GROUP PROJECT DESCRIPTION

1. [7.0] Consider a government **Capital Indexed Inflation Linked Bond** (ILB) with term sheet:

Notional amount	25000
Coupon Type	Fixed
Coupon rate	6.75%
Coupon frequency	Semi-annual
Currency	USD
Issue Date	31/7/2020
Maturity Date	21/7/2025
Trade Date	18/09/2020
Settlement Lag	T+1
Day Count	ACT/ACT
Inflation Reference Index	US Consumer Price Index
Inflation Reference Index Level at issue	237.14365
Inflation Reference Index Level at Settlement	251.14721

Assume the CPI index I_t follows a log-normal model (geometric Brownian motion), i.e.,

$$\frac{dI_t}{I_t} = \mu dt + \sigma dW_t,$$

where W_t is a Wiener process, μ the constant drift, and $\sigma > 0$ is the diffusion coefficient with estimates $\hat{\mu} = 0.05321$ and $\hat{\sigma} = 0.06358$. Assume there is no inflation indexation lag.

Assume the issuers yield curve on the valuation date is given by the Nelson–Siegel-Svensson zero-coupon rate function parameters,

β_0	β_1	β_2	β_3	τ_1	τ_2
5.9%	-1.6%	-0.5%	1%	5	0.5

Tasks:

a) Compute the accrued interest.

b) Simulate 1000 scenarios for the inflation rate curve and CPI index

c) For each scenario, compute the ILB cash flows and estimate its fair value.

d) Summarise and analyse the inflation linked bond price distribution, including risk measures

2. [6.0] Consider the following bond market information for a set of Treasury government bonds:

Bond	Coupon rate	Coupon frequency	Maturity (years)	Dirty-Price (% of par value)
1	1.50%	Annual	1	96.60
2	1.75%	Annual	1.25	93.71
3	2.00%	Annual	2.75	91.56
4	2.25%	Annual	4	90.24
5	2.50%	Annual	5	89.74
6	2.75%	Annual	6	90.04
7	3.00%	Annual	7	91.09
8	3.25%	Annual	8	92.82
9	3.50%	Annual	9	95.19
10	3.75%	Annual	10	98.14
11	4.00%	Annual	8	98.10

a) Estimate the spot yield curve using the Bootstrap method considering bonds 1 to 10.
b) Estimate the 3.65-year spot interest rate using the following interpolation method: (i) linear; (ii) cubic. Comment.
c) Estimate the fair value of Bond 11 using the yield curve estimated in (a). Formulate a trading recommendation (buy/sell/hold) for this bond.
d) Estimate the yield to maturity of Bond 11.

3. [7.0] An asset manager holds the following portfolio of fixed rate Treasury bonds (delivering annual coupons, with a €100 face value).

Bond	Maturity	Coupon rate (%)	Quantity
1	01/12/2025	4	10000
2	04/12/2026	7.75	250000
3	06/12/2027	4	50000
4	10/12/2028	7	100000
5	03/12/2029	5.75	10000
6	09/12/2030	5.5	200000
7	06/12/2032	4	15000
8	03/12/2035	4.75	10000
9	03/12/2030	4.5	30000
10	04/12/2045	5	75000
11	04/12/2050	4.5	100000
12	01/12/2051	4	10000
13	07/12/2052	5	10000

He wants to hedge it against yield curve shifts. Assume the spot market yield curve on the valuation date 09/02/2022 is well described by the Nelson–Siegel-Svensson (NSS) parameters

β_0	β_1	β_2	β_3	τ_1	τ_2
5.9%	-1.6%	-0.5%	1%	5	0.5

He selected the following annual coupon paying Treasury bonds (with a €100 face value) as hedging instruments:

Hedging asset	Coupon rate (%)	Maturity
H1	4.5	12/04/2026
H2	5	28/12/2032
H3	6	06/05/2035
H4	6	10/10/2040
H5	6.5	10/10/2051

Tasks:

a) Compute the level, slope and curvature durations and $durations of target portfolio.

b) Compute the level, slope and curvature durations and $durations of the hedging assets.

c) Estimate the hedging portfolio holdings assuming the hedger wants to implement a self-financing (full) hedging strategy.

d) Assume that immediately after the hedging strategy was set up, the yield curve changed and is now given by the following set of NSS parameters

β_0	β_1	β_2	β_3	τ_1	τ_2
6.5%	-1.0%	0.1%	2%	5	0.5

i. Estimate the impact of this yield curve shift on the Target Portfolio assuming no hedging strategy had been put in place. Discuss the results.

ii. Estimate the impact of this yield curve shift on the global portfolio (target bond portfolio plus the hedging instruments) and discuss the performance of the hedging strategy.

GROUP SIZE, PROJECT MILESTONES & REPORTS

The standard (and recommended) group size is 4. You are responsible for organizing your own groups. A single digital report with answers to all the questions above must be submitted by email to jbravo@novaims.unl.pt no later than November 4, 2022. Additionally, you are asked to send the Word & EXCEL & PDF & RScript / Python files used in the project.