Macroeconometrics
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Homework 1

Due date: Monday, 13 April, 1:30pm

1. **Question 1**
   Consider an ARMA(1,2) model:

$$y_t = \phi y_{t-1} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}, \qquad \varepsilon_t \sim iidN(0, \sigma^2).$$

   (a) What are the stationarity conditions for this process?

   (b) What are the invertibility conditions for this process?

   (c) Express the process in the Wold form and specify Wold form coefficients in terms of ϕ and θ_is.

2. **Question 2**
   For an AR(1) with $\phi = 0.5$, calculate and plot the true ACF and PACF and the IRF for $j = 0, 1, \ldots, 5$. Do the same for an AR(2) with $\phi_1 = 1.25$ and $\phi_2 = -0.75$. See Hamilton p. 111 on solving PACF given ACF.

3. **Question 3**
   EViews Exercise
   Save gdpq.prn from the class website. Open up EViews. Select New from the File menu, then select Workfile. Select Quarterly and enter the dates from 1954:1 to 2007:3 (so we use the data before the crisis). Select Import from the File menu, then select Read Text/Lotus/Excel. Find the gdpq.prn file and select. Click OK. A box will open that will allow you to name the series. Name it gdpq. The series is U.S. quarterly real GDP from St. Louis Fed website. Once you've imported the data, save your workfile using the title hw.wf1.

   (a) Double click on the series and select View and Line Graph to examine it. Note that the series has a somewhat exponential shape to it. Also note that the variance of the series appears to grow somewhat as the time progresses. Paste graph and comment. Transform the series by typing genr lgdpq = log(gdpq). (Note: the log function in EViews corresponds to natural logs, usually denoted ln, which is what you want to use rather than base 10 logs.) Examine lgdpq. The resulting series should look more linear and, to some extent, more like it has a stable variance. Paste graph and comment.

   (b) Click View and select Correlogram. Click Okay to Levels. Paste the output. What ARMA model(s) would you consider for lgdpq given this correlogram?

(c) Select Estimate Equation from the Quick menu. Estimate the model you chose in part b. Paste. Is the estimated model stable? Do you think this is a good model of log real gdp? Why or why not? What is the R-squared statistic? Why is it so high?

(d) Create the First Differences Series: In the field just below the menus, type genr dlgdpq=d(lgdpq) (note: if you just type without selecting the field, it will work the same). The d(*) function takes first differences of a series. Then, select dlgdpq and click view and select line graph. The linearity of lgdpq should imply that dlgdpq has a fairly stable mean. Meanwhile, the log transformation should keep the variance of the series reasonably stable. Having said that, note that the variance of output has been lower since 1984. Paste and comment.

(e) Click View and select Correlogram. Click Okay to Levels. Paste the output. What ARMA model(s) would you consider for dlgdpq given this correlogram?

(f) Since it is not as clear as before what the appropriate model is, estimate all the possible ARMA(p,q) models for max(p)=2 and max(q)=2. (I.e., run ARMA models in EViews such as AR(1), MA(1), ARMA(1,1), ARMA(1,2), ARMA(2,2), etc...) To run, say, an ARMA(2,2) model type dlgdpq c ar(1) ar(2) ma(1) ma(2). Make sure the adjusted sample period is the same in each case by adjusting Sample in the Quick menu to 1955:1-2007:3. Dont worry about pasting the output for each model. But, record the AIC and BIC numbers for each case and report. What model fits best according to the two criteria? Paste output for best model(s). Click View/Residual Test/Correlogram and Paste. Comment on the output.

(g) Create the Linearly Detrended Series: Makes sure sample is 1954:1-2007:3. Type genr t=@trend in the main field. Select t. The series should be a linear progression (0,1,2,3,...). Now, select Estimate Equation from the Quick menu. Type lgdpq c t. Then click on resids. Then type genr tlgdpq=resid. Select tlgdpq and click view and select line graph. Note that by construction detrended gdp has a zero mean. The variance looks large, but relatively stable over the sample. Paste and comment.

(h) Click View and select Correlogram. Click Okay to Levels. Paste the output. What ARMA model(s) would you consider for tlgdpq given this correlogram?

(i) Since it is again not entirely clear what the appropriate model is, estimate all the possible ARMA(p,q) models for max(p)=2 and max(q)=2. Again, adjust the sample to 1955:1-2007:3. Record the AIC and BIC numbers for each case. What model fits best according to the two criteria? Paste output for best model(s). Click View/Residual Test/Correlogram and Paste. Do the selected models pass the residual diagnostic. Comment on the output.

(j) Estimate an AR(2) model for the time trend case by typing the following in Quick/Estimate Equation, lgdpq c t ar(1) ar(2), with sample period set to 1955:1 1969:4 in the sample field. Paste output. Click the Forecast button. In the Forecast name field type lgdpqf1. In the Standard Error field type sef1. In the sample range field type 1970:1 2007:3. Click Okay. Type genr uf1=lgdpqf1+1.96*sef1 and genr lf1=lgdpqf1-1.96*sef1 to get standard error bands. Select lgdpq, lgdpqf1, uf1, and lf1 (hold down the ctrl key to

select multiple series). Click View/Open Selected One Window/Open Group. Click View again and select Graph/Line. You should have a picture with the series forecast for the time trend model (with 95% confidence bands) and the actual realized series. Paste graph. What do you notice?
NOTE: be very careful to follow directions about sample periods here!!!

(k) Again, setting the sample to 1955:1 1969:4, estimate an AR(2) model for the first differences case (i.e., an ARIMA(2,1,0) model for lgdpq) by typing d(lgdpq) c ar(1) ar(2). By typing the equation in this d(*) format, you will get forecasts for the level, rather than first differences. Paste output. Click the Forecast button. In the Forecast name field type lgdpqf2. In the Standard Error field type sef2. In the sample range field type 1970:1 2007:3. Click Okay. Type genr uf2=lgdpqf2+1.96*sef2 and genr lf2=lgdpqf2-1.96*sef2. Select and graph series as in part j. Paste graph.