GDS Individual Assignment – Portfolio Decarbonisation

Objective: Find the portfolio with the optimal financial and carbon performances by optimising portfolios with different constraints.

Key assumption: Long-only portfolio and not short sell is considered in portfolio construction.

Data: Five years' monthly return data is needed for the mean returns and variance/covariance computation, and you could get emissions and ESG data for a certain year (i.e., the end year of the sample period). For example, you use emissions and ESG data for the year 2019 and return data for the year 2015-2019. However, historical emissions and ESG data might be needed when you are dealing with missing data.

Software to use: You could choose either Excel (solver) or Python PyPortfolioOpt library to conduct the portfolio optimisation practices.

Portfolio optimisation with Excel Solver:

https://youtu.be/prFCWrfJHBs

Python PyPortfolioOpt:

https://pyportfolioopt.readthedocs.io/en/stable/UserGuide.html

1. Randomly select 100 firms from the Russell 3000 constituents list that is uploaded to the shared Google Drive.
    - Describe your sample. E.g., sector distribution, number/percentages of firms for each sector etc.

2. Carbon metric choice: you can choose one or more carbon metrics that are used to decarbonise the portfolios with the considerations of the following questions: What is it aimed to show? How good is it at aligning the portfolio with climate goals? What are the advantages and disadvantages (e.g. data availability, the possibility of international comparison etc.)? Why would you think the carbon metric is important?
    - E.g., emissions scores from conventional databases, such as Bloomberg or Refinitiv Eikon, or carbon intensity, e.g., total carbon emissions (scope 1+2)/EBIT; total carbon emissions/sales.
    - Dealing with missing data: you might find that some companies have missing emission data. You can either replace these companies by drawing new firms from the Russell 3000 constituent list or assign the average emissions of past years (e.g., for company A, there is no emission data in the year 2019, then you could use the average emissions for the year 2015-2018). This can also be applied to ESG data.
3. Optimisation: Table 1 shows examples of portfolio constructions. Generally, the carbon performance and tracking error constraints are considered. You could try additional constraints for your portfolio optimisations. In Table 1, the first three portfolio optimisations test that if there is an optimal carbon reduction target (i.e., reduction by

50%, 25% or 10%?) which allows a minimum sacrifice of financial performance (i.e., the highest Sharpe ratio)

4. Comparison of key statistics/properties for all constructed portfolios (summarised in a table):
    - Carbon performance of your choice. E.g., carbon intensity
    - Sharpe ratio
    - Monthly expected return
    - Annualised expected return
    - Variance
    - Monthly Standard deviation
    - Annualised standard deviation
    - Number of companies invested in
    - Others (optional)
5. Comparison of ESG performance for all constructed portfolios (summarised in a table):
    - ESG score
    - Environmental score
    - Social score
    - Governance score
    - Other sub-level scores: e.g., Emission scores, Environmental innovation scores
6. Sector/industry composition for all constructed portfolios (summarised in a table): The weightings of each sector/industry in each constructed portfolio.
7. Sector analysis for ESG performance. Choose one decarbonised portfolio along with the benchmark portfolio for the sector analysis. In the analysis, you need to compute each sector's contribution (in percentage) to the decarbonised portfolio and the benchmark portfolio in terms of ESG performance.

Table 1 Example of Portfolios with Different Objectives and Constraints

Objectives/Constraints	**Benchmark portfolio (Market cap-weighted)**	**Decarbonised portfolio 1**	**Decarbonised portfolio 2**	**Decarbonised portfolio 3**	**Decarbonised portfolio with the industry balance adjustment**	**Mean-variance portfolio**	**Mean-variance portfolio (i.e., MTP) with decarbonisation constraint**
Objectives	For comparison purpose It is used to compute the tracking errors of constructed portfolios	Maximising carbon performance Minimising tracking error (i.e., not deviate too much from the benchmark)	Maximising carbon performance Minimising tracking error (i.e., not deviate too much from the benchmark)	Maximising carbon performance Minimising tracking error (i.e., not deviate too much from the benchmark)	Choosing one decarbonised portfolio, for instance, if the reduction of carbon intensity by 25% (Decarbonised portfolio 2) gives the highest Sharpe ratio. Add: Sector balance (e.g., the portfolio's sectoral weightings cannot deviate by +/-30% from the benchmark's sectoral weighting)	Maximising the Sharpe ratio	Maximising the Sharpe ratio Achieving carbon performance target at the same time
Constraints (if any)	The sum of weights is 1	E.g., Reducing the carbon intensity of the portfolio by 50%	E.g., Reducing the carbon intensity of the portfolio by 25%	E.g., Reducing the carbon intensity of the portfolio by 10%	E.g., No individual sector has 30% higher or lower weighting than the weighting in the benchmark	Maximising the Sharpe ratio	Maximising the Sharpe ratio
	Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed	E.g., Tacking error<1%	E.g., Tacking error<1%	E.g., Tacking error<1%	Same constraint as Decarbonised portfolio 2: Reducing the carbon intensity of the portfolio by 25%	The sum of weights is 1	Imposing a carbon performance constraint
		The sum of weights is 1	The sum of weights is 1	The sum of weights is 1	Same constraint as Decarbonised portfolio 2: Tacking error<1%	Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed	The sum of weights is 1
		Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed	Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed	Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed	The sum of weights is 1 Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed		Each holding in the portfolio must be equal to or greater than 0, i.e., no short selling is allowed