

Climate Change Finance

Case Study - Low Carbon Index Tracking Portfolio

(By groups of two students)

Important information - A soft copy of the solution to the case study should be emailed to me as a pdf document on the due date, which is February 27, 2025. No late assignment will be accepted. A professional-level presentation is expected, and you will be judged both on the form and the content of your assignment. Students' names, as well as the chosen sector, should be displayed on the front page of the document.

A large US public pension fund is currently using the cap-weighted S&P500 index as a benchmark for their allocation to large cap US stocks. The senior investment management team of the pension fund recognizes that this index, as all standard cap-weighted indices, suffers from two main shortcomings from a pure investment standpoint: (i) poor diversification of unrewarded risk exposures and (ii) poor diversification of rewarded risk exposure. In parallel, as one of the founding signatories of the UN Principles for Responsible Investment in 2006, the pension fund supports the ambition to reduce the carbon footprint of their equity portfolios so as to contribute to maintain the rise in global mean temperature to less than 2° C above pre-industrial levels as per the 2015 Paris Agreement on climate change.

As part of the ESG investment team, you are asked to propose a low carbon version of the S&P500 portfolio for this pension fund. You will measure the impact of the pension fund equity portfolio in terms of CO2 emissions, using scope 1 and scope 2 emissions as a (rather imperfect) proxy for the global footprint of the portfolio. Broadly speaking, you are asked to significantly reduce the portfolio carbon impact, measured in terms of carbon intensity, while controlling the tracking error with respect to the benchmark and ideally generating an improvement in risk-adjusted performance.

For this, you are expected to use two non-mutually exclusive carbon footprint reduction strategies, namely selection and optimization.

In more details, the first step for each team consists in proposing a selection (positive screening) of 50 stocks in the S&P500 universe. You will carefully explain how this selection allows you to achieve a significant reduction in carbon footprint, while maintaining the absolute risk (measured by volatility) and relative risk (measured by the tracking error with respect to the S&P500 index) of the portfolio at reasonable levels.

The next step consists of designing an efficient low carbon benchmark via a suitable optimization procedure.

In terms of optimization, each group should generate (using Python) an out-of-sample backtest for the portfolio strategies listed below, implemented on the selected basket of 50 stocks, using a 2-year calibration window for the estimation of the covariance matrix and a quarterly rebalancing frequency. Between two rebalancement dates, the portfolio will be left in a buy-and-hold mode (no transaction within a quarter). In the selection process, you will pay specific attention to avoid large sector biases.

- Max Effective Number of Constituents applied to dollar contributions subject to carbon intensity/footprint constraints as well as any other suitable weight constraints;
- Max Effective Number of Constituents applied to risk contributions subject to carbon intensity/footprint constraints as well as any other suitable weight constraints;
- Min Variance subject to carbon intensity/footprint constraints as well as any other suitable weight constraints;
- Max Diversification subject to carbon intensity/footprint constraints as well as any other suitable weight constraints;
- Max Decorrelation subject to carbon intensity/footprint constraints as well as any other suitable weight constraints;
- Min Tracking Error subject to carbon intensity/footprint constraints as well as any other suitable weight constraints.

For each of the chosen strategies, you are expected to report the standard risk and return indicators, namely expected return, annualized volatility, Sharpe ratio (you may assume that the risk-free rate is equal to zero for this calculation), as well as tracking error with respect to the S&P500 index. You are finally expected to select a meaningful investment solution based on a suitable 50 stocks selection and a suitable portfolio strategy.

Overall the suitability of your proposed solution will be measured in terms of 3 distinct dimensions:

- (1) reduction of the carbon footprint of the portfolio (e.g. achieving a target reduction of 50% with respect to the S&P500);
- (2) increase if possible, or at least limited decrease, of the risk-adjusted performance of the portfolio; and
- (3) control of the tracking error of the portfolio with respect to the S&P500 at a relatively low level (e.g. 3% or 5%).