GROUP PROJECT DESCRIPTION

1. [4.0] Consider the following set of on-the-run government bonds:

Bond #	Maturity (years)	Coupon rate (%)	Bond price ($)	Yield Volatility (%)
1	0.5	0.50	98.00	3.50
2	1.0	0.75	98.50	3.40
3	1.5	1.00	100.00	3.30
4	2.0	1.25	99.50	3.15
5	2.5	1.50	99.00	3.00
6	3.0	1.70	100.50	2.80
7	3.5	1.80	101.00	2.60
8	4.0	2.00	101.00	2.40
9	4.5	2.25	101.50	2.20
10	5.0	2.50	100.50	2.00

a) Bootstrap the spot rate curve for the given set of maturities. Assume a face value of $100, semi-annual coupon payments, and continuous compounding.

b) Consider the above historical annualized yield volatilities for each maturity. Estimate the bond volatility for all bonds. Discuss the results.

c) Suppose you want to purchase a 5-year corporate bond, face value $100,000 and coupon rate of 3%, semi-annual coupon payments (continuous compounding) with the same currency denomination as the government bonds listed above. You estimate the credit spread curve is flat at 1.00%. Estimate the fair price of this bond, together with its interest rate risk measures.

2. [6.0] Consider the collection of (continuously compounded) spot rates provided in the Excel sheet "Yield_Curve" (filename Yield_data.xlsx).

   a) For each given date, fit the Nelson-Siegel (NS) function to the market data. Report the NS parameter estimates as well as the mean squared error (MSE).

   b) Use visualization tools to represent, analyse and discuss the yield curve dynamics.

   c) Analyse the dynamics of the yield curve parameters.

3. [10.0] An asset manager holds the following portfolio of fixed-rate Treasury bonds (Assume a face value of $100, annual coupon payments, and continuous compounding).

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

d) Assume that immediately after the hedging strategy was established, 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 shift in the yield curve on the Target Portfolio assuming no hedging strategy had been implemented. Discuss the results.

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

INDIVIDUAL PROJECT DESCRIPTION

4. Consider again the market spot rate curve provided in the Excel sheet "PCA" (filename Yield_data.xlsx).

   a) Analyse the correlation structure of the matrix of the spot rates.

   b) Run a Principal Component Analysis (PCA) on the covariance matrix of the spot rates. Report the fraction of variance explained by each principal component. Is there one dominant component? Discuss your findings.

   c) Plot the loadings for each factor. Discuss the results for the loadings for the three most dominant factors?

   d) Plot the three most dominant factors over time. What do these factors resemble?

   e) Simulate hedging a bond portfolio against yield curve shifts using PCA.

GROUP SIZE, PROJECT MILESTONES & REPORTS

The standard (and recommended) group size is 4. You are responsible for organizing your own groups. The group and individual projects outputs consist of a single digital written PDF/Word/TeX/Bookmark report detailing the outline, methods and results obtained for the problems set above. The reports must be uploaded through the course Moodle webpage no later than January 31, 2025. The individual project report should be identified as follows **FirstName_Surname_Student#.PDF** Additionally, you are asked to send the Word/LaTeX, EXCEL, PDF, R Script, Python or other files used for eventual replication of the results.