Advanced Risk Management

Computer Exercise Week 1

In this exercise, we compare the RiskMetrics VaR to the (Weighted) Historical Simulation approach. We compare the time patterns of the three VaR measures applied to S&P 500 index returns in the period January 2001 through December 2010. Next, we evaluate the three approaches using backtests.

Efficient programming of the Weighted Historical Simulation method requires a function that can deliver weighted percentiles from a sample. The code for this has been found on the web, and imported in the Jupyter notebook `ComputerExercise1.ipynb`, which also loads the necessary data (using the `pandas DataReader` connected to Yahoo! Finance; this does not always work properly, and alternatively the data can be imported from `SP500.csv`). The notebook will need to be completed for this exercise.

1. Calculate the 1%, one-day VaR for S&P 500 index returns for each day in the evaluation period (January 2001 through December 2010), using each of the three methods, and keep the result in three vectors / arrays. The scripts already contain the definition of a weight vector `w`, based on a historical period $m = 250$, and a parameter $\eta = \lambda = 0.94$ for the WHS and RM methods. Note that WHS and the σ_{t+1} sequence in RM need a start-up sample period, for which we use data from the year 2000 (252 observations).
Note: an easy way to implement the RM method to construct σ_t^2 is to use the `series.ewm()` function from `pandas`. Note that in that function, $\alpha = 1 - \lambda$, and also that you need to apply this to the *lagged* squared return (so using the `series.shift()` function).

2. Make a figure where each of the three VaR measures are plotted against time. Discuss the similarities and differences.

3. Investigate the effect of changing the η parameter in the WHS method: what happens if we give η a value very close to 1, e.g. 0.999?

4. Construct the hit sequences $I_{t+1} = \mathbb{I}(R_{t+1} < -VaR_{t+1}^{0.01})$, for each of the three VaR methods.[1] Next, test unconditional coverage and independence using the methods described in the slides (you may also use Christoffersen's LR tests for comparison). What do you conclude?

[1] $\mathbb{I}(\cdot)$ is the indicator function, i.e., $\mathbb{I}(A) = 1$ if A is true and 0 otherwise.