Exercises

Portfolio Optimization: Theory and Application
Chapter 4 – Financial Data: Time Series Modeling

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portfoliooptimizationbook.com

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

Mean Modeling

Exercise 4.1: Autocorrelation function of returns

Choose one asset and plot the autocorrelation function of the log-returns at different frequencies.

Exercise 4.2: MA modeling

Choose one asset and try the MA(q) model on the log-returns and log-prices for different values of the lookback q. Compute the mean squared error of the forecast.

Exercise 4.3: EWMA modeling

Choose one asset and try the EWMA model on the log-returns and log-prices for different values of the memory α. Compute the mean squared error of the forecast.

Exercise 4.4: ARMA modeling

Choose one asset and experiment with ARMA(p, q) models with different values of p and q. Compute the mean squared error of the forecast.

Exercise 4.5: Kalman for mean modeling

Choose one asset and experiment with different state-space models together with Kalman filtering. Compute the mean squared error of the forecast.

Exercise 4.6: Kalman for ARMA modeling

Choose one asset and compare the results of a direct ARMA model with the corresponding state-space model via Kalman filtering.

Exercise 4.7: VARMA modeling

Choose several assets and compare the results of asset-by-asset ARMA modeling and VARMA modeling. Discuss the results.

Exercise 4.8: Kalman for multivariate mean modeling

Choose several assets and compare the results of asset-by-asset Kalman modeling and vector Kalman modeling. Discuss the results.

Volatility Envelope Modeling

Exercise 4.9: Autocorrelation function of absolute returns

Choose one asset and plot the autocorrelation function of the absolute value of the log-returns at different frequencies.

Exercise 4.10: MA volatility modeling

Choose one asset and try the MA(q) model on the squared log-returns for different values of the lookback q. Plot the volatility envelope.

Exercise 4.11: EWMA volatility modeling

Choose one asset and try the EWMA model on the squared log-returns for different values of the memory α. Plot the volatility envelope.

Exercise 4.12: ARCH volatility modeling

Choose one asset and experiment with ARCH(q) models with different values of q. Plot the volatility envelope.

Exercise 4.13: GARCH volatility modeling

Choose one asset and experiment with GARCH(p, q) models with different values of p and q. Plot the volatility envelope.

Exercise 4.14: SV modeling

Choose one asset and experiment with the SV model. Plot the volatility envelope and compare with the GARCH modeling.

Exercise 4.15: Kalman SV modeling

Choose one asset and experiment with the SV model via Kalman filtering. Try the AR(1) model and the random walk model. In addition, compare the models under the Gaussian distribution and the heavy-tailed t distribution.

Exercise 4.16: Multivariate GARCH modeling

Choose several assets and compare the results of asset-by-asset GARCH modeling and multivariate GARCH modeling via the constant conditional correlation model. Discuss the results.

Exercise 4.17: Kalman for multivariate SV modeling

Choose several assets and compare the results of asset-by-asset Kalman SV modeling and vector Kalman SV modeling (including correlation among assets). Discuss the results.