STOCKHOLM UNIVERSITY
Department of Statistics
Econometrics II, Time Series Analysis, ST223G
Autumn Semester 2020

Written Re-Examination in Time Series Analysis

Date	2021-02-12
Hour:	13.00-18.00
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.

For questions about the content of the exam, contact the course coordinator on jorgen.save-soderbergh@stat.su.se. Incoming e-mail questions are answered between 14.00 and 15.00 during the exam.

If the course coordinator needs to send out information to all students during the exam, this is done to your registered email address. Therefore, check your email during the exam.

Please note that practical help is only available during the first hour of the exam by email expedition@stat.su.se. Carefully read the enclosed instructions for exam submission. There you find all the necessary information about submission, anonymous code, etc. If you, despite the instructions have problems submitting the exam, email the exam to tenta@stat.su.se. However, this is only done in exceptional cases.

Good luck!

1. (12 points) Analyze the following data with the simple exponential algorithm

$$\tilde{y}_T = (1-\theta)\, y_T + \theta \tilde{y}_{T-1},$$

using $\theta = 0.4$ and as starting value $\tilde{y}_0 = 10$

Time	
1	11
2	14
3	12

Make a forecast for time period four.

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

	Actual Sales	Predicted Sales
November	172	169
December	170	172
January	171	170

   (a) (4 points) Calculate the forecast error for each month.

   (b) (4 points) Calculate the MAD (mean absolute deviation).

   (c) (4 points) Calculate MSE (mean squared error).

3. (12 points) A time series model is given by

$$y_t = 0.2y_{t-1} + 0.8y_{t-2} + \varepsilon_t$$

where ε_t is independent and normally distributed with expected value 0 and with known variance $\sigma_\varepsilon^2 = 1$.

   (a) (3 points) What model is this? What are the parameter values?

   (b) (3 points) Is the model stationary? Is it invertible?

   (c) (3 points) Rewrite the model using the backshift operator B.

   (d) (3 points) Solve the equation $1 - \phi_1 y_{t-1} B - \phi_2 B^2 = 0$ in the backshift operator B.

4. (12 points) Assume the model

$$y_t = \varepsilon_t - 0.80\varepsilon_{t-1}$$

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

   (a) (4 points) What kind of model is this? Is it invertible?

   (b) (4 points) Compute $E(y_t)$.

   (c) (4 points) Compute $\text{Var}(y_t)$.

5. (12 points) Rewrite the following ARIMA(0,2,2) model

$$(1-B)^2 y_t = \left(1 - \theta_1 B - \theta_2 B^2\right) \varepsilon_t$$

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 regression* refers to a situation where:

   A. the direction of the relationship between the dependent variable and the explanatory variables is uncertain.

   B. even though two variables are independent, the OLS regression of one variable on the other indicates a relationship between them.

   C. a few important and necessary explanatory variables are left out of a regression equation, thus leading to inefficient and inconsistent forecasts.

   D. at least one of the variables used in a regression equation does not have a unit root and the error terms are heteroskedastic.

7. (10 points) A process is *stationary* if:

   A. any collection of random variables in a sequence is taken and shifted ahead by h time periods; the joint probability distribution changes.

   B. any collection of random variables in a sequence is taken and shifted ahead by h time periods, the joint probability distribution remains unchanged.

   C. there is serial correlation between the error terms of successive time periods and the explanatory variables and the error terms have positive covariance.

   D. there is no serial correlation between the error terms of successive time periods and the explanatory variables and the error terms have positive covariance

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

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

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 $\text{Var}(y_t)$.