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Master in Actuarial Science

Asset-Liability Management

Vasicek parameters	
Strength of the gravitation back to the average rate	**0.2**
long-term average rate	**0.03**
sigma	**0.04**
Initial rate	**0.02**

1. **Affine term structure**

   Calculate the current term structure with the given parameters, for a period of 5 years divided in yearly sub-periods (start with a data frame with a single column for the time periods).

2. **Simulate random r(1)**

   Simulate 3000 replications of the short rate **r(**t =1**)** that will prevail in one year's time if the yield curve development observes this stochastic model. You may consider the Brownian motion term as a Normal(0,1) distributed random number.

3. **Simulate stochastic yield curves**

   For each of the 3000 replications of **r(**t =1**)**, calculate the discount function five years ahead, i.e. P(1,T) for T = 2,...,6.

4. **Gross claim simulation**

   Simulate 2000 replications of a year's worth of claims, using resampling from the Claim sample. Calculate also the minimum, maximum and average, as well as percentiles 1, 5, 50, 95 and 99.

5. **Gross claim present values**

   Assume the gross claims are paid in equal parts over 5 years. For each of the 2000 replications of a gross claim amount, calculate its random present value at time 1, using this cash flow payment pattern and the discount function from the CIR model you computed earlier. You may assume that the payments are made at the end of years 2, ..., 6. **Hint:** You should pair the gross claim simulations with the CIR simulations.

6. Premium calculation

Premium	
gross loading	20%
expense	25%

Now return to the original 2000 replications of a gross claim amount. Use them to compute the gross premium and expenses, according to the data given above.

7. Quota-share reinsurance

Quota-share conditions	
retention	50%
ceding comission	25%
loss corridor	100% xs 100%

For each of the 2000 replications of a gross claim amount, calculate its quota share premium, ceding commission, loss corridor liabilities and the result of quota share for the insurer. Remember that the loss corridor clause concerns the combined ratio.

8. Payment matrix and fully matching portfolio

Bond maturity	Face value	Coupon rate (annual)
31-12-2025	100	1,00%
31-12-2026	100	1,00%
31-12-2027	100	1,00%
31-12-2028	1.000	1,50%
31-12-2029	10.000	2,00%

Today is the 31st of December of 2024. Construct the payment matrix for one unit of each of these 5 bonds. Using these bonds, match a liability cash flow of 10M annually over the course of 5 years. You may assume payments are made at the end of the year.