Exercises

Portfolio Optimization: Theory and Application
Chapter 2 – Financial Data: Stylized Facts

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portfoliooptimizationbook.com

Choose one or several assets (e.g., stocks or cryptocurrencies) for the following exercises.

Exercise 2.1: Price time series

Choose one asset and plot the price time series using both a linear and a logarithmic scale. Compare the plots and comment.

Exercise 2.2: Return time series

Choose one asset and plot the linear returns and log-returns. Compare the plots and comment.

Exercise 2.3: Volatility envelope

Choose one asset and compute the volatility (square root of the average of the squared returns over k samples) on a rolling-window basis in two ways:

a. Left-aligned window: at each time t, use the samples $t-k+1,\ldots,t$. Try different values of k, observe the effect, and discuss.
b. Centered window: at each time t, use the samples $t-\lfloor k\rfloor/2,\ldots,t+\lceil k\rceil/2-1$. Try different values of k, observe the effect, and discuss.

Finally, compare the left-aligned and centered rolling-window approaches and discuss.

Exercise 2.4: Return distribution

Choose one asset and perform the following tasks:

a. Plot histograms of the log-returns at different frequencies. Compare the plots and comment.
b. Draw Q–Q plots to focus on the tail distribution. Do the returns follow a Gaussian distribution?
c. Compute the skewness and kurtosis to see if they correspond to a Gaussian distribution.

Exercise 2.5: Return autocorrelation

Choose one asset and perform the following tasks:

a. Plot the autocorrelation function of the log-returns at various frequencies. Compare the plots and comment.
b. Repeat the process using squared returns instead of log-returns. Compare these plots and comment.

Exercise 2.6: Asset correlation

Choose several stocks and perform the following tasks:

a. Compute the cross-correlations and plot a heatmap.
b. Compute the correlation between each of the stocks and the index. Discuss the results.
c. Compute the correlation between a stock and a cryptocurrency. Discuss the result and the implications.