ECON90033 – QUANTITATIVE ANALYSIS OF FINANCE I

Second Semester, 2023

Assignment 2

Due date and time: Thursday 5 October, 11:00 AM

Please read the following instructions carefully before starting to work on the assignment.

- **There is a total of 25 marks for this assignment. It is worth 25% of the final grade for QAF1.**
- **This assignment must be submitted online via the LMS by 11:00 AM on Thursday 5 October. Any assignment not submitted by the due date and time will incur a 10% penalty of available marks for each full hour late until zero mark.**
- **Students may work alone and submit their own assignment answers if they wish to do so, or they can work on the assignment in pairs. In the latter case, each assignment pair must submit only one set of assignment answers and both students of the pair will receive the same mark for their assignment. It is not allowed to form assignment groups of more than two students.**
- **Please note that the assignment submission process has two stages:**

  1. Registering your assignment group (only if you work in a pair), and

  2. Submitting the assignment online via the LMS.

  Students who intend to work on the assignment in pairs must register their groups. To do so, click the "People" link and then the Groups tab in the Canvas course navigation menu. The group names (set by default) are QAF1 Assignment 2 1, QAF1 Assignment 2 2, QAF1 Assignment 2 3, etc. Every assignment pair MUST register as one of these created groups for submitting the assignment and not create a new group. The deadline for registering your group is 5:00 PM on Wednesday 27 September. If a pair fails to register their group before the deadline for group registration, both students will need to make an individual, i.e., sufficiently different, submission.

  Students making individual submissions do not need to register.
- **You must answer the assignment questions using Microsoft Word or some other word processing software (WordPerfect Office, LaTeX, R markdown, Scientific Work, etc.). Make sure to include a cover page in the document with the student ID, the name, and the tutorial group of each group member.**
- **If a task involves some manual calculations, use your calculator (not *R*, *Excel,* or any other software), the relevant statistical table(s), and show the**

major steps, including the formulas in the document. Otherwise, use only *R / RStudio* and paste your scripts, screenshots, and printouts (graphs, output tables, etc.) into the document.

- **Once you complete the assignment, convert the whole file to PDF before submitting it online via the LMS. Please note that only PDF files can be uploaded to the LMS.**
- **Do not forget to preview your assignment after uploading it on the LMS to ensure that you have indeed uploaded the correct and complete assignment and that its formatting is in order as in the original document. Submissions that are late because of formatting issues or because a version is incomplete, will not be accepted.**

Assignment Tasks and Questions

There is one exercise in this assignment, consisting of seven parts. Perform all your calculations with *R*. Download the *a2e1.xlsx* file.

Exercise 1 (2 + 4 + 2 + 3 + 2 + 8 + 4 = 25 marks)

This exercise is based on a 2001 *Quantitative Finance* paper of R.F. Engle and A. J. Patton titled “What good is a volatility model?”. You are going to perform similar analysis but on an updated data set saved in the *a2e1.xlsx* file. This file contains daily data for the period 3 January 2000 to 31 August 2023 on the Dow Jones Industrial Index (*DJ*).

(a) Launch *RStudio*, create a new project and script, and name both *a2e1*. Import the data from the *a2e1.xlsx* file to *RStudio*, save it as *a2e1.RData*, and attach this data set to your *R* project. Create an *xts* objects of the *DJ* series.

Plot the Dow Jones index and its percentage log returns (*r*) and comment on any volatility clustering.

There are gaps in the *r* series because *DJ* is not recorded every day. Since many functions cannot handle gaps in the data series, generate a new series

r = na.omit(r)

and do all subsequent calculations on this new series.

(b) Perform the *ADF* and *KPSS* tests on *r*. What conclusion do you draw from these tests about the order of integration of the percentage log returns of the Dow Jones Industrial Index?

(c) Plot the correlogram of *r* and r^2. What do they suggest about autocorrelation in the returns and in the squared returns on the Dow Jones Industrial Index?

(d) Compute the daily standard deviation, variance, skewness, and kurtosis of *r*. Comment on the results.

(e) In general, the daily volatility of a stock is measured by the standard deviation of the daily stock price, and the annualized volatility is calculated by multiplying the daily volatility by the square root of 252. What is the annualized volatility of the Dow Jones Industrial Index?

(f) Estimate the following *GARCH*(1,1) model for the returns on the Dow Jones Industrial Index:

$$
\begin{aligned}
&r_t = \mu_0 + \varepsilon_t \\
&\varepsilon_t : idN(0, h_t) \\
&h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}
\end{aligned}
$$

Consider your printout. Comment on the coefficients and on their significance based on robust standard errors. Briefly evaluate the weighted Ljung-Box tests, the weighted *ARCH LM* tests, the Nyblom stability tests, and the sign tests. For each group of these tests, state the null and alternative hypotheses, the statistical decision, and the conclusion.

(g) Estimate the following *TGARCH*(1,1) model for the returns on the Dow Jones Industrial Index:

$$
\begin{aligned}
&r_t = \mu_0 + \varepsilon_t \\
&\varepsilon_t : idN(0, h_t) \\
&h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \eta_1 d_{t-1} \varepsilon_{t-1}^2 + \beta_1 h_{t-1}
\end{aligned}
$$

where $d_{t-1} = 1$ if $\varepsilon_{t-1} < 0$ and zero otherwise.

Do the results imply that negative innovations have greater impact on the conditional variance of the Dow Jones returns than positive innovations? Which model do you prefer, *GARCH*(1,1) or *TGARCH*(1,1)? Explain your answers.