

46-976 Financial Optimization, Project 1

Due September 14, 2020

You may work in a group of at most four people.

This project involves two deliverables:

First and most important, submit a report (pdf format) with succinct answers to each of the questions below. Make sure your report includes the names of all members of your team. Your report should be at most five pages long. You may also include references to your demo code if you deem it appropriate.

Second, submit a “demo code” (zip format) that the instructor or any of your peers could run to replicate the results summarized in your report. Your demo code would likely include some combination of Excel, Python, MATLAB, or .csv files.

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

Dec 2020	Jun 2021	Dec 2021	Jun 2022	Dec 2022	Jun 2023	Jun 2024	Dec 2024
11	9	7	9	9	12	8	10

Dec 2023	Jun 2025	Dec 2025	Jun 2026	Dec 2026	Jun 2027	Dec 2027	Jun 2028
6	5	7	7	8	7	9	9

Questions

1. Determine the current term structure of treasury rates, and find the present value of the stream of liabilities. Please explain the main steps (interest rates, discount factors, compounding, etc) followed in your calculations. You can find current data in a number of sources including
<http://fixedincome.fidelity.com/fi/FILanding>
<http://finance.yahoo.com/bonds>
<https://wrds-web.wharton.upenn.edu/wrds>
2. Identify at least 30 fixed-income assets that are suitable for a dedicated portfolio. Use assets that are considered risk-free, i.e., US government non-callable treasury bonds, treasury bills, or treasury notes. Display a succinct summary of the main characteristics of the bonds you chose (prices, coupon rates, maturity dates). For each date, assume you can use any bond payment received up to the end of that month. For instance, for the liability on Dec 2020, you can use any bond coupon or principal payments received up until and including Dec 31, 2020.
3. Formulate a linear programming model to find the lowest cost dedicated portfolio that covers the stream of liabilities. To eliminate the possibility of any interest risk, assume a 0% reinvestment rate on cash balances carried from one period to the next. Assume no short sales are allowed. What is the cost of your portfolio? What is the composition of your portfolio?
4. Use the linear programming sensitivity information to determine the term structure of interest rates implied by the portfolio. Use a plot to compare it with the current term structure of treasury rates.
5. Find an additional set of 5 or more non-callable top-rated (S&P rating AAA, Moody's rating Aaa) corporate bonds suitable for including in your dedicated portfolio. Assume now that up to 50% of your portfolio can be invested in these kinds of bonds. Repeat parts 3 and 4 above with the larger set of available bonds (treasury and corporate). How do the new results compare with those previously obtained?