PYTHON FOR THE FINANCIAL ECONOMIST, ORDINARY EXAM 2025
ASSET ALLOCATION STUDY

Copenhagen Business School
22. December 2025

3 weeks, home assignment

The home assignment is to be answered in groups of two students (maximum of 25 A4-pages) or individually (maximum of 15 A4-pages). The students must individualize the assignment.

The take-home assignment should take the form of an academic report written in either Word or Latex converted to pdf format. It is expected that students present relevant formulas, present results using visualizations and tables, include relevant references, etc. The overall impression of how the results are presented will count in the assessment.

The analysis should be performed using Python. Please attach code / Jupyter notebooks.

If you think that you do not have all the necessary information to answer a problem, make the necessary assumptions in order to proceed and state these assumptions in the solution.

Good luck!

Asset Allocation Study

Assume that an investor has observed 40 years of financial data with a weekly frequency. The file *fixed_income_data.csv* contains the prices of a 3 month zero coupon bond and 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 year bullet bonds with annual payments and a coupon rate of 6% and a principal of 1 for each point in time. The file *equity_index_data.csv* contains the index values for 9 different equity indices (total return).

The investor wants to model the historical dynamics. First, you are asked to present an analysis of the dynamics of the risk free term structure of interest rates including a relevant modelling framework and estimation of parameters. Estimation could be performed using a Chen-Scott type of estimation (see Chen and Scott (1993)) or similar approaches. Second, you are asked to present an analysis of the equity dynamics. You should present relevant findings and discuss the results and the chosen methods.

The investor seeks to allocate the initial wealth of 1 based on a one year investment horizon and a buy-and-hold investment strategy. Assume that the investor can invest in

- A bank account earning the short rate
- 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 year bullet bonds with annual payments and a coupon rate of 6% and a principal of 100
- The 9 different equity indices re-based to 1 at the end of the estimation window

The investor would like to understand the PnL distribution of the assets over the investment horizon. You should simulate the dynamics of the assets with weekly time steps until the investment horizon using a large number of scenarios and calculate the PnL of the assets over the investment horizon. You should present relevant metrics and visualizations and discuss findings.

Using the simulated PnL distribution, the investor would like to find an optimal portfolio. The investor can use some leverage (negative allocation to the bank account) to potentially increase the risk-return trade-off. The investor would like high expected PnL but also wants to limit tail risk. You should present a relevant specification of the portfolio optimization problem and perform a portfolio construction analysis, including a discussion of findings, relevant metrics and visualizations.

The investor is worried about estimation uncertainty. You should discuss and analyze how this affects the analysis and what possible remedies can mitigate these effects. You are asked to implement methods to increase the robustness if necessary.

The investor would like to implement subjective views in the asset allocation process. You should briefly describe a relevant approach and show the investor how some relevant views could be implemented and how it affects the asset allocation decisions.

References

Chen, R.-R. and L. Scott (1993): "Maximum Likelihood Estimation for a Multifactor Equilibrium Model of the Term Structure of Interest Rates," *The Journal of Fixed Income*.