

You will use `HW05.RData` for this homework. The `RData` file contains two objects.

`y` – Weekly returns from Jan 1, 2011 to Sep 30, 2024 of 8 stocks, Amazon (AMZN), Coke (KO), Nike (NKE), Pfizer (PFE), Tesla (TSLA), United Health (UNH), United Rentals, VISA (V).

The object `y` is a regular matrix with `xts` class being removed. The returns have been converted to percentage (%). The returns have been converted to percentage (%).

`syb` – a vector of the 8 ticker symbol names.

1. You will construct portfolios with stocks of these 8 companies. In this problem, consider portfolios with short sales.

- (a) Find the minimum variance portfolio: its expect return, its risk and allocation weights.
- (b) The current annual risk-free rate is 4.37%, convert it to weekly (52 weeks a year). Find the tangency portfolio: its expect return, its risk and allocation weights.
- (c) Plot the efficient frontier, the tangency portfolio, the minimum variance portfolio, location of each stock in the plot. Find and plot the efficient portfolios (combing with risk free asset), this is the line connect risky free portfolio (0,  $\mu_f$ ) and tangency portfolio ( $\sigma_T$ ,  $\mu_T$ ),

```
> lines(c(0,  $\sigma_T$ ), c( $\mu_f$ ,  $\mu_T$ ))
```

If you are not familiar with plotting in R, you may find the solution of Chapter 16 (Problem 1) from the [book website](#) helpful, except the part for locating individual stocks. We have 8 stocks, you may want to write a loop instead of plotting each stock one by one. Each stock is located at the point (its std dev, its mean) and its name is in `syb`. Use the R function `text()`. For example, if the first stock return has mean  $\mu_1$  and standard deviation  $\sigma_1$ ,

```
> text( $\sigma_1$ ,  $\mu_1$ , syb[1])
```

Presumably, you have a vector of 8 means and a vector of 8 standard deviations.

- (d) Find the efficient portfolio of an allowed risk 2.5%. Compute its return.
- (e) Find the efficient portfolio of a target return 0.55%. Compute its risk.
- (f) Find the efficient portfolio of a target return 0.85%. Compute its risk.

2. Repeat Question 1 for the case that short selling is not allowed. Parts (d)-(f) should be done only if it is applicable.

There will be lots of rounding errors for 0's that make your output difficult to read. Please remove those rounding errors. After computing the weight matrix, say `wmat`, apply the following command,

```
> wmat = wmat*(abs(wmat) > 1e-13)
```

3. Repeat Question 1 with box constraints  $-0.2 \leq w_i \leq 0.4$  for all  $i = 1, \dots, 8$ . Report the feasible set for the portfolio returns under these constraints. Parts (d)-(f) should be done only if it is applicable.