

FINANCIAL STATISTICS

2023-11-05

Time: 08.00 - 13.00
Place: TBD
Approved aid: available at the homepage of the exam; calculator

Questions about the content of the exam: Examiner plans to stop by the exam venue **at the start and close to the end of the exam**. Otherwise, check with the personal that supervises the exam.

To upload the R-packages use plain R. If you try to upload the packages in RStudio, your PC might become irresponsive and you need to restart the RStudio or/and computer. Remember to use a separate help file for R-commands available on the homepage of the exam. After the packages are uploaded using the nearest mirror site (usually, Umeå), you can link the libraries using RStudio. If you need to upload some additional packages, do so using plain R. If an R-package you want to use is missing from the provided list, indicate clearly in your exam report the name of the package and for what purpose you use it. No IT help is available for this step.

Remember to save your progress in RStudio frequently in case you need to re-start RStudio/PC.

Below are the examples of possible instructions if you decide to make separate uploads:

```
install.packages("forecast"); library(forecast)
install.packages("tseries"); library(tseries)
install.packages("lmtest"); library(lmtest)
install.packages("FinTS"); FinTS::ArchTest()
```

If you ask a question during the exam, you will get a clarifying answer about the content of the exam question, not an answer how to solve it. No IT help is available during the exam.

- **Part I (Time Series, R-Studio based)**

You are asked to analyze **WEEKLY** stock data **for the last 5 (five) years** using R and submit a written assignment in an essay form. Your essay should contain key R-commands, the output from R-Studio as well as clear interpretation of results. Submissions in .docx and .pdf formats are ok but the .pdf format is preferred. In case no key R commands are clear in the text of your answers, the final grade will be reduced. In case there is no output or interpretation of the output, zero credit is given.

Please attach your complete R-code as a separate file, preferably converted into the .pdf format for the reference purposes. The file that contains the R-code is not graded.

- **Part II (Exercises)**

You are expected to provide detailed solutions to the asked questions and write them clearly on the paper provided at the exam. Submit your solutions on time. Answers without solutions are not accepted.

Reminder (both parts): all the sheets you are submitting should contain your anonymous code and be ordered the way you want your answers are read. If labelling of the pages is not properly done, we cannot guarantee that the pages that are not marked properly will be graded.

Upload Deadline: 13:00 (no submissions after the deadline will be graded)

- **Grading, minimum requirements:**

- E: fully answer “Part I” a-d and make a fair attempt on remaining of “Part I” or at least one of the questions in “Part II”. Satisfactory answers in “Part II” or remaining of “Part I” may compensate for somewhat lacking but not wrong answer in d) of “Part I”
- C: fully answer Part I a-d, answer e-g in a satisfactory way; make a fair attempt on Part II (both questions) or solve one of the problems from Part II in a satisfactory way. Satisfactory answer to Part II (both parts) may compensate for lacking in e-g of Part I
- A: answer Part I in full with minor deficiencies. Answer Part II (both questions) in a satisfactory way

These are preliminary requirements. The examiner might adjust the scale upward, if necessary.

- NOTE! Fx and F are failing grades that require re-examination. Students who receive the grade Fx or F cannot supplement for a higher grade.
- If you are not satisfied with your grade, you may contact the examiner for further instructions.

