

**Problem statements that seem clear to one person may not be clear to another and it is difficult to fully specify all details and notes that could prevent you from interpreting this problem differently than intended. If you need clarification, please post to Piazza or contact the instructor or TA.**

Steve's Capricious Alphabetical Real Estate Yearly Index (SCAREY Index) tracks performance of U.S. REITs and will be reconstituted at the end of the year. Reconstitution is a process during which new securities enter an index and some existing securities may leave based on index rules.

The alphabetical nature of the SCAREY Indexes describes the rule for its construction. The SCAREY Index is currently holding REITS with names that begin with D, E or F. Ahead of the upcoming reconstitution event, the index provider has announced that after reconstitution the SCAREY Index will hold REITS with names that begin with F, G or H.

You are a REIT investment manager with a portfolio that is benchmarked to the SCAREY Index. Your performance is measured by the amount of excess return you can generate over the index relative to the tracking error of your fund. Index reconstitution time is always a challenging period in which to manage since changes in the underlying index will make it difficult to track closely and trading by other managers may impact the price of securities.

It is four weeks before the reconstitution occurs. Based on your current forecast of security performance (described below), you must determine portfolios to hold over the next four weeks that allow you to transition from the current index holdings (D, E and F) to the future index holdings (F, G and H). You don't need to worry about updating your forecast as the reconstitution event approaches. All decisions must be made now: four weeks before reconstitution.

There are several possible strategies for managing during this event. Some of them include

- Simply shift your portfolio to the new F, G and H weights immediately
- Shift weights in equal steps over the next 4 weeks
- Continue managing to the current index weightings until reconstitution occurs and make a big change at that time

Your strategy is most akin to the second of these. Your task is to identify portfolio weights across all of the D, E, F, G and H securities for each of the 5 decision points that have an expected excess return of at least 2 basis points per week (roughly equivalent to 1% per year) and that minimize the weighted sum of squared tracking error relative to the current benchmark and the future benchmark with the relative importance shifting from the current benchmark weights to the future benchmark weights over the four week period. The relative importance of current versus future is shown in the following table:

Weeks before reconstitution	Current Index (D, E and F)	Future Index (F, G and H)	Benchmark for Excess Return Calculation
4	100%	0%	Current
3	80%	20%	Current
2	60%	40%	Current
1	30%	70%	Current
0	0%	100%	Future

Some additional requirements:

- Allocations must add to 1
- Allocations must be non-negative
- The list of REITs with names beginning with D, E, F, G, or H are provided in the accompanying data file. This file includes the names, ticker symbols, investment type (equity or mortgage), sector and sub-sector, and market capitalization.
- Use the provided market capitalization to determine the current and future benchmark weights. I.e., the weights for each security are the market capitalization of that security divided by the sum of the market capitalizations of all of the other securities in the index. Of course, not all securities in the file are currently in the index and not all of them will be in the index after reconstitution.
- You are only allowed to include in your portfolio the D, E, F, G and H REITs in the provided file

You will need to have a forecast of the return behavior for each security to use as the basis for calculating squared tracking error and expected excess return. Please use the historical statistics (means, standard deviations and correlations) of the weekly log returns over the period from December 31, 2018 to December 31, 2020. Return data for the REITs can be accessed from Yahoo!Finance using the provided tickers and the `getSymbols()` function from the `quantmod` package in R. There may be similar functionality in other languages. Use the Adjusted closing price for each security to calculate its historical weekly log return series.

Please submit a short report (i.e, not 1 page and not more than 10 pages) that provides

1. a table showing the optimal allocation at each of the 5 time points
2. the tracking error relative to the current benchmark weights and the future benchmark weights for each of the 5 time points
3. the expected excess return relative to the current benchmark and future benchmark for each of the 5 time points

4. a discussion of the relationship (if any) between the allocations at each of the 5 time points and the returns and volatilities of the securities
5. any other observations that you have about the results or suggestions for other possible approaches to this problem

You may include any appendix material that you would like, but there is no guarantee that it will be carefully reviewed in the grading process.

Your report should be well-organized and easy to read. You are welcome to summarize information in bullet points, charts, graphs, tables or other formats that seem appropriate. If you include such exhibits, you should discuss the main conclusions rather than leave it to the reader to guess what they might be. I am not grading grammar and punctuation, but it always helps to present the material in a professional manner.

Please monitor Piazza as questions and clarifications discussed there may cause parts of the assignment to be modified. If this occurs, I will plan to note any such details as part of the Housekeeping segment of the subsequent lectures.