

Life insurance II – simple cash-flow model and simulation of net premium reserve

Computations using commutations functions

Use the Unisex Life Tables and commutation functions (CF), and technical interest rate 1.3%.

1. Consider a portfolio of life annuities due with premium refund which are deferred to age 65 of the insured person. You know the sum insured SI , the underwriting year and the age x of the insured person when the contract started. We assume that all contracts started at January 1. If the insured person dies during the deferment period, the paid premium is transferred to a beneficiary at the end of the year of death.
2. Using the commutation functions, estimate the net annual premium which is paid during the deferment period.
3. For each contract compute the net premium reserve to January 1, 2017 using the commutation functions.

You should be always sure what is the length of the deferment period m and the date of reserve computation k . They can be different for each contract.

Simulation part

Using suitable software tool (Mathematica, Matlab, R etc.) simulate future development of the contract and using these simulations estimate the net premium reserve to January 1, 2017.

1. During the deferment period the contract still pays the net annual premium. The payments of SI start just after reaching age 65.
2. Using the probabilities based on Life Tables you can simulate the death of the insured person and model the cash-flow until the death (for the annuity part) or related to the death (for the premium refund part).
3. For discounting use a general interested rate (yield curve) which is simulated using the discretized CIR process

$$r_t = r_{t-1} + \alpha(\mu - r_{t-1}) + \sigma\sqrt{r_{t-1}}\epsilon_t, \quad (1)$$

where $\alpha = 0.5$, $\mu = 0.013$, $\sigma = 0.01$ and $\epsilon_t \sim N[0, 1]$ are i.i.d. random variables. Do not use the negative values¹, although maybe it makes sense today:)

4. For each simulation of the yield curve and for each contract compute the discounted cash-flow.
5. Using the sum over all contracts for each yield curve (you will get 1000 simulations for the whole portfolio), estimate the descriptive statistics for the net premium reserve: mean, standard deviation, minimum, maximum, lower and upper quartile, median. The mean should be "close" to the estimate of NPR using CF.

¹Fix the scenario to the last positive value or start a new simulation, until you get 1000 positive scenarios.

Send a pdf file surname_name.HW2.pdf to my e-mail until April 24, 2017 with:

- the net annual premium and the net premium reserve computed using the commutation functions,
- the descriptive statistics for the simulations of the net premium reserve,
- YOUR commented source code.