(International) Bachelor Econometrics and Operations Research
FEB23001(X)-19 Tijdreeksanalyse / Time Series Analysis
Assignment 2

This assignment consists of 3 pages, with questions 2.a - 2.e

Instructions

This assignment should be made with a team of two students, or individually. Teams of three or more students are not allowed. It is not allowed to cooperate with other teams, or to copy their results.

The results of this assignment should be delivered in the form of a report of max. 8 pages (not including a possible appendix). The report may be written in English or Dutch. The report should provide a detailed and careful description of your results and interpretation. All relevant results should be included in the report (preferably in tables and graphs). 'Raw' output from EViews (or other software) may be attached as an appendix, but should not be included in the main text.

The deadline for submitting your report is Friday June 5, 2020 at 16:59h. Reports should be submitted via Canvas as a PDF file with the name "`FEB23001-19-A2-XXXXXX-YYYYYY.pdf`", where `XXXXXX` and `YYYYYY` are the 6-digit student IDs of the two group members. The report should be submitted by only one of the team members.

Note 1: Motivate your answers! For example, answers like "Yes" or "No" to question 2.c.iii) will not be rewarded any points.

Note 2: Some questions in the assignment are not specified up to the last detail and require you to make some choices yourself. Explain and motivate your choices in your report.

Note 3: Although easy-to-use and convenient, it is not required to make the assignment with EViews. You are free to use other programs such as Stata or Matlab. In case you write your own code, provide this in the appendix!

Note 4: **It is not allowed to copy-paste text from the exercises or from assignments of previous years. This will be considered as plagiarism and will be treated as such.**

Good luck!!

Questions related to this assignment should be posted on the discussion board on Canvas – see the course syllabus for further details.

ASSIGNMENT 2

DATA

The Excel file `IMPORTS.xlsx` contains quarterly observations on imports of goods and services (in real terms [i.e. adjusted for inflation], in billions of dollars) for the US over the period 1979Q1–2019Q4. Columns B and C contain the original and seasonally adjusted time series. A dummy variable DREC is also included, which takes the value 1 during recession periods and 0 during expansions.[1]

2.a) Using the sample period 1980Q1–2019Q4, examine whether the time series of imports displays any of the 'key features' [(i) trend; (ii) seasonality; (iii) aberrant observations; (iv) heteroskedasticity; (v) nonlinearity] discussed in Chapter 2. You may involve both the original and the seasonally adjusted series in your analysis. You may also want to consider transformations of the time series such as the natural logarithm, or quarterly (or annual) growth rates, and use the graphical and auxiliary regression tools discussed in Chapter 2. Are there specific observations that are very 'influential' for the answer to this question?

In the remainder of this assignment we will only work with the seasonally adjusted time series.

2.b) Take the natural logarithm of the seasonally adjusted imports series (the resulting series will be referred to as '**log imports**' below). Apply the Augmented Dickey-Fuller (ADF) test to examine the presence of a stochastic trend in the log imports series using the sample period 1980Q1-2019Q4. Given the properties of the time series, which deterministic components do you include in the test regression? Does the outcome of the test depend on whether you use the Schwarz Information Criterion or the Akaike Information Criterion to select the 'lag length' in the test regression? How important is the period 2009Q1-2019Q4 for your findings (that is, do you reach the same or a different conclusion when you apply the ADF test using the sample period 1980Q1-2008Q4)?

2.c) Estimate the parameters in an AR(3) model with intercept and deterministic trend for the log imports series using the sample period 1980Q1-2019Q4. What are the roots of the AR(3) polynomial? Examine the properties of the residuals. In particular, consider the following questions:

i) What are the autocorrelation properties of the residuals, and what does this imply for the adequacy of the estimated AR(3) model?

ii) What are the autocorrelation properties of the squared residuals? What does this imply for the assumption of homoskedasticity of the shocks in the AR(3) model?

iii) Are the residuals normally distributed?

[1] Based on the turning points provided at `http://www.nber.org/cycles/`

2.d) Re-estimate the parameters in the AR(3) model with intercept and deterministic trend for log imports using the sample period 1980Q1–1999Q4 ($T = 80$ observations). Compute one-step ahead point forecasts for the period 2000Q1–2019Q4 (80 observations). Convert these to forecasts for the quarterly growth rate, that is, construct the series $\hat{g}_{t+1|t} = \hat{y}_{t+1|t} - y_t$, where $\hat{y}_{t+1|t}$ denotes the one-step ahead forecast for log imports in quarter $t + 1$ and y_t is the actual value in quarter t.

Evaluate the accuracy of these point forecasts for the quarterly growth rates in 'absolute' terms, by considering their a) unbiasedness, b) accuracy, and c) efficiency. Also evaluate their 'relative' accuracy by comparing the point forecasts with those obtained from an AR(2) model with intercept (but no deterministic trend) for quarterly growth rates $g_t = y_t - y_{t-1}$ (following the same procedure as above; in particular, estimating the parameters in the AR(2) model using the observations for the period 1980Q1-1999Q4, and then constructing one-step ahead point forecasts for the period 2000Q1-2019Q4). Are the results of this forecast comparison in agreement with the conclusions from the ADF test applied in question 2.b?

2.e) Repeat question 2.d, but now updating the estimates of the parameters in the AR(3) model with intercept and deterministic trend for log imports using a moving window of 80 observations as you move through the out-of-sample period. That is, first estimate the parameters using the sample period 1980Q1–1999Q4 and compute a one-step ahead forecast for 2000Q1. Then re-estimate the parameter using the sample period 1980Q2–2000Q1 and compute a forecast for 2000Q2. Continue in this way until you compute a forecast for 2019Q4 using the model parameters as estimated on the sample period 1999Q4–2019Q3.[2] **Please provide the code of the program you have written for this part of the exercise in an appendix to your report.** Again, as in question 2.d), convert the forecasts obtained from the AR(3) model for log imports to forecasts for the quarterly growth rate.

Evaluate the quality of the resulting forecasts and compare this with the forecasts obtained in 2.d). Can you explain the differences in accuracy? *Hint: it might be insightful to examine the estimates of the parameters in the AR(3) model with deterministic trend as obtained for the different moving windows. Alternatively, examine moving window estimates of the parameters in the 'simple' linear trend regression* $y_t = \alpha + \beta t + \varepsilon_t$.

Also compare the forecasts obtained here with the forecasts obtained from an AR(2) model with intercept (but no deterministic trend) for quarterly growth rates, also updating the parameter estimates using a moving window of 80 observations. Are the results of this forecast comparison in agreement with the conclusions from the ADF test applied in question 2.b?

[2] In order to obtain these 'recursive' estimates and forecasts efficiently, you may want to consider the EViews program `GDPRF.prg` that comes with the workfile `GDP.wf1`. This program implements the moving window estimation and forecasting procedure using an AR(4) model for quarterly GDP growth rates. It can be modified quite easily for the purpose of this assignment.