ECO 5350 T. Fomby
Intro. Econometrics Fall 2008

Time Series Model Practice Exercise

KEY

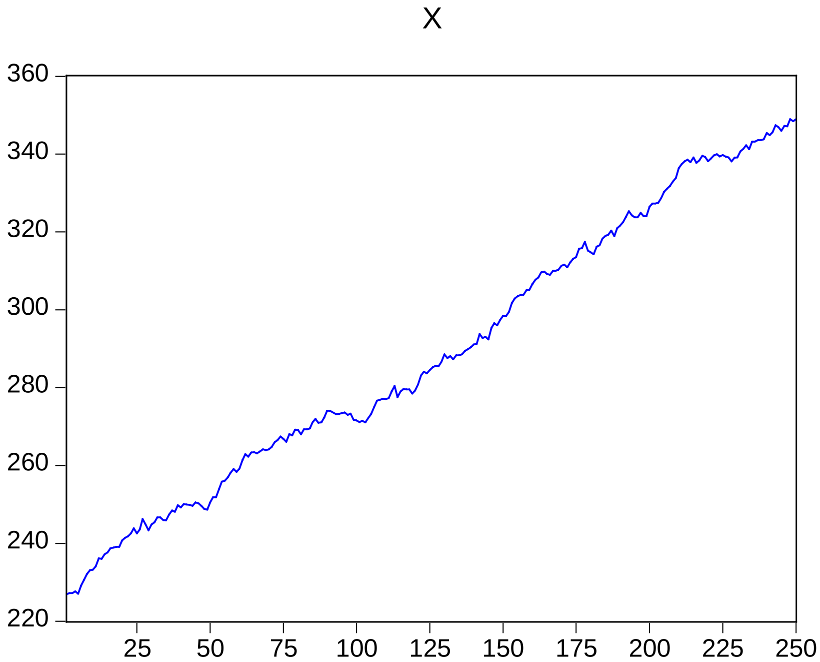
Purpose: **To learn how to build an Autoregressive Distributed Lag (ARDL) Model of two time series that have unit roots in them.**

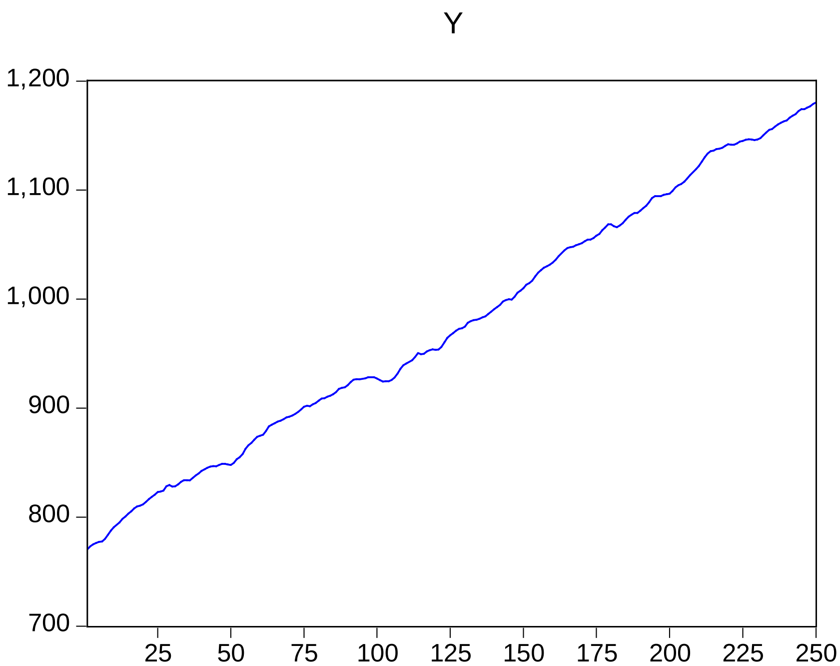
Go to the website of this course and download the EVIEWS program **ardl.wf1**. Use it to answer the various parts of this exercise.

Scenario: Let us suppose that the time series **y** represents the weekly sales of **100 randomly chosen franchise stores owned by ABC Corporation** (in thousands of dollars). In these 100 randomly chosen stores, ABC decides to check out the usefulness of its weekly **newspaper** advertising expenditures **x** (in thousands of dollars) over a period of **250 weeks**. During this 250 week period **only** newspaper advertising is used by the 100 stores. What we need to do is build an autoregressive distributed lag model that describes how newspaper advertising expenditures affect the sales of these 100 stores. You will be able to do that by going through the following steps.

a) **STEP 1: Conduct unit root tests of the x and y series.** Use your EVIEWS program plot the advertising (x) series, print it out, and hand it in with this exercise. Do the same for the sales (y) series. Given these two graphs you should be able to choose the correct case of the ADF test to use. For these two series we should be using Case (1/2/**3**) with (no intercept – no trend / intercept – no trend / **intercept and trend**).

