

STUDENT N. :

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M1 - Financial Economics, academic year 2021 - 2022

22_M1_NI_FE_S1_CCO_627

**FINANCIAL
ECONOMETRICS WITH R**

FINAL ASSIGNMENT

START DATE: 19/11/2021, time: 11:59 AM (Paris time)

DUE DATE: 10/12/2021, time 4:00 PM (Paris time)

Professor/Lecturer: RUBIN Mirco

INSTRUCTIONS:

- APPENDIX(CES) PROVIDED : Not Applicable.
- SafeAssign : **THIS ASSIGNMENT IS PROTECTED AGAINST PLAGIARISM**

- Assignment Type : Individual assignment
- Assignment File(s) Type and Number : **1 unique file in either DOC, or DOCX, or PDF**
 - Submission Attempts : **2 attempts**, nevertheless in case of two submissions, the only attempt graded will be the second one .
- Instructions for students : see top of page 2.

INSTRUCTIONS for students:

You must answer all the 3 Questions, respecting the following page number limits:

- **Question 1:** answer must be provided in **maximum 8 pages** .
- **Question 2:** answer must be provided in **maximum 4 pages** .
- **Question 3:** answer must be provided in **maximum 3 pages** .
- R code used to answer Question 1 must be provided in an Appendix at the end of all 3 answers, and there is no page number limit for the R code.

Answers to all Questions 1, 2, 3 and the Appendix with the R code for Question 1 must be included in **one unique file** in one of the following three formats: **.DOC, or .DOCX, or .PDF** .

QUESTION 1 [Points : 11 out of 20]

INSTRUCTIONS

You must answer this question by generating tables / graphs using the software R. You must insert the tables / graphs you generated, relevant formulas and the commentary to them in **maximum 8 pages**. Only the first 8 pages with the answer to this question will be graded, and all the additional pages (9th, 10th etc.) will not be graded.

The R code used to generate the numbers / Tables / Figures provided for this answer should be copy-pasted in an Appendix to the submitted final file, to be placed after all the answers to all the 3 Questions. There is no page number limit for the R code of this Appendix. The title of this Appendix must be **“APPENDIX: R code for Question 1”**.

PRELIMINARY STEP 1

Download **one time series** of **at least 20 consecutive years** of daily Adjusted Prices from Yahoo Finance website of either **one stock** or **one stock market index** from the stock market in **one of the following countries**:

- **USA**
- **Australia**
- **Canada**
- **France**
- **Germany**
- **Italy**
- **Netherlands**
- **Switzerland**
- **United Kingdom**

Your sample of at least 20 years of consecutive daily data **must include the entire year 2020**, and must end on the last trading day of the year 2020 (that is at the end of December 2020).

You are allowed to use either one stock of a company, or one stock market index representing the stock markets (or a segment of the stock markets, for instance the index of energy stocks) of these countries, as long as the data can be downloaded from Yahoo Finance using the R function **“getSymbols”** from the R package **“quantmod”**, as we have done in **“Lecture 2: Financial Returns: Description and Stylized Facts”**.

You cannot use the following indexes / stocks: S&P500, DOW JONES (DJIA), IBM, TESLA.

Any choice of your sample/data not compliant with the above instructions will cause a heavy penalization on your grade of this question.

PRELIMINARY STEP 2

At the beginning of your answer to Question 1, indicate clearly:

- the **name** and the **exact ticker** of stock or index you are considering,
- the length of your sample (number of days, months, years),
- the initial and final dates of your sample, and
- the **stock market** and **country** in which the stock you selected is traded, or to which the stock index you selected refers to.

Using the time series you downloaded in PRELIMINARY STEP 1, compute the log-returns at **daily, monthly, and annual frequencies** and present a table of summary statistics of these three series of returns. The table should be similar to the one appearing in slide n. 91 of the set of slides titled ``Lecture 2: Financial Returns: Description and Stylized Facts''.