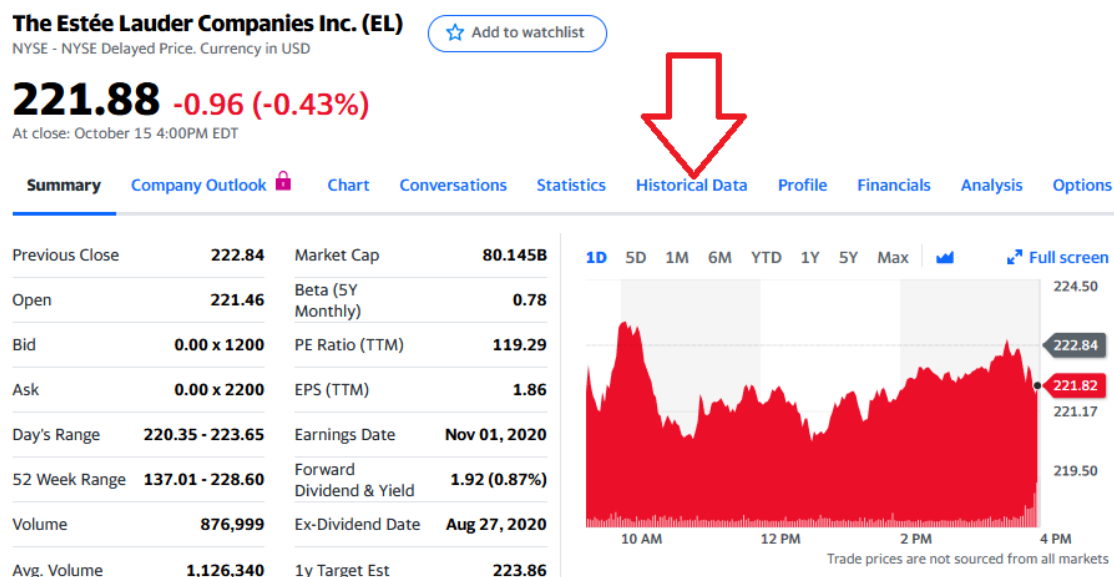
GOOD LUCK

Part I, Data

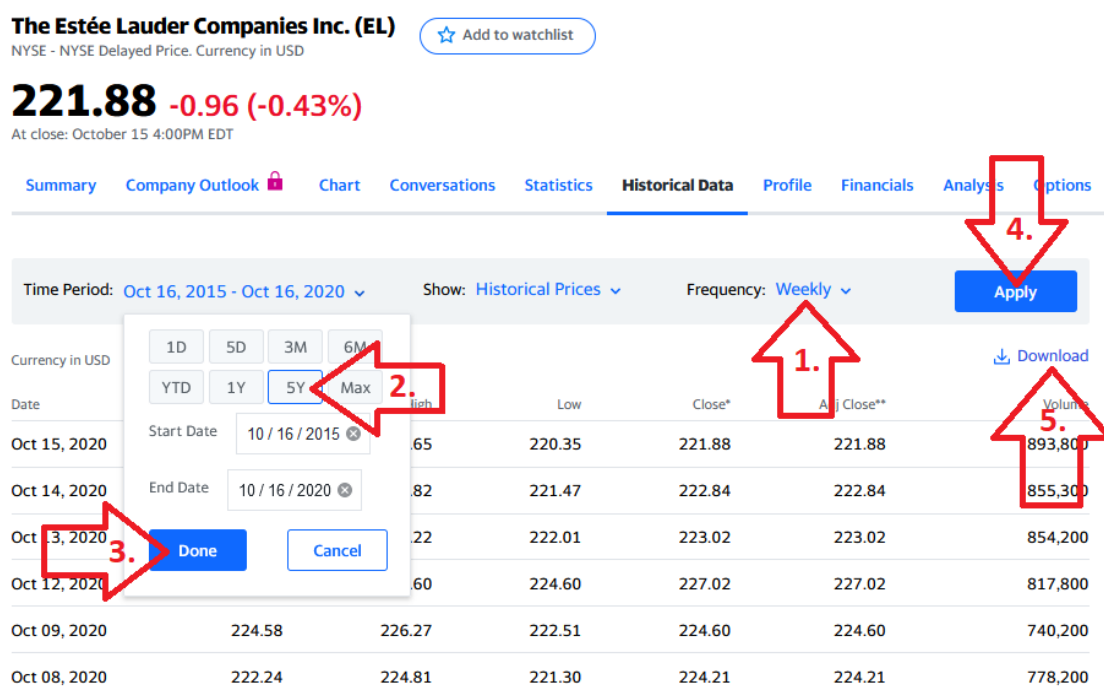
Below, you will find a selection of data sets, mostly the time series of stock price for the companies from S&P 500. Your data corresponds to the number from the anonymous code, assigned to you for this exam. For instance, if you have the anonymous code 311-0001-XXX, your data is “NVDA’s”, Nvidia Corporation. Follow these instructions to download your stock but modify them to the frequency/length of the time series. The example below exemplifies how to upload 1 year of daily data. The exam question might request something different.

