Math 420, Spring 2020
First Team Homework
Markowitz Portfolios and Frontiers
due Tuesday, 18 February, 2020

Exercise 1. Describe each asset in groups (A), (B), and (C) from your project. If it is a fund then describe the assets held by the fund. If it is a company then describe the company. (This information is easily found on the internet. A few sentences about each is all that you need.)

Exercise 2. Use adjusted closing prices to computer the return for each trading day over the three years 2017-2019. Compute $\mathbf{m}$ and $\mathbf{V}$ for the assets in group (A), groups (A) and (B) combined, and groups (A), (B), and (C) combined using one-year histories with uniform weights and daily data for each the three years ending 31 December 2017-2019. Print out the three $\mathbf{m}$ and $\mathbf{V}$ for each of the three years 2017-2020 to four significant digits. What relationship do the three $\mathbf{m}$ and $\mathbf{V}$ for each year have to each other?

Exercise 3. For each $\mathbf{m}$ and $\mathbf{V}$ computed in Exercise 2, compute the minimum volatility portfolio allocation $\mathbf{f}_{\mathrm{mv}}$. Present these in three tables (one for group (A), one for groups (A) and (B) combined, and one for groups (A), (B), and (C) combined) that lists years and the allocations for each asset rounded to the nearest thousandth. Comment on how these change from year to year for the same groupings of assets.

Exercise 4. For each year graph in the $\sigma\mu$-plane:
- the three frontiers associated with the appropriate $\mathbf{m}$ and $\mathbf{V}$ were computed in Exercise 2;
- the volatility and return mean for that year of each asset;
- the volatility and return mean for that year of the three minimum volatility portfolios;
- the volatility and return mean for that year of the three Markowitz portfolios that are equidistributed in group (A), in groups (A) and (B) combined, and in groups (A), (B), and (C) combined.

There should be 3 graphs — one for each year — each with three frontiers, nine assets, and six portfolios plotted. Use different symbols or colors to distinguish points associated with the different groups (A), (AB), and (ABC). Comment on any relationships that you see between the objects plotted on each graph. (This will be easier to do if you use the same scales for each of the graphs. Each σ-axis should begin at $\sigma = 0$.)

Exercise 5. Present a table that for each year gives the efficiency and proximity relative to the ABC frontier to four significant digits for each asset that year. The table should have six columns of numbers (two for each year) and nine rows (one for each asset). Comment on what these metrics say about the efficient market hypothesis.