# Practical Problem for the Midterm Exam - Fall 2023

FE-570

23 October 2023

**Problem 11.** (20pt)

The data for this problem is contained in the file `taqdata_BTCUSD.RData`. This is a trade-and-quote file giving the trade price, size, and the quotes at the time of each trade for Bitcoin trades during 24 hours (19-Apr-2023).

i) Report the number of trades in the dataset, and the minimum and maximum trade price during the time interval in the dataset.

ii) For each transaction, compute the spread measures:

- Quoted spread $qs_t = ask_t - bid_t$
- Effective spread $\text{es}_t = 2d_t(p_t - mid_t)$ where $mid_t = \frac{1}{2}(ask_t + bid_t)$ is the mid-price, and $d_t$ is the trade sign ($\pm 1$ for buy/sell). The dataset has a column "SIDE" which reports the trade sign. Use this instead of the Lee-Ready rule for computing the effective spread. Note that using `getLiquidityMeasures` will return the incorrect result, as it assumes the Lee-Ready rule.

Compute the averages of these two measures over all transactions.

iii) Compute the Roll's estimate of the bid-ask spread.

*Hint.* Start with the time series of $p_t$ (the trade prices). Compute the covariances `acf(type="covariance")` of the price changes $\Delta p_t = p_t - p_{t-1}$. Denoting the covariances at lags 0 and 1 as $\gamma_0$ and $\gamma_1$, respectively, proceed as in the lecture on the Roll model.

**Extra credit.** (iv) Compare the trade sign in SIDE with the prediction of the Lee-Ready empirical rule. What is the accuracy of the Lee-Ready rule? This can be measured as the percentage of trade signs which are predicted correctly by the Lee-Ready rule.