Name: Kevin Montana Wongso Student ID: 01501554

QF600 (Asset Pricing) – Homework 4

Efficient Frontier Revisited

Part 1: Minimum-Tracking-Error Frontier

1. Let market return be the target return. Estimate expected deviation from market return, for the ten industry portfolios:

$$R_i = E\left(\tilde{R}_i - \tilde{R}_m\right)$$

Answer:

Industry	Expected Deviation
NoDur	0.15475
Durbl	-0.01475
Manuf	0.26475
Enrgy	0.483083
HiTec	0.018167
Telcm	0.133333
Shops	0.16825
Hlth	0.03575
Utils	0.159083
Other	-0.259

2. Also estimate covariance matrix of return deviations, for the ten industry portfolios:

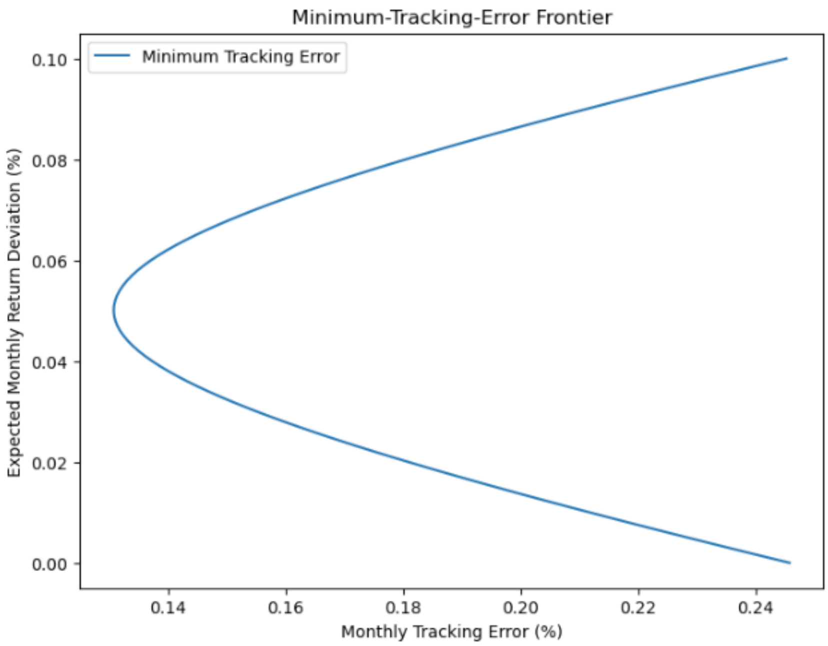
$$V_{ij} = \mathrm{Cov}\left[\left(\tilde{R}_i - \tilde{R}_m\right), \left(\tilde{R}_j - \tilde{R}_m\right)\right]$$

Answer:

	NoDur	Durbl	Manuf	Enrgy	HiTec	Telcm	Shops	Hlth	Utils	Other
NoDur	5.439696	-6.073035	-1.396192	-1.200533	-1.883151	1.538885	1.140741	3.815137	4.272002	-1.768738
Durbl	-6.073035	26.6289	4.908024	-3.481055	1.891577	-1.707625	-0.354335	-8.082946	-9.61749	4.385865
Manuf	-1.396192	4.908024	2.950499	1.666133	0.065267	-0.626416	-1.154597	-2.2889	-1.901412	0.358904
Enrgy	-1.200533	-3.481055	1.666133	19.27491	-1.516972	-1.040525	-3.710439	-2.485796	4.454368	-3.864826
HiTec	-1.883151	1.891577	0.065267	-1.516972	5.098746	-0.773294	-0.24535	-1.936284	-2.342839	-1.40405
Telcm	1.538885	-1.707625	-0.626416	-1.040525	-0.773294	4.682567	0.463797	0.693157	2.721477	-1.271778
Shops	1.140741	-0.354335	-1.154597	-3.710439	-0.24535	0.463797	4.452628	0.76451	-0.176666	-0.256987
Hlth	3.815137	-8.082946	-2.2889	-2.485796	-1.936284	0.693157	0.76451	7.820446	3.496136	-1.726842
Utils	4.272002	-9.61749	-1.901412	4.454368	-2.342839	2.721477	-0.176666	3.496136	12.26748	-4.055112
Other	-1.768738	4.385865	0.358904	-3.864826	-1.40405	-1.271778	-0.256987	-1.726842	-4.055112	4.503204

