Stat 444 — Winter 2024

Homework Assignment 6

Due Date: Thursday, April 4th at 2:00 pm

General Notes:

- For Part I, you may submit your assignment on Learning Suite.

- For Part II, you should use a spreadsheet.

  - Submit electronically the Excel spreadsheet you create to answer the questions in Part II to Learning Suite. Your spreadsheet should be neatly organized and labeled; each answer should be highlighted in some manner, and it should be very clear how each of your answers was obtained.

Part I

1. An insurer sells both Type A and Type B universal life insurance policies to lives age 75. You are given the following information about these policies:

   - The cost of insurance rates for the policy are 100% of the mortality rates in the Standard Ultimate Mortality Model.

   - The interest rate used to discount the cost of insurance charge is 4%.

   - The expense charges at the beginning of each policy year are 100 plus 10% of premium.

   - The credited interest rate during all policy years is 7%.

   - The corridor factor in all years is 1.05.

   (a) Explain why Type A universal life policies are more commonly affected by corridor factors than Type B universal life policies.

   Consider a Type B universal life policy, with a death benefit of 100,000 plus the account value. The premium paid at the beginning of the first policy year is 10,000.

   (b) Calculate the cost of insurance charge for the first policy year. [1772.40]

   (c) Calculate the account value of the policy at the end of the first policy year. [7626.53]

Now consider a Type A universal life policy with a face amount of 100,000. The premium paid at the beginning of the first policy year is 10,000.

(d) Calculate the account value of this policy at the end of the first policy year. [7773.96]

(e) The account value at the end of the 8th policy year for the Type A policy is 81,618.64. The policyholder pays a 10,000 premium at the beginning of the 9th policy year. Calculate the account value at the end of the 9th policy year. [96626.45 (pay attention to the corridor factor if you get 96698.82)]

2. You are conducting a profit test of a Type A universal life insurance policy with a face amount of 150,000 issued to (40). You are given the following information used to project the policy account values, assuming the policy remains in force.

Policy year k	Annual premium	Percent of premium charge	Annual expense charge	COI rate per 1000 of insurance	Annual interest rate for discounting the COI	Annual credited interest rate	Corridor factor
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	7,000	6%	55	2.0	5%	6%	1.97
10	7,000	6%	55	2.2	5%	6%	1.91

The projected account value at the end of year 8 is 62,000.

(a) Calculate the projected account value at the end of year 9. [72480]

(b) Calculate the projected account value at the end of year 10. [83576]

You are given the following profit test assumptions.

- The interest earned on all insurer's funds is 7.5% per year.
- At the end of each of the first 9 policy years, 2% of the in-force policyholders surrender.
- At the end of policy year 10, 15% of the in-force policyholders surrender.
- The surrender charge for policy year 10 is 1,500.
- Mortality experience follows the Standard Ultimate Life Table.
- Commission expenses are 5% of premiums.
- Other incurred expenses are 45 at the start of each year, 100 on surrender, and 250 at the end of the year of death.
- There are no reserves held other than the account value.

(c) Calculate the expected cost of death benefit plus associated expenses payable at the end of year 10, given that the policy is in force at the start of the year. [175.9]

(d) Calculate the expected profit emerging at the end of year 10, given that the policy is in force at the start of the year. [1566]

(e) Calculate the expected profit emerging at the end of year 10, per policy issued, Π_{10} [1297]

(f) Describe two reasons why the insurer might hold reserves higher than the account value.

Part II

Consider the following UL policy issued to a life aged 45:

- Face amount 100,000

- Type A death benefit with corridor factors and surrender charges available here.

- CoI based on: 120% of mortality rates from the Standard Select Survival Model and 4% interest.

- Expenses:

    - First premium: 20% + 200

    - Renewal premiums: 3%

- Initial premium of 3500

1. Project the account and cash values for this policy assuming level premiums of 3500 are paid annually in advance, that the policyholder surrenders the contract after 20 years, and that the credited interest rate is 4% per year. $[AV_1 = 2626.97, AV_2 = 6173.08]$

2. Profit test the contact using the basis below. Use annual steps, and determine the NPV and DPP using a hurdle rate of 10%. [NPV $= 2210$, DPP $= 7$] Assume:

    - Level premiums of 3500 paid annually in advance.

    - Insurer's funds earn 6% per year.

    - Policyholder's accounts are credited at 4% per year.

    - Surrender rates are defined here.

    - Mortality follows the Standard Select Survival Model

    - Incurred expenses are:

        - pre-contract expenses of 60% of the premium due immediately before the issue date.

- maintenance expenses of 2% of premium at each premium date, including the first.
- 50 on surrender
- 100 on death

- Insurer holds reserves equal to the policyholder's account value.