Hand-In Assignment #4
German Stock Market Volatility and Trading Volume

This assignment considers the relationship between stock-market return, volatility, and trading volume. Large trading volume tends to indicate larger movements in asset prices and may also be associated with higher volatility. More precisely, some behavioral theories suggest, that it is not trading volume *per se* but rather unexpected movements in trading volumes–referred to as *surprise trading volume*–which is associated with movements in returns and volatility.

An interesting journal article considering the relationship between equity prices and surprise trading volume is Wagner and Marsh (2005), analyzing a number of stock markets using a plethora of model specifications. This assignment asks you to build a basic model for daily changes in the German blue chip stock market index, DAX, and augment it with a surprise volume indicator in order to replicate parts of the analysis in Wagner and Marsh (2005).

The Data

The data file Assignment_4.in7 contains daily data for the period November 1, 1999, to November 22, 2021, for the following variables

DAX	:	Stock market index consisting of blue chip German companies trading on the Frankfurt Stock Exchange
logDAX	:	log(DAX).
DlogDAX	:	$100 \cdot (\text{logDAX}_t - \text{logDAX}_{t-1})$.
Vol	:	Trading volume (number of stocks traded).
logVol	:	log(Vol).
logVolMA50	:	50 days moving average of logVol.
FirstTrDay	:	Dummy variable for day after a closing day.
LastTrDay	:	Dummy variable for day before a closing day.
isJan,....,isDec	:	Dummy variables for month of the year.

The data has been downloaded from `https://finance.yahoo.com/`.

We use log-volume in order to consider percentage changes in volume. The time series logVolMA50 is included to represent the underlying trend in trading volume, and we are interested in the deviation from the trend, i.e. the variable

$$S_t = \mathsf{logVol}_t - \mathsf{logVolMA50}_t, \tag{2.1}$$

see also the discussion in Wagner and Marsh (2005). The variable S_t is highly autocorrelated and therefore also predictable, and it does not well represent the surprise trading volume. Following Wagner and Marsh (2005), we use a simple univariate time series model to filter out the predictive part, e.g.

$$S_t = \delta + \sum_{i=1}^{k} \phi_i S_{t-i} + \gamma_1 \mathsf{FirstTrDay}_t + \gamma_2 \mathsf{LastTrDay}_t + \kappa_1 \mathsf{isJan}_t + ... + \kappa_{11} \mathsf{isNov}_t + f_t, \tag{2.2}$$

where the unpredictable part, the estimated residual $\hat{f}_t$, is our measure of surprise trading volume.

The model M4 in Wagner and Marsh (2005) focuses on *positive surprise trading volume*,

$$f_t^{\text{pos}} = \hat{f}_t \cdot \mathbb{I}(\hat{f}_t > 0),$$

where

$$\mathbb{I}(\hat{f}_t > 0) = \begin{cases} 1 & \text{if } \hat{f}_t > 0 \\ 0 & \text{elsewhere} \end{cases}$$

is the indicator function, but the negative surprise trading volume,

$$f_t^{\text{neg}} = \hat{f}_t \cdot \mathbb{I}(\hat{f}_t \leq 0),$$

may also be considered.

The Assignment

Try to replicate parts of the analysis in Wagner and Marsh (2005) by doing the following:

(1) Use a dynamic univariate model, e.g. the one in (2.2), to filter out the predictable part of the trading volume and save the residual, $\hat{f}_t$.
(2) Build a model for the daily change in the stock market index, DlogDAX, and analyze if the surprise trading volume the same day seems to affect the conditional mean and the conditional variance.

Hints

(1) For the graphical analysis, use any transformations of the variables you find relevant. You may use the autocorrelation function to illustrate predictability.
(2) You can use any model for the conditional mean and variance of the stock market index that you find relevant.
(3) Carefully motivate the model you use. In particular, you may consider the following:

(a) Do market shocks have symmetric effects on the conditional variance?
(b) Do positive and negative surprises in trading volume have symmetric effects?
(c) Have the effects from trading volume been stable over time?

(4) Be precise about the statistical tests you use for testing various hypotheses. Explain which null hypotheses you test, how you test them, and what your conclusions are.

Formal Requirements

(1) You must hand in a report that (*i*) presents your graphical analysis, (*ii*) describes the econometric model, (*iii*) outlines the modeling progress (e.g., the approach you have taken, the alternative models you have tried, etc.), (*iv*) presents your preferred model including interpretation and statements on economic and statistical significance, and (*v*) discusses the potential weaknesses of the model.
(2) The report must be a maximum of 12,000 characters including spaces (corresponding to 5 normal pages of text) plus 2 pages with output in the form of tables and graphs. The report must be written in English. It must be handed in as a pdf document through Peergrade on Absalon.
(3) If you prefer, you are allowed to work in groups of up to three persons (not necessarily in the same exercise class as yours). The assessment criteria are given on the course page on Absalon.

References

[1] Wagner, N. and Marsh, T. (2005): "Surprise volume and heteroskedasticity in equity market returns", *Quantitative Finance*, Vol. 5, No. 2, 153–168.