1. Go to <https://finance.yahoo.com/>
2. Enter the “Symbol” for your stock into the Yahoo! Finance search field and press enter. For example, if your stock is The Estee Lauder Companies Inc. enter “EL” into the search field and press enter.

- Click historical data:



- Change Frequency to “Daily”; Click Time Period, choose “1Y”, and click “Done”; Click “Apply”; finally, click “Download.” Make sure that you have one year of daily data, or slightly more (252 observations or so). If your stock does not have 1 year of data, choose “Max.” In this case, you will of course have less than 252 observations.



- You may read the data into R any way you want; the following step is just a suggestion. Open a new .R-file and paste in the following code:

```
EL <- read.csv("EL.csv")
```

This assumes that you have copied the downloaded stock data file to your work directory. Remember that you can find out what your work directory is with the command

```
getwd()
```

You can list the files in your work directory with

list.files()

If you are having trouble loading the file, first make sure that your file is in the work directory. Save the .R-file and run it. Then verify that the data is correctly read into R.

Use Adj.Close price when available. Otherwise, state clearly what data you use.

Code	Symbol	Name
0001	NVDA	Nvidia Corporation
0002	TSLA	Tesla, Inc.
0003	BA	The Boeing Company
0004	BTC-USD	Bitcoin USD
0005	ERIC	Telefonaktiebolaget LM Ericsson
0006	Telia.st	Telia Company AB
0007	AZN	AstraZeneca PLC
0008	MSFT	Microsoft Corporation
0009	LLY	Eli Lilly and Company
0010	JPM	JPMorgan Chase & Co.
0011	CVX	Chevron Corporation
0012	ACN	Accenture plc
0013	NVDA	Nvidia Corporation
0014	TSLA	Tesla, Inc.
0015	BA	The Boeing Company
0016	BTC-USD	Bitcoin USD
0017	ERIC	Telefonaktiebolaget LM Ericsson
0018	Telia.st	Telia Company AB
0019	AZN	AstraZeneca PLC
0020	MSFT	Microsoft Corporation
0021	LLY	Eli Lilly and Company
0022	JPM	JPMorgan Chase & Co.
0023	CVX	Chevron Corporation
0024	ACN	Accenture plc
0025	NVDA	Nvidia Corporation
0026	TSLA	Tesla, Inc.
0027	BA	The Boeing Company
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0043	AZN	AstraZeneca PLC
0044	MSFT	Microsoft Corporation
0045	LLY	Eli Lilly and Company
0046	JPM	JPMorgan Chase & Co.
0047	CVX	Chevron Corporation
0048	ACN	Accenture plc
0049	NVDA	Nvidia Corporation
0050	TSLA	Tesla, Inc.

The goal of the assignment in Part I is to perform the analysis of your assigned stock in **R** and then write a short essay answering the questions below. Make one headline in the essay for each part that you answer, e.g. “a. Introduction and Trend” and “b. Stationarity.” Preferably, use a new page when you answer a new question. It is important that you include plots/tables that are outputs from R and the key R-commands.

- (a) Describe the time series with an appropriate plot/diagram. Comment on the diagram and provide summary statistics. Is there a visible trend? Test for the trend using simple linear regression. You can choose different time intervals to “prove” that the time series has extensive time periods of trends, if any.

For steps b, c, and d, leave out **the last 4 observations** that will be referred to as “the testing set”.

