FINAL PROJECT - SII

Consider a simplified insurance company whose assets and liabilities sides are characterized as follows:

ASSETS

- for each policyholder there is a single fund made of equity (80%) and property (20%), $F_t = EQ_t + PR_t$
- at the beginning (t=0) the value of the fund is equal to the invested premium $F_0 = C_0 = 70{,}000$
- equity features
  - listed in the regulated markets in the EEA
  - no dividend yield
  - to be simulated with a Risk Neutral GBM (sigma=20%) and a time varying forward rate
- property features
  - listed in the regulated markets in the EEA
  - no dividend yield
  - to be simulated with a Risk Neutral GBM (sigma=10%) and a time varying forward rate

LIABILITIES

- contract terms
  - whole Life policy
  - benefits
    - in case of lapse, the beneficiary gets the value of the fund at the time of lapse, with 20 euros of penalties applied
    - in case of death, the beneficiary gets the maximum between the invested premium and the value of the fund
  - others
    - Regular Deduction, RD of 2.20%
    - Commissions to the distribution channels, COMM (or trailing) of 1.40%
- model points
  - just 1 model point of 100 insured
  - each insured is a male with insured aged x=60 at the beginning of the contract
- operating assumptions
  - mortality: rates derived from the life table SI2024
  - lapse: flat annual rates l_t=15%
  - expenses: constant unitary (i.e. per policy) cost of 50 euros per year, that grows following the inflation pattern
- economic assumption
  - risk free: rate r derived from the yield curve (EIOPA EUR without VA at 31.03.25)
  - inflation: flat annual rate of 2%

Other specifications:

- time step: annual.
- time horizon for the projection: 50 years.
  In case of outstanding portfolio in T=50, let all the people leave the contract with a massive surrender (no penalties applied)
- the interest rates dynamic is deterministic, while the equity and property ones are stochastic
- apply the symmetric adjustment to the equity risk charge

QUESTIONS

1. code a Matlab/Python script to compute the Basic Solvency Capital Requirement via Standard Formula and provide comments on the results obtained.
   The risks to be considered are:
   - Market Interest
   - Market equity
   - Market property
   - Life mortality
   - Life lapse
   - Life cat
   - Expense
2. Split the BEL value into its main PV components: premiums (=0), death benefits, lapse benefits, expenses, and commissions
3. Replicate the same calculations in an Excel spread sheet using a deterministic projection.
   - Do the results differ from 1? If so, what is the reason behind?
   - For the base case only
     i. calculate the Macaulay duration of the liabilities;
     ii. calculate the sources of profit for the insurance company, deriving its PVFP
     iii. check the magnitude of leakage by verifying the equation MVA = BEL + PVFP (i.e. MVA=BEL+PVFP+LEAK)
     iv. sense check the PVFP using a proxy calculation, based on the annual profit and the duration of the contract
4. Open questions:
   - what happens to the asset and liabilities when the risk-free rate increases/decreases with a parallel shift of, say, 100bps? Describe the effects for all the BEL components;
   - what happens to the liabilities if the insured age increases? What if there were two model points, one with males and one with females?

DELIVERABLES

- send one email with object "[SII project] - GROUP XX", attaching the .pdf doc and .xlsx file, where XX specifies the number of your group, such as 03 or 12
- the .pdf document shall be named "GROUP_XX_SII_project.pdf" and organized as follows
    - cover with group number and full names of the participants
    - index
    - original text of the project
    - a summary tables showing the results, as follows

Results	MVA	BEL	BoF	d_BoF	dur_L
BASE					
IR_up					
IR_dw					
…					
…					
…					
…					
…					
…					
BSCR					

    - section with specifications of all the formulas adopted for the calculations
        - please provide comments on the rationale of number of scenarios adopted, based on an analysis on the martingale tests for the equity
        - subsections (one per each risk) that recall the results under discussion and provide comments on the outcomes
    - section that illustrates the deterministic calculations and provides comments on the results
        - subsection for the questions related to the base case only
    - section with the answers to the open questions
    - annex with the Matlab/Python code embedded (no need to share the code)
- the excel workbook shall be named "GROUP_XX_SII_project.xlsx", containing the deterministic projections and a summary tab providing the results in the same format of the table above
- every deviation from this scheme will be penalized