Homework: Core European Stock Portfolio

Important remarks:

- This work is an **INVIVIDUAL WORK**
- Deadline: January 21, 2024, 20:00
- A complete .zip file must be sent by email at guillaume.monarcha@dauphine.psl.eu before this deadline, with the following content:
    - The working python code
    - The report in pdf format
    - Any other additional files used to conduct this work.
- Format and content of the report
    - A maximum of 3 pages
    - A clear description and justification of the methodological options employed to conduct this work.
    - A clear presentation of the results.
    - No need to incorporate any pieces of code in the report.

Dataset: DATA.xlsx

Content: Monthly returns of European stocks and of the Eurostoxx 50 index (the market benchmark), from January 2006 to December 2023.

Guidelines

1. Through principal component analysis of the European equity returns, extract the K main latent factors (principal components) F_k of the European equity market, i.e. the core factors that drive the returns of European equities.

   We define the core equity factors as the rescaled principal component to a volatility of 15%.

   Note: if the eigenvector of the first principal component mainly contents negative values, then consider $-F_1$ instead of F_1, to obtain a positive correlation between this first factor and the returns of individual stocks.

2. Estimate the exposures $\hat{b}_{k,i}$ of each stock to the K core equity factors from the following linear model:

$$r_{i,t} = \alpha_i + \sum_{k=1}^{K} b_{i,1} F_{k,t} + \varepsilon_t$$

3. Compute the weights of the equity portfolio designed to replicate the first core equity factor, defined as:

$$Argmin_{w_k}\left(w_k{}'\widehat{\Omega} w_k\right)$$

   subject to:

$$\sum_{i=1}^{N} w_{k,i} = 1$$

$$w_{k,i} \geq 0$$

$$\sum_{i=1}^{N} w_{k,i} \hat{b}_{i,1} = 1$$

   with:

   - $\widehat{\Omega}$ the sample covariance matrix of the stock returns,
   - $\hat{b}_{i,1}$ the estimated sensitivity of stock i to the 1st core equity factor.

4. Estimate the alpha of this portfolio against the market benchmark.

5. Assess the impact of estimation errors in the covariance matrix $\widehat{\Omega}$ on the alpha of the replicating portfolio. Compute the 95% confidence interval of the estimated alpha.