ISE 337/447: Bond Portfolio Project

(Based in Case Study 3.7 in Textbook)

Due Date: Wednesday, May 14, by 11:59pm on Coursesite

Note: Under otherwise stated, all textbook references are for"Optimization Methods in Finance", Cornuéjols, Peña, Tütüncü, 2nd edition, Cambridge, 2018.

A municipality sends you the following liability stream (in millions of dollars):

Date Due	Amount
6/15/2025	8
12/15/2025	7
6/15/2026	9
12/15/2026	10
6/15/2027	9
12/15/2027	12
6/15/2028	9
12/15/2028	6
6/15/2029	5
12/15/2029	7
6/15/2030	9
12/15/2030	7
6/15/2031	8
12/15/2031	7
6/15/2032	11
12/15/2032	9

1. Determine the current term structure of treasury rates (see textbook Section 3.4 or other resources that you can find), and find the present value, duration, and convexity of the stream of liabilities. Please explain the main steps followed in your calculations. You can find data on numerous websites such as `http://finance.yahoo.com/bonds`, `http://fixedincome.fidelity.com/fi/FILanding`.

2. Identify **at least** 30 fixed-income assets that are suitable to construct a dedicated bond portfolio for the municipality liabilities that you have been given. Use assets that are considered risk-free; for example, US government non-callable treasury bonds, treasury bills, or treasury notes. Display in an appropriate table the main characteristics of the bonds you choose. Namely, prices, coupon rates, maturity dates, face value).

3. Formulate a linear programming model to find the lowest cost bond dedicated portfolio that covers the stream of liabilities. To eliminate the possibility of any interest risk, assume that a 0% reinvestment rate on cash balances carried out from one date to the next. Assume no short selling of bonds is allowed. What is the cost of your portfolio? How does this cost compares with the NPV of the liabilities? What is the composition of the portfolio?

4. Use the linear programming sensitivity analysis information to determine the term structure of interest rates implied by the optimal bond portfolio you found in the previous question. Use a plot to compare these rates with the current term structure of treasury rates you found in the first question.

5. Formulate a linear programming model to find the lowest cost bond immunized portfolio that matches the present value, duration, and convexity of a stream of liabilities. Assume that no short rates are allowed. What is the cost of your portfolio? How much would you save by using this immunization strategy instead of the dedication one? Is your portfolio immunized against non-parallel shifts in the term structure? Explain why of why not.

6. Combine a cash matching strategy (dedication) for the liabilities for the first three years and an immunization strategy based on matching present value, duration and convexity for the liabilities during the last five years. Compare the characteristics of the three bond portfolios you have obtained. Explain which one you think is the best one and why.

7. The municipality would like to make a second bid (find a different portfolio of bonds). What is your best dedicated portfolio of risk-free bonds you can create **if short sales are allowed?** Did you find arbitrage opportunities? Did you take into consideration the bid-ask spread of the bonds? How would you take them in consideration and what is the result? Did you set limits in the transaction amounts? Discuss the practical feasibility of your solutions.

8. Consider proposing a new portfolio of bonds using any additional consideration or change to the model that you see fit. For example, can you do something to make your portfolio of bonds immune to non-parallel changes in the term structure. Is there a better way to combine the techniques you used before. Explain clearly what you do and your results.