**Analysis of Infrastructure Investment Opportunities**

This audit trail has been produced by A. N. Actuary on 10th October 2020. It relates to the spreadsheet ‘Infra Loan Investments.xlsx’.

**Objective**

This spreadsheet has been produced for InvestX. The purpose of the spreadsheet is to check the data on the company’s existing loans for errors and to analyse three potential future loans.

The company has $250,000 to invest and wants to offer the full amount as a loan to one of the following companies. All of the companies will pay interest annually in advance and repay the initial loan at the end of the term.

* Company A would like a 15 year loan at a rate of interest of 4% p.a.
* Company B would like a 25 year loan at a rate of interest of 5% p.a.
* Company C would like a 35 year loan at a rate of interest of 6% p.a.

The potential investments are analysed by calculating the net present value (NPV) and internal rate of return (IRR) and results are produced to go into a report discussing the options. The discount rate used to evaluate the option varies by the term of the loan. The discount rates used are 3%, 3.5% and 4% for the 15, 25 and 35 year terms respectively. The probability of default is 0.5% p.a., from the start of the second year of the loan.

**Data**

Data on the 20 current outstanding loans held by InvestX has been provided by the Head of Investments. The company only provides loans in USD and GBP. This data is shown on the ‘Data’ sheet. Checks are also carried out on this sheet.

For each of the 20 loans, the data includes:

* The original loan amount.
* The current loan outstanding.
* The original loan term in years.
* The current term to maturity in years.
* The currency of the loan.

The following validation checks have been performed on the data:

* There are 20 items for each type of data, therefore there are no blank entries.
* The maximum and minimum values of the original loan and the outstanding loan have been calculated. These look reasonable as they are all positive, there are no outliers, and the outstanding loan values are less than the original loan values.
* The maximum and minimum values of the original term and the outstanding term have been calculated. These look reasonable as they are all positive, there are no outliers, and the outstanding term values are less than the original term values.
* For each of the 20 loans the outstanding loan is less than the original loan, as expected.
* For each of the 20 loans the term to maturity is less than the original term, as expected.
* For each of the 20 loans the currency is either GBP or USD, as expected.

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

**Assumptions**

The following assumptions have been made in the model:

* For each potential investment, the interest rate is constant across the term of the loan.
* Discount rates are constant across the term of each loan.
* The probability of default is constant for each company and across the term of the loan.
* The probability of default in each year is independent of all other years.
* Inflation can be ignored.
* The data and information provided is complete and correct.
* Taxes can be ignored.
* The impact of changes in exchange rates can be ignored.

**Data Statistics**

This sheet is used to calculate the maximum, minimum and mean original loan amount separately for GBP loans and USD loans. These numbers are then presented in a column chart.

This sheet first looks up the loan number, original loan amount and loan currency from the ‘Data’ sheet. This data is then copied and pasted as values before sorting by currency using Data > Sort. Note that as manual intervention is required here the calculations will not automatically update if the data in the spreadsheet is changed.

The maximum, minimum and mean are calculated using the Excel functions MAX, MIN and AVERAGE. The range for each formula has been manually chosen to capture the loans of the required currency (e.g. in this version of the spreadsheet the GBP loan amounts are in range H7:H21 and the USD loan amounts are in range H22:H26).

This data has then been presented in a column chart with appropriate axes labels and title.

The following checks have been performed:

* Data for 20 loans has been looked up from the ‘Data’ sheet.
* The count of USD and GBP loans in the original data matched that for the sorted data.
* The maximum USD loan and the maximum GBP loan are less than or equal to the maximum across all loans.
* The minimum USD loan and the minimum GBP loan is greater than or equal to the minimum across all loans.
* The mean loan across all loans has been calculated. This is closer to the GBP mean than the USD mean, which is reasonable as there are more GBP loans.

