University of Washington
Department of Economics

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Econ 584 Lab #1
Fun with ARMA models

Readings:

(1) Hamilton, chapters 1-3, 4 (pgs 72 - 87, 108 - 113), 5.
(2) Zivot and Wang, chapter 2.

Data:

(1) Real gross domestic product (quarterly). Download from www.economagic.com

Note: You may want to review the EVIEWS manual information regarding estimation and forecasting of autoregressive models. To see information on any EVIEWS command simply select **Help/Search** from the main menu and then type in the name of the command for which you want information. If you are not familiar with EVIEWS, I strongly suggest that you start with **Help/Basics** and go through each selection to get an overview of EVIEWS.

Analytical Questions

1. Hamilton, chapter 3 (page 70), exercises 3.1, 3.2, and 3.3.

Computer Exercises and Hints

For the computer exercises, answer all questions on the computer output. Also, please feel free to comment liberally on the computer output. Note any unusual results or simply make comments to yourself about what the results tell you.

Exercise 1: Identify ARMA models for log real GDP

(a) Plot the log level of real GDP over the period 1947.1 to 2003.4. Comment on any unusual features of the data. Compute, plot and interpret the correlogram for the level of real GDP.

(b) Estimate an AR(1) model for the level of log real GDP in two different ways. First estimate the autoregression

$$Y_t = c + \varphi Y_{t-1} + \varepsilon_t$$

and then estimate the mean-adjusted model

$$Y_t - \mu = \varphi(Y_{t-1} - \mu) + \varepsilon_t.$$

Interpret the constant terms in the two regressions. What does your estimate of φ tell you about the stability of the model?

(c) Detrend log real GDP by forming the residuals of a regression of log real GDP on a constant and a time trend. Compute, plot and interpret the corrrelogram (ACF) and partial correlogram (PACF) for the detrended series. What ARMA models seem most appropriate?

(d) Compute, plot and interpret the ACF and PACF for the first difference of log real GDP. What ARMA models seem most appropriate?

(e) For detrended log real GDP and the first difference of real GDP, compute the AIC and BIC information criteria for all ARMA(p,q) models with p=0,1,2,3 and q=0,1,2,3 Which models are suggested by these model selection statistics?

Computer Hints for Exercise 1

Loading the data

Download the postwar quarterly real GDP data from www.economagic.com. UW has site subscription so this should not be a problem if you are on computer with a UW domain. The real GDP data is the first data series listed after clicking the link for the Most Requested Series

Start EVIEWS in the usual way.

The first thing we must do is to create a workfile which specifies the type of data that will be analyzed. We will be working with postwar quarterly real GDP over the period 1947.1 to 2003.4. From the main menu, select **File/New/Workfile**. Select **Quarterly** data and specify **1947.1** as the **start date** and **2003.4** as the **end date** and then click **OK**. This creates a workfile where the data for your session will be stored.

Note: To save paper, it is useful to redirect the EVIEWS printer output to a file. To do this, click **Options/Print Setup**. Under **destination** choose **Text file** and give it the filename **584lab1.txt**. Then, every time you use the [**Print**] command in EVIEWS the printer output will end up in a disk file. When you finish the lab, you can edit the output file and print out the results. Only text-based output will be redirected to the output file. Graphs will still be sent to the printer. Because of this, you might want to save your graphs as objects and then print them all out at the end of the lab.

Load the real GDP data into the Eviews work file.

To transform the data into logs, click [**Genr**], type the equation **lrgdp = log(gdpq)** and click **OK**. The series lrgdp should be added to the workfile.

Analysis of the level of lrgdp

Make a time plot of the level of log real GDP. Highlight the series lrgdp and double click to bring up the spreadsheet view of the data (note: in EVIEWS all series are treated as objects and each object has a number of views). Click [**View**] and select **Line Graph** to change the view to a time plot. Click [**Print**] to send a copy of the graph to the printer (note: if you are in the econ computer lab you must make sure that the printer is selected for your computer).

Next, compute the autocorrelation function or correlogram of lrgdp. Click [**View**], select **Correlogram**, choose **16** lags and then [**Print**]. (Alternatively, click [**Ident**], choose **16** lags and then [**Print**]).

