FEM21010 - Portfolio Management
Assignment

November, 2023

- The deadline for the submission of the assignment is **Wednesday, December 6, 2023 at 23:59**.
- Submit your assignment via the course page on Canvas.
- Groups should consist of 3 members.
- You need to hand in a pdf-file with the answers to the questions. Add your code as an appendix to the pdf so it becomes part of the plagiarism scan.
- The (single) pdf-file should contain the answers to all questions in the assignment.
- The name of your pdf-file should include at least one group members student number.
- Plagiarism is obviously not allowed. This holds for (i) copying answers from each other and (ii) copying code from each other.
- All returns given on Canvas are simple gross returns (i.e. they are not log returns and they are not excess returns) and are given as fractions (i.e. a return of 3% is given as 0.03).
- Report numbers by including 2 decimals.

The purpose of this assignment is to help you build your intuition and apply the material we cover in class. You will be evaluated on how clearly (and concisely!) you present your results. Present as clearly as possible what formulas you use for all questions. You should provide enough information to ensure that your work can be replicated. Report out-of-sample results unless it is explicitly stated otherwise.

Add your code to an appendix of your report so it becomes part of the plagiarism scan.

Simulation experiment

The out-of-sample performance of tangency portfolios can be very poor. In this question you will perform a simulation to evaluate some of the different alternative allocations that we discussed in class.

Produce a simulation that provides a market where excess returns follow a single-factor model, *e.g.*,

$$R_t^e = \beta f_t + \varepsilon_t.$$

Here R_t^e denotes a N-vector of excess returns and β is a vector of exposures to the single factor. Assume that the factor and error terms are independent and that $f_t \sim N(\mu_f, \sigma_f^2)$ and $\varepsilon_t \sim N(0, \Sigma_\varepsilon)$, where Σ_ε is diagonal. Further, assume that factors are not tradable, i.e. your allocation should not hold positions in these assets.
Some design choices in the simulation are left up to you, give a concise motivation for the choices that you make. Remember to present formulas you use. To help, you have access to a collection of almost 550 stock return series. You can get factors from the data library on Kenneth French's website.[1]

(a) Calibrate the parameters of the single-factor model. Summarize your parameters in a table.

(b) Compute the highest achievable Sharpe ratio if a market is determined by your factor model.

From this market draw $N = (10, 100)$ assets over $T = 20000$ observations. For your plug-in estimates, let the estimation window be $M = (120, 240, 3600)$.

Summarize your results from the following questions (c), (d), (e), (f), (g) and (h) in two tables, one for the Sharpe ratios and one for the Turnover.

(c) Compute the Sharpe ratio and Turnover of an equally weighted portfolio allocation.

(d) Compute the Sharpe ratio and Turnover of the tangency portfolio using the sample mean and covariance matrix as plug-in estimators.

[1] `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html`

(e) Compute the **in-sample** Sharpe ratio of the tangency portfolio using the sample mean and covariance matrix as plug-in estimators.

(f) Compute the Sharpe ratio and Turnover of the unconstrained minimum variance portfolio using the sample covariance matrix as plug-in estimators.

(g) Compute the Sharpe ratio and Turnover of the minimum variance portfolio with no-short selling constraints.

(h) Compute the Sharpe ratio and Turnover of a portfolio allocation of your own choice. You are free to choose the allocation and the plug-in estimators.

You should now have two tables that summarize the performance of portfolios that you have formed. Next step is interpret your findings.

(i) Summarise and explain your findings with respect to the Sharpe ratios in (c), (d), (e), (f) and (g) in one to two paragraphs.

(j) Summarise and explain your findings with respect to the Turnover in (c), (d), (e), (f) and (g) in one to two paragraphs.

Lastly, we want to perform inference to assess the financial performance of the portfolio allocations.

(k) Test whether the difference in the Sharpe ratios between the equally weighted allocation (question (c)) and the portfolio allocation that you chose in question (h) is statistically significant.