheet. The table in cells C4 to D8 shows the four different premiums investigated and the NPV calculated. The NPV values link to the previous sheet.

The results are then plotted on a line chart. The chart shows that the NPV is negative for premiums below around £1,200 and positive above this value.

The following checks have been performed:

- Cells E6 to E8 show that the NPV increases as the premium increases.
- Visual inspection of the chart shows that the NPV increases linearly in line with the premium amount as expected.

### **Single Premium NPV**

Columns D to F on this sheet simply repeat the calculations from columns D to F of the 'Fund Values' sheet, i.e. they project the fund value for a £5,000 single premium investment.

In columns I to L the NPV for FundCo is calculated in the same way as it is calculated in columns I to L on the 'Regular Premium NPV' sheet. The final result is shown in cell L7.

These calculations are then repeated in columns N to V, but the user can change the premium modelled using the input in cell O6. Goal seek was used to find the premium that gives an NPV of zero in cell V7, as this is the lowest premium FundCo should accept. Any premium below this will give a negative NPV.

The following checks have been performed:

- Columns G and Q check that that the end of the month fund value is greater than the start of the fund of the month value if the fund return is greater than the charge applied, and vice versa.
- Cell F132 checks that the projected fund value after ten years for the £5,000 single premium product is the same as that calculated on the 'Fund Values' sheet.
- Cell W7 checks that the NPV in the second scenario is higher than the NPV in the £5,000 premium scenario if the premium in O6 is higher than £5,000, and vice versa.