Session 5

Efficient Frontier Revisited

Part 1: Minimum-Tracking-Error Frontier

Let the market return be the target return. Estimate the expected deviation from market return, for the ten industry portfolios:

$$R_i = E\left(\tilde{R}_i - \tilde{R}_m\right)$$

Also estimate the covariance matrix of return deviations, for the ten industry portfolios:

$$V_{ij} = \mathrm{Cov}\left[\left(\tilde{R}_i - \tilde{R}_m\right), \left(\tilde{R}_j - \tilde{R}_m\right)\right]$$

- Plot the minimum-tracking-error frontier generated by the ten industry portfolios.

  This graph must have expected (monthly) return deviation on the vertical axis vs (monthly) tracking error on the horizontal axis.

  This graph must cover the range from 0% to 0.1% on the vertical axis, in increments of 0.005% (or less).

- Also plot the line starting from the origin that is tangent to the upper half of the minimum-tracking-error frontier.

- Calculate the information ratio and portfolio weights for the "tangency" portfolio.

Part 2: Minimum-Variance Frontier w/o Short Sales

Use the monthly returns of the ten industry portfolios to generate the minimum-variance frontier without short sales, using Monte Carlo simulation. Portfolio weights will be limited to the range [0, 1].

Randomly draw each element of **w**, the 10 × 1 vector of portfolio weights, from the (standard) uniform distribution in the range [0, 1]. Divide **w** by the sum of the portfolio weights, to ensure that the portfolio weights sum to one. Use the normalised **w** to calculate the mean return and standard deviation of return for the simulated portfolio. Repeat this process until you have (at least) 10^5 data points.

- Plot the data points with mean return on the vertical axis vs standard deviation of return on the horizontal axis.

Repeat this entire process by simulating 1/w using the standard uniform distribution ⇒ take the reciprocal of the random draw from the standard uniform distribution as the portfolio weight.

- Plot the new data points (on a separate graph) with mean return on the vertical axis vs standard deviation of return on the horizontal axis.

Please submit all relevant results as an Adobe PDF file to Homework 4 before the end of Sunday, 8 Oct 2023.

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Q&F: Black–Litterman Model

Link

- Lecture Notes: Efficient Frontier Revisited

  PDF document