MSDS 413, Assignment 6
Volatility Models (TS6)

Introduction

For this assignment, you will use the datasets and R script (TS6.R) included in the zip file (TS6.zip), posted to the Module 6 Overview page of Canvas. You will read the data files into R and conduct the requested analyses.

The instructions for submitting your assignment follow the Procedure section below.

The following list defines the data sets and their respective variables.

The daily returns of Microsoft stock (msft) stock for the period given in the starter R script. The data are available from yahoo! finance (https://finance.yahoo.com/quote/MSFT/history?p=MSFT) and in the file MSFT.csv. Date" "Open" "High" "Low" "Close" "Adj.Close" "Volume"

- Date: year month day

- Open: daily opening price

- High: daily high

- Low: daily low

- Close: daily closing price

- Adj.Close: adjusted daily closing price

- Volume: daily volume

The monthly returns of Boeing (BA) stock for the period given in the starter R script. The data are available from yahoo! finance (https://finance.yahoo.com/quote/BA/history?p=BA) and in the file BA.csv.

- Date: year month day

- Open: monthly opening price

- High: monthly high

- Low: monthly low

- Close: daily closing price

- Adj.Close: adjusted monthly closing price

- Volume: monthly volume

Your objective is to explore the time series behavior of these data sets including EDA, modeling, model diagnostics, and interpretation.

Procedure

The following steps are necessary to complete this assignment. Address each and every part and ensure that you cover all the details specified in the questions.

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1. **MSFT** (30 points) Consider the daily returns (msft) of Microsoft stock from January 4, 2010 to April 17, 2020. Construct time series models of the Microsoft daily adjusted closing price as follows.

   1.1. Use EDA on the msft daily log returns. Is the expected log return zero? Why? Are there any serial correlations in the log returns? Why?

   1.2. Write a mean model (arima to forecast expected values) to be fitted based on your EDA. Construct a mean model for the log returns. Is there an ARCH effect in the log return series? Why?

   1.3. Fit a Gaussian ARMA-GARCH volatility model to the log return series. Obtain the normal QQ-plot of the standardized residuals, and write the model to be fitted. Is the model adequate? Persistent? Why?

   1.4. Build an ARMA-GARCH model with Student-t innovations (cond.dist="std") for the log return series. Perform model checking and write the model to be fitted.

   1.5. Obtain 1-step to 90-step ahead mean and volatility forecasts using the fitted ARMA-GARCH model with Student-t innovations.

   1.6. As the estimated coefficient of the mean equation is small, we may ignore the mean equation; i.e., use the mean equation $r_t = a_t$. Fit an IGARCH(1) model to the log returns. Write the model to be fitted.

   1.7. Let σ_t be the fitted volatility of the IGARCH(1) model. Define the standardized residuals as $\epsilon_t = r_t/\sigma_t$, where r_t is the daily log return. Is serial correlation in the standardized residuals present? Persistent? Why?

   1.8. Is serial correlation in the squares of the standardized residuals present? Why?

   1.9. Based on the model checking, is the IGARCH model adequate? If yes, obtain 1-step to 5-step ahead volatility forecasts for the log return series (forecast origin is the last data point).

   1.10. Which model do you recommend and why?

2. **Boeing returns** (30 points) Consider the monthly returns of Boeing (ba) stock.

   2.1. Use EDA on the BA monthly closing prices. Is the expected ba log return zero? Why? Is there serial correlation in the log returns? Why? Is there any ARCH effect in the log returns? Why?

   2.2. Build a GARCH model with Gaussian innovations for the log return series. Perform model checking and write the model to be fitted.

2.3. Fit a GARCH model with skew-Student-t innovations (cond.dist="sstd") to the log return series. Perform model checking and write the model to be fitted. Based on the fitted model, is the monthly log returns of ba stock skewed? Why?

2.4. Fit a GARCH-M model to the monthly log returns. Write the model to be fitted. Is the risk premium statistically significant? Persistent? Why?

2.5. Fit a TGARCH(1,1) model to the monthly log returns. Write the model to be fitted. Is the leverage effect statistically significant? Persistent? Why?

3. **Report** (20 points) Write a Boeing returns analysis executive summary.

Deliverables

Your instructor may modify these and all the following directions. See Section Submission Directions below. The assignment deliverables, each in pdf format, are as follows:

- *Only if requested by instructor*

  - The program or script
  - Logs
  - Outputs

- Mandatory
  Data analysis write-up: no programs, logs, or just code outputs; **complete EDA and model diagnostics are expected unless otherwise instructed; I will be looking for innovative interpretations in the assignments over and above the rote adherence to assignment requirements. Only partial credit will be awarded for rote adherence to assignment requirements.**.

The data analysis must follow and use the item numbering of each assignment, i.e., use the numbers, say, 1 - 5, with the sub-lettering if used. These deliverables are provided according to the instructions in the Submission Directions section below.

Submission Directions

Title Page

Include a title page with your name and the assignment designation. Leave room for instructor comments.

File Names

The assignment write-up file shall be submitted to Canvas according to the schedule in the syllabus using the item (1) naming convention below. The naming convention is case sensitive. Use letters and numbers as given. **The file name parts have no spaces or other separator characters**. TS6Lastname.pdf (submit via Canvas)

The parts are the assignment code, TS6; your last name with only the first letter capitalized; a period, and lastly, the extension "pdf". Generically,

TS6Lastname.pdf

For example: Suppose your name is Student McStats. Your filename then is:

TS6Mcstats.pdf

The analysis write-up file must be submitted for grading. Each write-up requires a title page for instructor comments. The analysis may use either R or any other statistics package you wish, or if you use more than one package, you must use the germane tables, plots, etc., in a single report. If you use more than one package, differences and similarities should be indicated.

email

ONLY IF REQUESTED email your instructor the program (script or code), log and output as separate pdf files. The R log and output may be combined. The file names shall be as follows:

- The program or script file names
    - TS6LastnameRprog.pdf
- The log file names
    - TS6LastnameRlog.pdf