## 7   VaR and ES

1. VaR and ES estimation

   (a) Get historical prices for the S&P500 index, from 04-04-2014 to 28-10-2022, convert into log returns.

   (b) Compute in-sample estimates for VaR and ES at 1% and 5% levels, with normal residuals. Base your estimates on GARCH(1,1) volatility estimates.

   (c) Compute in-sample estimates for VaR and ES at 1% and 5% levels, with Student-t residuals. Base your estimates on GARCH(1,1) volatility estimates.

   (d) Compute the Historical Simulation VaR and ES at 1% and 5% levels.

2. Past exam question

   Your investable universe consists of two bonds, A and B. Each of the bonds has face value GBP 100, and the payoff distribution for the two bonds over the relevant investment horizon is identical and independent across the bonds. The following is known regarding the payoff of each of the bonds:

   - The probability of default is 6%;
   - In the event of no default, the profit in the bond is GBP 5;
   - In the event of default, the recovery rate on the bond is 40%.

   (a) Compute the Value-at-Risk and Expected Shortfall on a portfolio that consists of Bond A alone in the level p = 10%;

   (b) Compute the Value-at-Risk and Expected Shortfall on a portfolio that consists of Bonds A and B at the level p = 10%;

   (c) Is sub-additivity satisfied in this example for Value-at-Risk? Is sub-additivity satisfied in this example for Expected Shortfall?