**Parameters**

This sheet sets out the parameters used in the model for evaluating the three investment options:

* The loan amount is $250,000 for all three companies.
* The loan term is 15, 25 and 35 years for Company A, B and C respectively.
* The loan interest rate is 4%, 5% and 6% for Company A, B and C respectively.
* The discount rate used is 3%, 3.5% and 4% for Company A, B and C respectively.
* The probability of default is 0.5% for all companies from the start of year two onwards.

Each parameter has been set as a named range, with the name shown in grey under the parameter.

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

**NPV Calculations**

This sheet calculates the net present value (NPV) for each of the three investment options.

Cells D3:F6 show the parameters of the model for ease of reference.

Columns D:F set out the cashflows for each of the three potential investments (i.e. the loans to companies A, B and C). Annual cashflows are shown from t = 0 to t = 35. Interest cashflows are calculated as initial loan \* interest rate \* (1 – probability of default) for each company. Note that the probability of default for the first cashflow is zero. At the maturity date the cashflow is equal to the initial loan \* (1 – probability of default). After the maturity date there are no further cashflows.

Columns G:I set out the discount factor for each of the three potential investments. The discount factor is calculated as (1+i)-t, where i is the relevant discount rate for the term of the loan.

Columns J:L set out the present value of each cashflow. The present value is equal to cashflow \* discount factor.

Columns M:O set out the NPV for each potential investment. The NPV is calculated as follows:

$$\sum\_{t=0}^{M}LoanCashFlow×DiscountFactor-InitialLoan$$

The following checks have been performed:

* Checks by eye show that there are no cashflows after the maturity date for each potential investment.
* Columns Q:S check that the discount factor for year t is less than the discount factor for year t-1 for each year for of the three investments.
* Spot checks have been performed. For example, the discount factor for year 35 using a 4% discount rate should be (1.04)-35 = 0.2534. This matches the value in the spreadsheet.
* The total undiscounted cashflows have been summed for each investment. The Company B loan has a higher term and interest rate than the Company A loan, so the total is higher as expected. The same applied for Company C relative to Company B.

**IRR Calculations**

This sheet calculates the internal rate of return (IRR) for each of the three investment options.

Columns D:F set out the cashflows for each of the three potential investments (i.e. the loans to companies A, B and C). These are the same as in the sheet ‘NPV Calculations’.

Columns G:I set out the discount factor for each of the three potential investments. The discount factor is calculated as (1+i)-t, where i is the IRR for each loan. Before calculating the IRR this is simply set equal to the discount rate used in the ‘NPV Calculations’ sheet.

Columns J:L set out the present value of each cashflow. The present value is equal to cashflow \* discount factor. This is the same calculation as in the sheet ‘NPV Calculations’.

Columns M:O set out the NPV for each potential investment, using the same calculation as in the ‘NPV Calculations’ sheet.

Cells M3:O3 show the IRR. This is calculated using the goal seek function in Excel. The IRR for each investment is calculated separately by setting the NPV to zero by changing the IRR. Once the IRR is calculated, all three NPV values should be zero. If the parameters are changed then goal seek will need to be run again to calculate the new IRR.

The following checks have been performed:

* The total undiscounted cashflows have been summed for each investment. There is a check that this matches the values in the ‘NPV Calculations’ sheet.
* There is a check that the calculated IRR is higher than the prescribed discount rate. As the NPV using the prescribed discount rate is positive, we would expect the IRR to be higher than the discount rate.
* There is a check that the NPV is very close to zero (i.e. less than 0.001).

**Results**

This sheet shows a table of results and a chart that will go into a report discussing the three potential investments.

The table of results shows the following for each of the three potential investments:

* Term of loan.
* Loan interest rate.
* NPV of loan (rounded to the nearest thousand).
* IRR of loan.

The term and interest rate values are populated using the relevant named ranges for these parameters. The NPV value links to the ‘NPV Calculations’ sheet and uses the Excel function ROUND to round to the nearest thousand. The IRR value links to the ‘IRR Calculations’ sheet.

The chart shows the NPV calculated for each of the three investments. The NPV comes from the ‘NPV Calculations’ sheet. The chart used is a column chart and a suitable title and axes labels have been added.