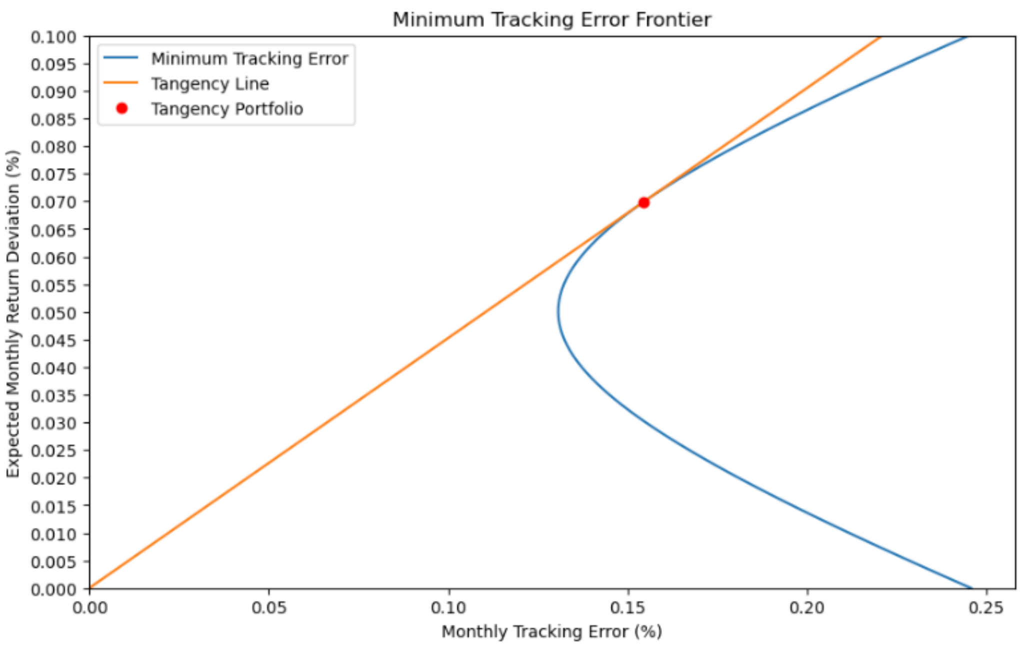
3. Plot the minimum-tracking-error frontier generated by the ten industry portfolios:
    - This graph must have expected (monthly) return deviation on the vertical axis vs (monthly) tracking error on the horizontal axis.
    - This graph must cover the range from 0% to 0.1% on the vertical axis, in increments of 0.005% (or less).

    Answer:



4. Also plot the line starting from the origin that is tangent to the upper half of the minimum-tracking-error frontier.

    Answer:



5. Calculate information ratio and portfolio weights for the "tangency" portfolio.

$$I_i = \frac{E\left(\tilde{R}_i - \tilde{R}_t\right)}{\sqrt{\mathrm{Var}\left(\tilde{R}_i - \tilde{R}_t\right)}}$$

Answer:

Information Ratio = 0.45248753961993365

Industry	Portfolio Weights
NoDur	0.052634
Durbl	0.000153
Manuf	0.137627
Enrgy	0.087032
HiTec	0.179353
Telcm	0.071074
Shops	0.106884
Hlth	0.102776
Utils	0.040162
Other	0.222304

Part 2: Minimum-Variance Frontier w/o Short Sales

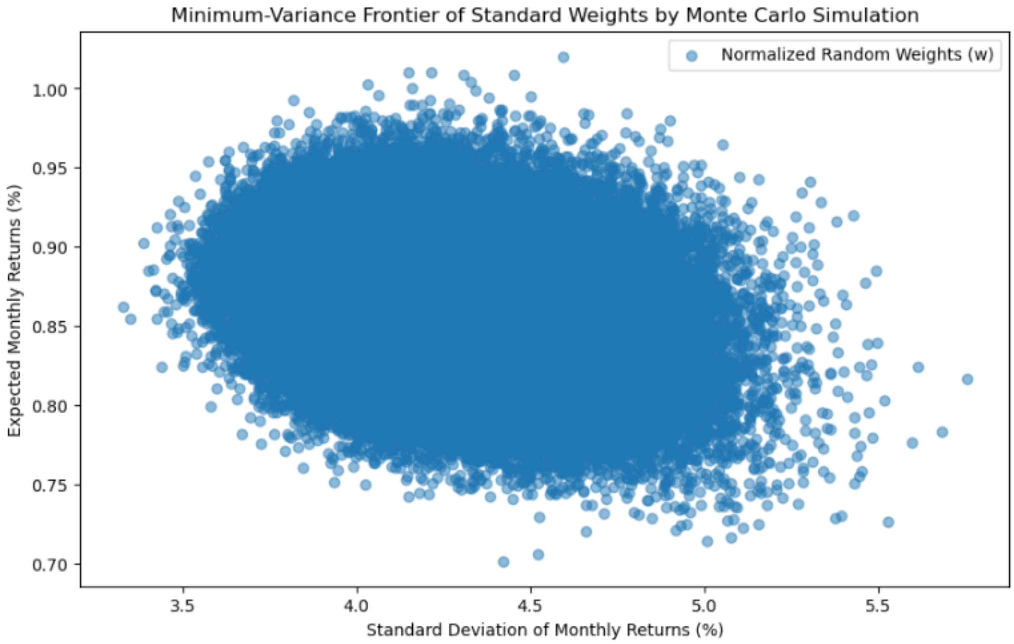
Use Monte Carlo method to simulate the minimum-variance frontier without short sales, generated by the ten industry portfolios. Portfolio weights will be limited to the range [0, 1].

Randomly draw each element of **w**, the 10 × 1 vector of portfolio weights, from the (standard) uniform distribution in the range [0, 1]. Divide **w** by the sum of portfolio weights, to ensure that the portfolio weights sum to one. This normalised **w** represents portfolio weights for one simulated portfolio, without short sales.

Use the normalised **w** along with the vector of mean returns and the covariance matrix of returns (for the ten industry portfolios) to calculate the mean return and standard deviation of return for the simulated portfolio. Repeat this process until you have (at least) 10^5 data points.

1. Plot the data points with mean return on the vertical axis vs standard deviation of return on the horizontal axis.

Answer:



Repeat this entire process by simulating 1/w using the standard uniform distribution ⇒ take the reciprocal of the random draw from the standard uniform distribution as the portfolio weight.

2. Plot the new data points (on a separate graph) with mean return on the vertical axis vs standard deviation of return on the horizontal axis.

   Answer: