

## FINANCIAL STATISTICS 2022-10-28

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**Time:** 08.00 - 13.00  
**Place:** TBD: **Data Hall 34-36**, Albano Hus 4  
**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 of the exam and after about 1.5-2h. Otherwise, check with the personal that supervises the exam.

You are expected to upload R-packages you need and link the corresponding libraries. There is a separate file provided on the homepage of the exam. Below are examples of possible instructions:

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

If some package you want to use is missing from the provided list, indicate clearly what package and for what purpose you use. No IT help will be provided for this step, except for if R-Studio does not work as expected.

If you ask a question during the exam, you will get a clarifying answer about the content of the exam question, not how to solve it.

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

You are asked to analyze **WEEKLY** stock data using R and submit a written assignment in essay form. Your essay should contain output from R as well as clear interpretation of results. You are also asked to attach R code for the outputs you use to motivate your answers. In case no R code is attached, the final grade will be reduced.

- **Part II (Exercises)**

You are asked to provide detailed solutions to the asked questions. You may choose using pen and paper or typing your solutions in the Microsoft Word and then converting into .pdf format for further electronic submission. 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 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. Satisfactory answer in Part II can 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). Satisfactory answer to Part II 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**

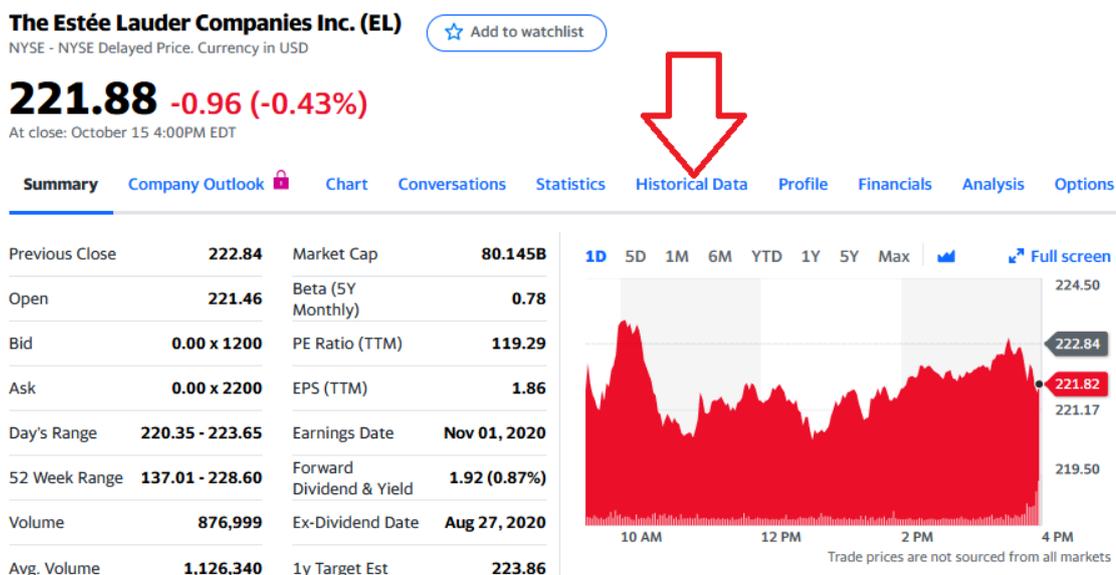
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### **Part I, Data**

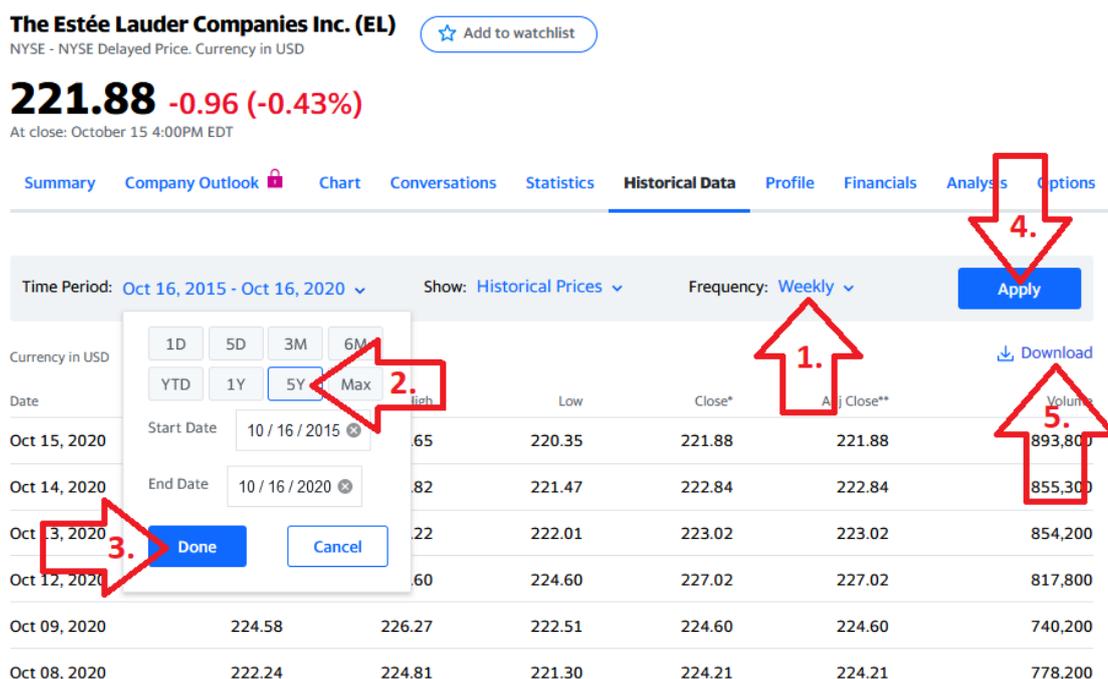
Below, you will find a selection of companies from the S&P 500. Your data corresponds to the number from the anonymous code, assigned to you for this exam. For instance, if you have the anonymous code 311-0001-XXX, your data is “SHOP”. Follow these instructions to download your stock:

