

The 1st Heriot-Watt University Actuarial Challenge

Theme: Loan schedule with death benefit. -Credit Life Insurance. -Borrowing covered by Life Insurance



Part 1: Problem statement

There are increasing bank customers interested in getting a mortgage to buy a house. In exchange, they will repay the loan by making a payment at the end of each year. However, there are certain risks that the customers need to be aware of. For instance, the bank could use a variable interest rate to calculate the loan repayments. Hence, the loan repayments would need to be adjusted if the interest rate does change. Moreover, customer is required to buy a life insurance policy that will repay the loan to the bank to cover the risk of the customer dying in the next years.

Students will play the role of the customer's financial advisor and make some recommendations which you consider will benefit them in the long run. Students will ensure that the customer has the financial protection in place in the unfortunate case of their death considering one types of sum assured which matches exactly the loan outstanding at the end of year of death.

Part 2: Data Sources

All the financial data and probability of dying has been provided to students (See "Data_Case study.xls" file).

Part 3: Mathematical Modeling

Students will construct a loan schedule showing explicitly each annual level repayment. Then calculate the expected present value at certain age of the insurance contract in which the benefit would be paid out at the end of year of the customer's death such that this is exactly enough to repay the outstanding loan at the end of the year.

Part 4: Risk Mitigation Concepts

Students will advise the customer to either take out or not such a policy. Explain what payments are made under the decreasing and level term insurance policy.

Students will also explain the advantages and disadvantages of the two types of cover (i.e. decreasing and level), the risks to the customer, and their overall recommendations to the customer.

Part 5: Report writing

Write a report which includes the following:

- An introduction which is a brief summary of the customer's situation.
- The purpose of the term insurance policy.
- Why might the customer take out such a policy.
- The advantages and disadvantages of the types of cover (i.e. decreasing).
- The risks to the customer.
- Your recommendations to the customer.

Part 6: The loan schedule

A bank customer, now aged 35 exactly, borrows £200,000 to buy a house. He agrees that he will repay the loan by making a level payment at the end of each year. The final payment will be made exactly n=21 years from now.

Currently, the bank uses an interest rate of 6.00% per annum nominal, convertible monthly, to calculate the loan repayments.

To do: On the first worksheet construct the loan schedule.

The work should show explicitly each annual level repayment and contain the following columns:

- 1. Convert the interest rate per annum nominal convertible monthly to per annum effective,
- 2. Time *k*, for *k*=0,1,...*n*,
- 3. Loan outstanding, just before the repayment paid at time *k*,
- 4. Loan repayment at time k, and
- 5. Loan outstanding, just after the repayment paid at time *k*.

Note: The worksheet should **not** show the interest and capital parts of each payment separately, as they are not used in this case.

Part 7: Repaying the loan outstanding if death occurs

The same customer is required, by the bank who lends them 200,000, to buy a life insurance policy that will repay the loan to the bank, if the customer dies in the next *n* years.

The type of sum assured to be considered should match exactly the loan outstanding at the end of year of death.

The policy considered is a type of decreasing term insurance contract.

If the customer dies during a year, then he will not make a loan repayment at the end of that year. Instead, when the first loan repayment after death is due, the insurance company will pay the full amount outstanding on the loan to the bank.

The first stage of the life office calculation is to value this decreasing term insurance contract.

To do: On the second worksheet of the same spreadsheet, calculate:

- 1. You should estimate the interest rate (*i*) per annum effective such that the expected present value (EPV_x) of decreasing term assurance = £2,483.00.
- 2. The expected present value at age 35 of the insurance contract in which the benefit paid out at the end of year of the customer's death is exactly enough to repay the outstanding loan at the end of the year.

The expected present value is calculated as follows:

$$EPV_x = \sum_{k=0}^{n} (Amount_k) * (Discount Factor_{k+1}) * (Probability_k)$$

Where

Notation	Description
EPV_x	Expected Present Value for age x
Amount _k	Death benefit= Loan outstanding at time
	<i>k</i> + 1
Discount Factor _{k+1} = $v^{k+1} = \left(\frac{1}{1+i}\right)^{k+1}$	Discount Factor
i	Interest rate per annum effective
$Probability_k = \frac{1}{k} q_x$	Probability of someone age x dying between x+k and x+k+1