ANSWER THE FOLLOWING QUESTION :

Does the time series you have downloaded following the preliminary steps present features in line with all the **8 Stylized Facts** of financial prices / returns discussed in ``Lecture 2: Financial Returns: Description and Stylized Facts''?

Explain carefully your answer **for each of the 8 stylized facts** by using additional computations, tables and graphs done/generated using the software R and the data you have downloaded/computed following the two preliminary steps. You are free to decide the right mix of tables, graphs, formulas and comments needed to answer this question.

END OF QUESTION 1

QUESTION 2 [Points : 5 out of 20]

INSTRUCTIONS

You must answer to this question in maximum 4 pages. Only the first 4 pages with the answer to this question will be graded, and all the additional pages (5th, 6th etc.) will not be graded.

ANSWER THE FOLLOWING QUESTION, which is made by five sub-questions: 2.a, 2.b, 2.c, 2.d, and 2.e. :

Let z_t be the excess returns on month t of the stock IBM, computed as the difference between returns of IBM and the yield of a T-bill issued by the US Treasury with maturity 1 month. Consider the following “4 factors model” for z_t :

$$z_t = \beta_0 + \beta_M \cdot z_{M,t} + \beta_{SMB} \cdot z_{SMB,t} + \beta_{HML} \cdot z_{HML,t} + \beta_{MOM} \cdot z_{MOM,t} + \epsilon_t, \quad (1)$$

where $z_{M,t}$, $z_{SMB,t}$ and $z_{HML,t}$ are the 3 “Fama and French factors”, $z_{MOM,t}$ is the “Momentum” factor and ϵ_t is assumed to be $\epsilon_t \sim iid(0, \sigma^2)$. Model (1) has been estimated by OLS using the software R on a sample of 84 months (that is 7 full years of monthly data). The output of the estimation is given in Table 1. Note that some lines of the R output in Table 1 have been computed by the software, but your professor has hidden them: you might need to compute them to answer the following sub-questions.

```
Call:
lm(formula = IBM ~ MKT + SMB + HML + MOM)

Residuals:
    Min       1Q   Median       3Q      Max
-17.6900  -1.4814   0.5673   2.2927   8.8420

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -1.52976      0.48912  -2.928  0.00414
MKT           1.16978      0.16132   7.309  0.00000
SMB           0.12132      0.22398   0.628  0.53153
HML           0.12132      0.22798   0.628  0.53153
MOM          -0.02316      0.04318  -0.628  0.53153

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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.504
Multiple R-squared: 0.4504
```

Table 1: Output of R software for estimation by OLS of model (1)

Your professor is very concerned about the presence in the innovation terms of the model (1) of **conditional autocorrelation** up to order (lag) $p = 5$ and, instead of performing the usual Ljung-Box (or Box-Pierce test) on the residuals, he has performed for you the appropriate **auxiliary regression** to test for it. The adjusted R^2 of the appropriate auxiliary regression for this test is $\bar{R}^2 = 0.025$.

Question 2.a)

Using the above information, perform the test for the presence of autocorrelation in the innovations of the model with a significance level of 10% and discuss the results.

Question 2.b)

Given the results of the test you performed to answer Question 2.a), how would you construct appropriate standard errors for the coefficients of the regression model in equation (1)?