- (b) Stationarity. Use a formal test for stationarity. If it is clear from the diagram that your data is non-stationary, you may apply an appropriate transformation but perform testing first. State the hypotheses and interpret the outcome of the test. Use 5% significance level. If the data does not seem to be stationary even after transformation, attempt another transformation and repeat this step. Make sure that you have the figure containing the stationary time series. In case you have to choose between mildly (visualize the time series in question) non-stationary time series and “white noise” style time series, choose the former in favor of the latter.
- (c) Plot the ACF and PACF plots. Choose the number of lags appropriately and justify your choice. Explain what the plots show. Specifically state and interpret the value of the **first (1st)** bar in the ACF plot and explain how it has been used in the analysis. Compare with the same bar in the PACF. What is the difference? For the higher grade, remember to return to this question when you have chosen “the best” model. Make specific references to the models you selected for the step (d). Use these plots as the basis for your choices in (d).
- (d) Whatever the (P)ACF plots you got, choose (by performing proper statistical analysis) at least four the most promising ARIMA models that are top candidates to fit the data (leaving out the testing set). One of them should be an ARIMA(0,d,0): indicate what “d” you have

chosen and why. You have to have a detailed description of your selection process: why selected by you models are better than other potential candidates. Provide output, analysis and the AIC scores for each “potentially good” model. Interpret your findings. Which model seems most promising? Should any of your models be disregarded completely? Why?

- (e) Choose the two “best” models from (d). Use the last 4 observations, i.e. your testing set, to calculate RMSE. The calculations should be explicit and easy to follow. Compare the two and interpret the difference. Moreover, visualize both predictions and discuss the figures. Make clear and well-motivated conclusions. Specifically discuss the values of the RMSE for the selected models.
- (f) Pick “the best” model from question (e). Test that model for ARCH effect. State the hypothesis and explain the outcome of your test. Explain what the presence of ARCH effect would mean for your results in (d), even if you did not find any. Discuss briefly why estimating variance is important in financial forecasting. Visualize the ARCH effect for your model.
- (g) Pick “the best” model from question (e). Write down the model explicitly and discuss the coefficients. Discuss connection to the (P)ACF plots. Provide residual analysis of the model and report your conclusions. Further, provide overall conclusions for your analysis.

END OF PART I

Part II (“Pen-and-Paper-Answer” questions: one cannot use R-Studio to solve it. Write your answers on a paper.)

1. The sinking of Titanic is one of the most infamous shipwrecks in history. On April 15, 1912, during her maiden voyage, the Titanic sank after colliding with an iceberg, killing 1,502 of the 2,228 passengers and crew. Using the “Titanic data”, researchers fit the following multiple logistic regression:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3,$$

y = log-odds of surviving (0=Dead, 1=Alive)

x_1 = Age (0, 1, 2, ..., 99)

x_2 = Gender (0 = Male, 1 = Female)

x_3 = Class3 (0 = Class2 or better ticket, 1 = Class3 ticket)

The output of the analysis turned out to be the following:

Survive ~ Age + Gender + Class3				
	Estimate	Std. Error	Z-value	P-value
Constant	0.476	0.407	1.168	0.043
Age	-0.025	0.009283	-2.664	0.008
Gender	3.084	0.271	11.385	0.000
Class3	-1.857	0.256	-7.262	0.000

- Test at the 5% level whether the parameter for "Class3" is significantly different from zero.
- Calculate and interpret the odds-ratio for the variable "gender".
- Find the estimated probability that “Jack” (male) who was 20 years old and had a 3rd Class ticket survived. Calculate the confidence intervals and interpret them the best you can using estimates provided in the table above.

2. Provide detailed calculations for the following questions (note that the correct answer without calculations is not accepted as a solution):

- Derive the autocorrelation function for the following MA(1) process $Z_t = \varepsilon_t - 1.5\varepsilon_{t-1}$. Assume that Z_t is stationary.
- Derive the autocorrelation function for the following MA(2) process $Z_t = \varepsilon_t - 1.5\varepsilon_{t-1} + 0.6\varepsilon_{t-2}$. Assume that Z_t is stationary.
