STOCKHOLM UNIVERSITY
Department of Statistics
Econometrics II, Time Series Analysis, ST223G
Spring semester 2020

Written Re-Examination in Time Series Analysis

Date	2020-08-17
Hour:	15.00-20.00
Examiner:	Jörgen Säve-Söderbergh
Allowed tools:	1) Textbook: Wooldridge, J.M. *Introductory Econometrics: A Modern Approach*, Cengage, Boston. 2) Textbook: Montgomery, D.C., Jennings, C.L., and Kulachi, M., *Introduction to Time Series Analysis and Forecasting*, John Wiley & Sons, New Jersey. 3) Pocket calculator 4) Notes written in the text book are allowed.

- On problem 6 and 7 it is sufficient to just state which alternative you believe is true. Nothing further than that is required.
- Note that no formula sheet is provided.
- Passing rate: 50% of overall total, which is 100 points. For detailed grading criteria, see the course description.
- The maximum number of points for each problem is stated immediately after the question number. If not indicated otherwise, to obtain the maximum number of points on each problem, detailed and clear solutions are required. Answers may be given in English or Swedish.

Good luck!

1. (12 points) An astronomer has observed a time series over 120 weeks. She is interested in testing if there is any evidence for autocorrelation between observations three weeks apart. Using RStudio she has found that $r_3 = 0.85323$.

   (a) (3 points) Formulate the relevant null hypothesis and alternative hypothesis for this question.

   (b) (6 points) Calculate the relevant test statistic for this null hypothesis.

   (c) (3 points) Perform the hypothesis test with significance level 5%.

2. (12 points) The following table presents predicted monthly sales and actual monthly sales for a company over the first three months of 2020.

	Actual Sales	Predicted Sales
January	25	22
February	28	30
March	29	30

   (a) (2 points) Calculate the forecast error for each month.

   (b) (3 points) Calculate the MAD (mean absolute deviation).

   (c) (3 points) Calculate MSE (mean squared error).

   (d) (4 points) Calculate MAPE (mean absolute precent forecast error).

3. (12 points) Assume the model

$$y_t = \varepsilon_t + 0.65\varepsilon_{t-1} + 0.24\varepsilon_{t-2}$$

   where $E(\varepsilon_t) = 0$ and $\text{Var}(\varepsilon_t) = \sigma^2$ and ε_t are independent random variables.

   (a) (2 points) What model is this?

   (b) (2 points) What are the parameter values?

   (c) (6 points) Is the model stationary? Is it invertible?

   (d) (2 points) Rewrite the model using the backshift operator B.

4. (12 points) An astronomer had found interest in the following model

$$(1 - 0.9B)\, y_t = (1 - 0.50B)\, \varepsilon_t$$

   (a) (2 points) What model is this?

   (b) (4 points) What are the parameter values?

   (c) (6 points) Is the model stationary? Is it invertible?

5. (12 points) Rewrite the following ARIMA(0,1,1) model

$$(1-B)\,y_t = (1-\theta_1 B)\,\varepsilon_t$$

in difference-equation form (that is, in a formula without the backshift operator that contains y_t and lagged values of y_t among other things).

6. (10 points) A *spurious correlation* refers to a situation where:

   A. two variables are related through their correlation with a third variable.

   B. the correlation coefficient between two variables cannot be estimated.

   C. there is direct causal relationship between two variables but tests for correlations reject this relationship.

   D. the correlation between two variables is positive until the sample size reaches a threshold, and negative after the sample size crosses the threshold.

7. (10 points) In the given AR(1) model,

$$y_t = \alpha + \rho y_{t-1} + e_t, \quad t = 1, 2, \ldots,$$

the *Dickey-Fuller distribution* refers to the:

   A. asymptotic distribution of the t statistic under the hypothesis $H_0 : \rho = 1$.

   B. asymptotic distribution of the F statistic under the hypothesis $H_0 : \rho = 1$.

   C. asymptotic distribution of the t^2 statistic under the hypothesis $H_0 : \rho = 1$.

   D. asymptotic distribution of the z statistic under the hypothesis $H_0 : \rho = 1$.

8. (20 points) A stochastic process is given by

$$y_t = 0.50 y_{t-1} + \varepsilon_t$$

where ε_t is independent and normally distributed with expected value 0 and with variance σ_ε^2.

   (a) (2 points) What kind of model is this? Is it stationary?

   (b) (8 points) Find the moving average representation for y_t.

   (c) (4 points) Use the moving average representation to compute $E(y_t)$.

   (d) (6 points) Use the moving average representation to compute $\text{Var}(y_t)$.