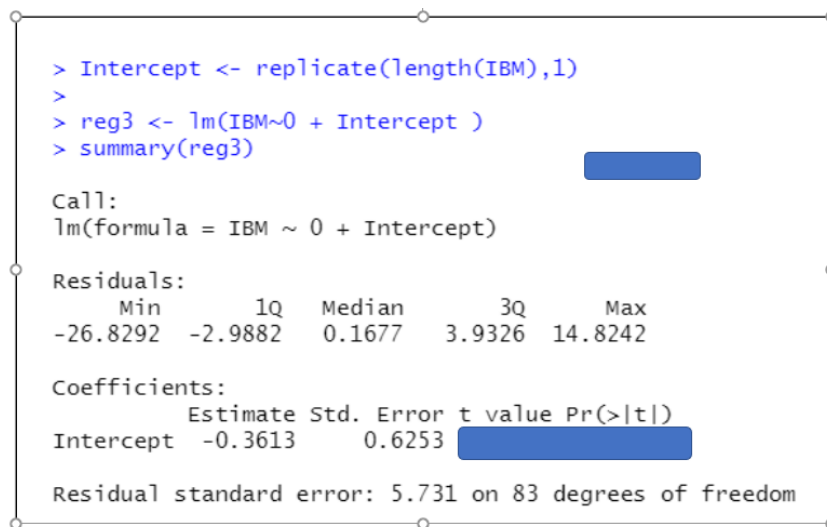
Question 2.c)

The same sample of $T = 84$ months used to estimate the model (1) has been used to estimate the following degenerate model including only the constant for the excess monthly returns of IBM:

$$z_t = \alpha_0 + u_t, \quad (2)$$

where z_t has been defined above, and u_t represents the innovations in this new model which are such that $u_t \sim iid(0, \sigma_u^2)$. The output of the estimation of model (2) is given in Table 2, displayed below.

Are all the 3 "Fama and French factors" and the "Momentum" factor useful to explain the time-series variability of the excess returns of IBM in this sample? Answer to this question by performing only one appropriate test of hypothesis using the information/numbers in Tables 1 and/or 2 and, if necessary, your own calculations based on those numbers.



```
> Intercept <- replicate(length(IBM),1)
>
> reg3 <- lm(IBM~0 + Intercept )
> summary(reg3)
```

Call:
lm(formula = IBM ~ 0 + Intercept)

Residuals:

	Min	1Q	Median	3Q	Max
	-26.8292	-2.9882	0.1677	3.9326	14.8242

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
Intercept	-0.3613	0.6253		

Residual standard error: 5.731 on 83 degrees of freedom

Table 2: Output of R software for estimation by OLS of model (2)

Question 2.d)

Is the monthly risk premium of IBM different from zero? Explain clearly whether, and eventually how, you can answer to this question by performing an appropriate test of hypothesis using the information/numbers in Tables 1 and 2 and, if necessary, your own calculations based on those numbers. In case you can perform the test for this question, do it by using a significance level of 1%. In case you don't have enough information to perform the test, explain why, and which additional information/quantities you would need to be able to perform it.

Finally, in case you can compute it with the information on the table, provide the unbiased estimate of the standard deviation of the returns of IBM.

Question 2.e)

Propose a way to modify the t-test of the null hypothesis of the test you proposed in question 2.d), which is consistent for both autocorrelation and heteroskedasticity of the excess returns z_t .

Note that for this Question 2.e) you are not provided in Tables 1 and 2 the necessary quantities to perform the test consistent for both autocorrelation and heteroskedasticity, so you just need to provide a written explanation and a few formulas, if needed, to answer.

END OF QUESTION 2

QUESTION 3 [Points : 4 out of 20]

INSTRUCTIONS

You must answer to this question in **maximum 3 pages**. Only the first 3 pages with the answer to this question will be graded, and all the additional pages (4th, 5th etc.) will not be graded.

ANSWER THE FOLLOWING QUESTION:

Why are ARCH and GARCH models (and their extensions) models appropriate to capture/replicate some, or even all, of the stylized facts of the financial returns?

You must answer this question by carefully presenting and discussing the features of **at least two ARCH or GARCH – type models** (including the extensions of the basic models). Moreover, you must write the formulas of the models you present and describe each term appearing in the formulas.

END OF QUESTION 3 and END OF ALL EXAM / ASSIGNMENT QUESTIONS.

*I WISH YOU A **NICE Xmas + NEW YEAR** break / vacations:
well-deserved after a very intense semester 1 !*