

Master SMT

Sustainable and Entrepreneurial Finance

Homework 3

Objectives

The objectives of this homework are the following:

- Evaluate the (weighted average) carbon intensity of a business-as-usual (BAU) portfolio
- Build a decarbonized portfolios of stocks based on the mean-variance criterion (efficient frontier)
- Evaluate the relative performance of BAU and decarbonized portfolios

Instructions

- Assignments should be done in groups of 4 students.
- You should work with the same group through the entire course.
- Submit on Moodle only one copy of solutions per group with the code.
- For each homework you can get a maximum of 100 points.
- All assignments turned in late will not be graded (zero points).

Due date

May 12th 2022.

Each group will pick firms to analyze for Homework 1 and Homework 3 as follows:

1. **Group 1:** U.S. firms with available **environmental** scores (MSCI)
2. **Group 2:** U.S. firms with available **social** scores (MSCI)
3. **Group 3:** U.S. firms with available **governance** scores (MSCI)
4. **Group 5:** U.S. firms with available scope 1, scope 2, and scope 3 emissions (Trucost)
5. **Group 7:** European firms available scope 1 to 3 emissions (Trucost)
6. **Group 8:** Firms from Emerging countries with available scope 1 to 3 emissions (Trucost)

7. **Group 9:** Utilities firms with available scope 1 to 3 emissions (Trucost)
8. **Group 10:** Energy firms with available scope 1 to 3 emissions (Trucost)
9. **Group 11:** Materials firms with available scope 1 to 3 emissions (Trucost)
10. **Group 12:** European firms with available **environmental** scores (MSCI)
11. **Group 13:** European firms with available **social** scores (MSCI)
12. **Group 14:** European firms with available **governance** scores (MSCI)
13. **Group 15:** Firms from Emerging countries with available **environmental** scores (MSCI)
14. **Group 16:** Firms from Emerging countries with available **governance** scores (MSCI)

Take the same data from Homework 1 and answer the following questions:

Portfolio allocation with ESG/carbon emissions constraints

1. Report summary statistics (mean, median, min, max, standard deviation) on the cross-sectional distribution of your group's variable of interest (i.e. environmental score for groups 1, 12 and 15; social score for groups 2 and 13; governance score for groups 3, 14, and 16; carbon intensity for groups 5 to 11; etc.). Draw the histogram of the cross-sectional distribution of the variable of interest and comment on the summary statistics and the histogram. (10 points)
2. In Question 5 of Homework 1, you calculated efficient portfolios with various target returns. Take these portfolios, calculate and report the weighted-average E/S/G score or weighted-average carbon intensity of these portfolios (you can take the average score/carbon intensity for each firm over time). Comment on the E/S/G score or carbon intensity of the portfolios. Which firms (e.g. top 10; report firm names along with ISIN) are driving the E/S/G score down or driving the carbon intensity up? Plot on the volatility-E/S/G score (carbon intensity) space the various portfolios (i.e., make a plot similar to the efficient frontier except that E/S/G score or carbon intensity replaces the return on the y-axis). (15 points)
3. This question is a follow-up of Question 8 of Homework 1. First, take the same 50 selected firms. Then, create a minimum variance portfolio with monthly rebalancing with an additional constraint: you exclude the worst firms in terms of E/S/G score/most polluting (high carbon intensity) firms. Specifically, exclude the **bottom** tercile of the distribution in month $t - 1$ for ESG scores or exclude the **top** tercile of the distribution

in month $t - 1$ for the carbon intensity. Report summary statistics on the performance (return, risk, Sharpe ratio) of this portfolio as well as its E/S/G score or carbon intensity. How do the performance measures (return, risk, Sharpe ratio) compare with the minimum variance portfolio from Question 4 of Homework 1. (20 points)

4. For each month, sort firms based on your group's variable of interest (E/S/G scores or carbon intensity) into quintiles. Create equally-weighted and value-weighted portfolios for each time period and each score or carbon intensity quintile. Report the average returns for each quintile portfolio as well as a portfolio that goes long in the highest quintile and short the lowest quintile. Comment on your results. What can explain the relationship between the return of your portfolios and firms' ESG score or carbon emissions? (25 points)
5. Take the minimum variance portfolio from Question 4 of Homework 1 and calculate its E/S/G score or carbon intensity. Reallocate its composition in order to improve the E/S/G score by 20%/reduce carbon intensity by 50% (see optimization problem below). Comment on the changes it took in order to improve the ESG score/carbon intensity (e.g. how many and which firms (firm names) had to be removed in the most recent year of your sample in order to achieve these objectives). (30 points)

$$\begin{aligned}
 \min_{\alpha} \quad & \alpha' \Sigma \alpha \\
 \text{s.t.} \quad & \alpha' e = 1 \\
 & \alpha' ESGscore \geq 1.2 \times (\alpha' ESGscore)_{Q4-Homework1}
 \end{aligned} \tag{1}$$

or

$$\begin{aligned}
 \min_{\alpha} \quad & \alpha' \Sigma \alpha \\
 \text{s.t.} \quad & \alpha' e = 1 \\
 & \alpha' CI \leq 0.5 \times (\alpha' CI)_{Q4-Homework1}
 \end{aligned} \tag{2}$$

6. For groups presenting this homework: prepare around 10 slides in order to present the key results from this homework with an emphasis on your area of focus (sectoral or geographical). Each group has 15 minutes to present. Presentations will count as separate points.