Finally, estimate a simple AR(1) model for lrgdp. There are two ways to estimate an AR model in EVIEWS - using lagged values of the dependent variable and using AR(.) terms. We do the regression with lagged values first. From the main menu, select **Quick/Estimate/Equation**. Type **lrgdp c lrgdp(-1)**, choose **ordinary least squares** as the estimation method and then click **OK**. This produces the equation object window with the estimation results displayed. Click [**Print**] on the window toolbar. Next we repeat the regression using AR terms. Click [**Estimate**], type **lrgdp c AR(1)**, click **OK** then [**Print**]. Close the equation window (click the close box in the upper left hand corner of the equation window).

Analysis of detrended log real GDP.

First, create detrended log real GDP by regressing lrgdp on a constant and a time trend. To create a time trend variable, click [**Genr**] and type **t = @trend(1947.1).** This creates the variable t that is equal to zero in 1947.1 and increases by one unit in every time period (see **Help/search/trend**). Next, regress lrgdp on a constant and trend. From the main menu, select **Quick/Estimate Equation** and type the equation **lrgdp c t**. Click **OK**, [**Print**] the regression results and close the equation window. To save the residuals in a new series click [**Genr**] and type **dtlrgdp = resid** (the residuals from the last regression are automatically stored in the series resid).

Compute the correlogram for detrended lrgdp. Highlight dtlrgdp, double click and then click [**Ident**]. Select **level** , choose **16** lags, **OK** then [**Print**]. Close the series view window.

Compute the correlogram for the first difference of lrgdp. Highlight lrgdp, double click and then click [**Ident**]. Select **1st Difference**, choose **16** lags, **OK** then [**Print**]. Close the series view window.

Compute information criteria for ARMA(p,q) models: p=0,1,2,3; q=0,1,2,3.

The estimation output in EVIEWS for ARMA models includes the AIC and BIC (Schwarz) statistics. To compute these statistics for the nine ARMA models with p=0,1,2 and q=0,1,2 do the following. First, we estimate the models for detrended lrgdp. Select **Quick/Estimate Equation** and type the ARMA(3,3) equation: **dtlrgdp c AR(3) MA(3)** and click **OK**. Next, fix the sample at the sample size for this (the largest) model. You must use the same estimation sample for all of the ARMA(p,q) models. From the estimation results write down the AIC and

BIC statistics (do not print). Click [**Estimate**] to bring back the equation window and type in the ARMA(3,2) model **dtlrgdp c AR(3) MA(2)**. Click **OK**, note the results and repeat the process for the remaining models.

Do the same process for the first difference of lrgdp. Start with the ARMA(3,3) model: [**Estimate**], **d(lrgdp) c AR(3) MA(3)**, **OK**, (write results), fix sample, go to next model and repeat.

Exercise 2: Estimate ARMA(2,0) model for detrended log real GDP

(a) Estimate ARMA(2,0) model for detrended log real GDP. Check the residuals for serial correlation and normality. Determine if the model is stable and compute and plot the impulse response function out to 4 years. Interpret your results.

Computer Hints for Exercise 2

Estimate ARMA(2,0) and analyze residuals

Select **Quick/Estimate Equation** and type **dtlrgdp c AR(1) AR(2), OK**, [**Print**]. Next, click [**Resids**], [**Print**]. To compute residual diagnostics, click [**View**] and select **Residual Tests/Correlogram**, choose **16** lags and [**Print**]. Next, click [**View**], select **Residual/Tests/Serial Correlation-LM Test**, [**Print**]. Finally, click [**View**], select **Residual Tests/Histogram -Normality Test** and [**Print**].

Note: you can compute the roots of the AR polynomial as follows: [**View**], **ARMA Structure**, **Roots, OK**.

Compute impulse response function

EVIEWS 5 allows you to compute the IRF for a general ARMA model. From the equation window select [**View], ARMA Structure**. In the ARMA Diagnostic Views dialogue box, select Impulse Response, choose 12 periods, click the graph button, and click **OK**.

Compute time trend regression with AR(2) errors

In exercise 4 will compare long-term forecasts for the level of log real GDP from the time trend model and the 1st difference model. Compute the levels time trend regression: [**Estimate**], **lrgdp c t AR(1) AR(2), OK**, [**Print**], [**Name**], **Eq1**, **OK**. Close the equation window.