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.*

3. Click historical data:



4. Change Frequency to “Weekly”; Click Time Period, choose “5Y”, and click “Done”; Click “Apply”; finally, click “Download.” Make sure that you have five years of weekly data, or slightly more (263 observations or so). If your stock does not have 5 years of data, choose “Max.” In this case, you will of course have less than 263 observations.



5. 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.

Code	Symbol	Name
0001	SHOP	Shopify Inc.
0002	SNAP	Snap Inc.
0003	BAC	Bank of America Corporation
0004	WMT	Walmart Inc.
0005	KO	The Coca-Cola Company
0006	NKE	NIKE, Inc
0007	TSLA	Tesla, Inc.
0008	AAPL	Apple Inc.
0009	NIO	NIO Inc.
0010	Telia.st	Telia Company AB
0011	NVDA	NVIDIA Corporation
0012	ERIC	Telefonaktiebolaget LM Ericsson
0013	PTON	Peloton Interactive, Inc.
0014	GOOGL	Alphabet Inc. Class A
0015	SBUX	Starbucks Corporation
0016	SHOP	Shopify Inc.
0017	SNAP	Snap Inc.
0018	BAC	Bank of America Corporation
0019	WMT	Walmart Inc.
0020	KO	The Coca-Cola Company
0021	NKE	NIKE, Inc
0022	TSLA	Tesla, Inc.
0023	AAPL	Apple Inc.
0024	NIO	NIO Inc.
0025	Telia.st	Telia Company AB
0026	NVDA	NVIDIA Corporation
0027	ERIC	Telefonaktiebolaget LM Ericsson
0028	PTON	Peloton Interactive, Inc.
0029	GOOGL	Alphabet Inc. Class A
0030	SBUX	Starbucks Corporation
0031	SHOP	Shopify Inc.
0032	SNAP	Snap Inc.
0033	BAC	Bank of America Corporation
0034	WMT	Walmart Inc.
0035	KO	The Coca-Cola Company
0036	NKE	NIKE, Inc

0037	TSLA	Tesla, Inc.
0038	AAPL	Apple Inc.
0039	NIO	NIO Inc.
0040	Telia.st	Telia Company AB
0041	NVDA	NVIDIA Corporation
0042	ERIC	Telefonaktiebolaget LM Ericsson
0043	PTON	Peloton Interactive, Inc.
0044	GOOGL	Alphabet Inc. Class A
0045	SBUX	Starbucks Corporation

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.” It is important that you include plots/tables that are outputs from R as well as key R-commands you use.

- (a) Describe the time series with an appropriate plot/diagram. Comment on the diagram and provide summary statistics. Is there a visible trend? You do not need to consider seasonal effects this time.

For steps b, c, and d, leave out **the last 6 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.
- (c) Plot the ACF and PACF plots. Explain what the plots show. Specifically state and interpret the value of the second (3rd) bar in the PACF plot and explain how you intend to use it in further analysis. Use these plots as basis for your choices in (d)
- (d) Choose 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. Provide output, analysis and the AIC scores for each 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 **6 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. Make clear and well-motivated conclusions.
- (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.
- (g) Pick “the best” model from question (e). Provide residual analysis of the model and report your conclusions. Further, provide overall conclusions for your analysis.

**Part II (Two Questions: one should not use R-Studio to solve them)**

1. Consider the following portfolio consisting of three (made-up) stocks. The “Expected Value” and the “Standard Deviation” entries are the expected return and standard deviation of the returns, over the next year. Assume that the correlation for each possible pair of the three stocks is 0.7

Stock	Expected Value	Standard Deviation	Weight
Magnavox	0.05	0.20	0.YY
Pong	0.10	0.40	0.20
Genesis	0.10	0.30	0.8-0.YY

where “YY” is exactly the number you used in Part I for selecting your individual stock. For instance, if you have your anonymous code 311-0040-XXX, the weight of Magnavox is 0.40 and the weight of Genesis is  $0.8-0.40 = 0.40$ .

Find the expected value and the variance of the portfolio described in the table. Provide calculations.

Find a better portfolio consisting of the three above stocks while keeping the same risk level as in portfolio above. Provide a clear argument and state clearly the weights of the preferred portfolio.

Explain how you would approach finding the best portfolio for the given risk level. No calculations are expected for this part.

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(2) process  $Z_t = \varepsilon_t - 1.4\varepsilon_{t-1} + 0.6\varepsilon_{t-2}$ . Assume that  $Z_t$  is stationary.
- What is the correlation between  $Z_t$  and  $Z_{t-1}$  for the model  $Z_t = 0.4 * Z_{t-1} + \varepsilon_t$ ? Repeat and report your calculations for the model  $Z_t = (-0.4) * Z_{t-1} + \varepsilon_t$ .
- Calculate the correlation between  $Z_t$  and  $Z_{t-2}$  for both models stated above in sub-question b).