Assignment 3

In this assignment you will find optimal portfolios. To your help, the handout "Mean-variance analysis with many assets in Python" is available.

Consider a mean-variance problem of a US investor investing in US cash, US bonds, US stocks, developed market (DM) stocks, and emerging market (EM) stocks.

Assume the following about the capital markets:

	Mean	Standard deviation	Correlations				
			1.	2.	3.	4.	5.
1. US cash	0.5	0.5	1.00				
2. US bonds	4.0	7.0	0.05	1.00			
3. US stocks	7.5	16.0	−0.05	0.50	1.00		
4. DM stocks	8.5	17.0	−0.05	0.50	0.80	1.00	
5. EM stocks	9.5	20.0	0.05	0.50	0.70	0.90	1.00

These assumptions are inspired by J.P. Morgan's 2023 long-term capital market assumptions. They are in real terms. Means and standard deviations are annualized and expressed in %.

1. Study the equal-weighted portfolio (no optimization involved here). What is the mean and standard deviation of this portfolio?

2. Find the optimal portfolio with the same mean as the equal-weighted portfolio. What is the standard deviation on this portfolio? How much lower is the risk compared with the equal-weighted portfolio? What are the weights? Is the portfolio well diversified? If not, which assets dominate, and why?

3. Trace out the minimum-variance frontier with means between 0% and 10%. Plot the frontier together with the individual assets. Print portfolio means, standard deviations, and weights for target means of 2%, 3%, 4%, 5%, 6%, and 7%.

4. Find the global minimum-variance portfolio. What are the mean and standard deviation on this portfolio? Does its location in the plot above make sense?

5. Add a short-sale constraint. Trace out the new frontier with means between 0% and 10%. Print portfolio means, standard deviations, and weights for target means of 2%, 3%, 4%, 5%, 6%, and 7%. Comment on the differences between these portfolios and the ones without short-sale constraints.

6. Change the mean assumptions by adding 0.5% to US stocks and subtracting 0.5% to DM stocks. Find the portfolio with a target mean of 6%. How does it differ from the one with the original assumptions. Do you find the differences small or large?