Exercise 3: Estimate ARMA(2,0) model for first difference log real GDP

(a) Estimate ARMA(2,0) model for the first difference of log real GDP. Check the residuals for serial correlation and normality. Determine if the model is stable and compute and plot the impulse response function out to 4 years. Interpret your results

Computer Hints for Exercise 3

Estimate ARMA(2,0) and analyze residuals

Select **Quick/Estimate Equation** and type **d(lrgdp) c AR(1) AR(2), OK**, [**Print**]. Next, click [**Resids**], [**Print**]. Name the equation for later use: [**Name**], **Eq2**, **OK**. To compute residual diagnostics, click [**View**] and select **Residual Tests/Correlogram**, choose **16** lags and [**Print**]. Next, click [**View**], select **Residual/Tests/Serial Correlation-LM Test**, [**Print**]. Finally, click [**View**], select **Residual Tests/Histogram -Normality Test** and [**Print**].

To compute the IRF, use the same procedure described above for Exercise 2.

Exercise 4: Compute and compare long-term forecasts of log real GDP

(a) Estimate the level of log real GDP by regressing log real GDP on a constant, time trend and two autoregressive terms over the period 1947.1 - 1999.4. Using this model, compute and plot the quarterly forecasts of log real GDP for the next four years along with 95% confidence intervals for the forecasts and the actual value of log real GDP. Interpret your results.

(b) Estimate the ARMA(2,0) model for the first difference of log real GDP over the period 1947.1 - 1999.4. Using this model, compute and plot the forecasts of the level of log real GDP for the next four years (until the end of the sample) along with 95% confidence intervals for the forecasts and the actual value of log real GDP. Interpret your results.

Computer Hints for Exercise 4

Compute and plot forecasts from AR(2) plus trend model

Highlight the equation object **Eq1** and click to bring up the equation view. Change the **estimation sample** period to **1947.1 1999.4**, reestimate the model and [**Print**] the results. To produce forecasts over the period 2000.1 - 2000.4, click [**Forecast**], name the forecasts series **lrgdpf1** and name the standard errors **sef1**, and specify the **forecast period** as **2000.1 2003.4.** Click **OK** and [**Print**]. Close the equation window.

To compute a 95% confidence interval for the forecasts do the following. First, compute the upper bound for the CI: Click [**Genr**], type **uf1 = lrgdpf1 + 1.96*sef1**, **OK**. Next compute the lower bound: Click [**Genr**], type **lf1 = lrgdpf1 - 1.96*sef1**, **OK**.

To plot the forecasts, 95% confidence interval and actual values of log real GDP over the period 2000.1 - 2003.4 do the following. Change the sample period: [**Sample**], **2000.1 2003.4**, **OK**. Then, highlight the four series **lrgdp, lrgdpf1, lf1, uf1** and double click to bring up the group window. Click [**View**], select **Graph** and [**Print**]. Close the group window.

Change the sample period back to 1947.1 - 2003.4: [**Sample**], **1947.1 2003.4**, **OK**.

Compute and plot forecasts from ARIMA(2,1,0) model

Highlight the equation object **Eq2** and click to bring up the equation view. Change the **estimation sample** period to **1947.1 1999.4**, re-estimate the model and [**Print**] the results. To produce forecasts over the period 2000.1 - 2003.4, click [**Forecast**], name the forecasts series **lrgdp2** and name the standard errors **sef2**, and specify the **forecast period** as **2000.1 2003.4.** Click **OK** and [**Print**]. Close the equation window (Notice that when a model is estimated with the dependent variable transformed with the **D()** operator, the forecasts produced by EVIEWS are for the level of the series and not the first difference).

To compute a 95% confidence interval for the forecasts do the following. First, compute the upper bound for the CI: Click [**Genr**], type **uf2 = lrgdpf2 + 1.96*sef2**, **OK**. Next compute the lower bound: Click [**Genr**], type **lf2 = lrgdpf2 - 1.96*sef2**, **OK**.

To plot the forecasts, 95% confidence interval and actual values of log real GDP over the period 2000.1 - 2003.4 do the following. Change the sample period: [**Sample**], **1990.1 2003.4**, **OK**. Then, highlight the four series **lrgdp, lrgdpf2, lf2, uf2** and double click to bring up the group window. Click [**View**], select **Graph** and [**Print**]. Close the group window.

That's it for Lab #1. Save the workfile, [**Save**], and exit EVIEWS, **File/Exit**. Go have a beer.