Assignment 2 Quantitative Risk Management:

PCA, copula and EVT

The purpose of this assignment is to familiarize ourselves with applications of PCA, copulae and Extreme Value Theory.

Recall that you have chosen three to five assets for your portfolio in Assignment 1. So for this assignment, you can carry on with the same assets, but now you need to extend your asset universe a bit, so add several more assets (e.g., a few more indices like commodity or stock indices or several individual stocks) to your portfolio. You can also choose an entirely new bunch of assets, like 10 individual stocks or 10 commodities.

You should have approx. 10 different assets in your portfolio: these can be market indices from different countries, bond prices, individual commodities or commodity indices, alternative investment classes (funds, trackers, ETFs), bitcoin or anything else you can think of. Alternatively, you can make a portfolio of individual stocks, these can be from the same stock index (e.g., 10 stocks from, say, S&P500 or AEX), or a portfolio of several commodities (10 or so). When you download the historical prices for your assets, take daily data, make sure you have enough of historical data to do the analysis. Several hundred observations per asset would be good. Download historical data for these new assets, for minimum of 4 years, but better for 8-10 years.

Make sure you synchronize your dataset by date, in other words, if some assets do not have quotes for some days, remove quotes for those days also for other assets – for all days/weeks, you should have ALL asset prices available simultaneously. For this assignment, you can ignore exchange rates.

Perform the following analyses:

1. PCA on daily returns. Report all the usual PCA diagnostics and interpret the first few principal components on the basis of their loadings.

2. Factor Analysis (you can do it as a non-orthogonal PCA such as PCA with oblique rotations, or choose for any other way to perform non-orthogonal FA). Compare the interpretation of factors with PCA.

3. Fit copulas to several pairs of asset returns (your choice which pairs) and give visual representation of these copulas, as well as determine which would be the best copula and report estimated copula parameters. So here only work with bivariate copulas.

4. Choose an asset in your portfolio (this one or the one from Assignment 1) with heaviest tails of returns – use QQ plot or histogram of returns to determine that. If none of your assets have heavy tails, use Bitcoin price (log)returns – see excel file in this folder. Perform EVT analysis to these returns, i.e., choose threshold, collect threshold exceedances, estimate parameters of GPD from these exceedances, give your opinion on heaviness of the tail (xi-parameter), estimate high quantile VaR and ES from EVT results and compare them with those obtained from historical simulation method and Student-t distribution (for that same asset).