Below are the two graphs of X and Y.


X
360
340
320
300
280
260
240
220
25
50
75
100
125
150
175
200
225
250


Y
1,200
1,100
1,000
900
800
700
25
50
75
100
125
150
175
200
225
250

Given these two graphs you should be able to choose the correct case of the ADF test to use. For these two series we should be using **Case 3** with **intercept and trend**.

Null Hypothesis: X has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.487195	0.3343
Test critical values:	1% level	-3.995340	
	5% level	-3.427975	
	10% level	-3.137353	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(X)
Method: Least Squares
Date: 12/01/07 Time: 15:50
Sample (adjusted): 2 250
Included observations: 249 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
X(-1)	-0.048650	0.019560	-2.487195	0.0135
C	11.60982	4.460986	2.602523	0.0098
@TREND(1)	0.023467	0.009562	2.454037	0.0148

R-squared	0.024817	Mean dependent var	0.490161
Adjusted R-squared	0.016888	S.D. dependent var	0.952610
S.E. of regression	0.944532	Akaike info criterion	2.735720
Sum squared resid	219.4666	Schwarz criterion	2.778099
Log likelihood	-337.5972	Hannan-Quinn criter.	2.752779
F-statistic	3.130129	Durbin-Watson stat	2.115704
Prob(F-statistic)	0.045458		

Based on the Schwartz criterion, use the automatic lag length selection capability of EVIEWS to produce a Dickey-Fuller t-test for a unit root in the **advertising series (x)**. The Dickey-Fuller t-statistic for the x series is **-2.487195** with one-tailed p-value of **0.3343**.

The null hypothesis of this test is **x has a unit root and needs to be differenced**.

The alternative hypothesis of this test is **x is trend stationary data (and needs to be detrended)**.

Given the results of this test on x, I conclude that **Ho should be accepted and the data needs to be differenced (i.e. it has a "unit root")**.

Now turning to the sales series **(y):**

Null Hypothesis: Y has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic based on SIC, MAXLAG=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.456943	0.3494
Test critical values:	1% level	-3.995800	
	5% level	-3.428198	
	10% level	-3.137485	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y)
Method: Least Squares
Date: 12/01/07 Time: 15:59
Sample (adjusted): 5 250
Included observations: 246 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
Y(-1)	-0.023270	0.009471	-2.456943	0.0147
D(Y(-1))	0.725754	0.063077	11.50587	0.0000
D(Y(-2))	-0.343888	0.075004	-4.584946	0.0000
D(Y(-3))	0.173260	0.063577	2.725196	0.0069
C	18.72872	7.296236	2.566902	0.0109
@TREND(1)	0.037743	0.015453	2.442419	0.0153

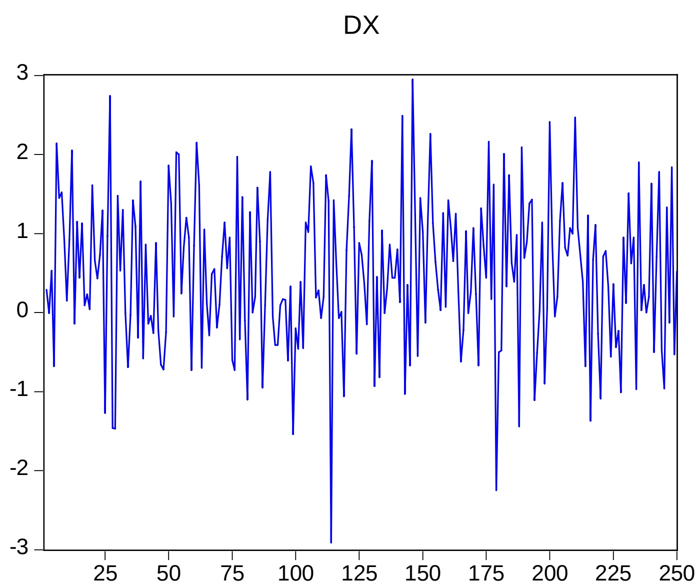
R-squared	0.374674	Mean dependent var	1.643130
Adjusted R-squared	0.361646	S.D. dependent var	1.225979
S.E. of regression	0.979521	Akaike info criterion	2.820582
Sum squared resid	230.2708	Schwarz criterion	2.906078
Log likelihood	-340.9316	Hannan-Quinn criter.	2.855007
F-statistic	28.75993	Durbin-Watson stat	1.996254
Prob(F-statistic)	0.000000		

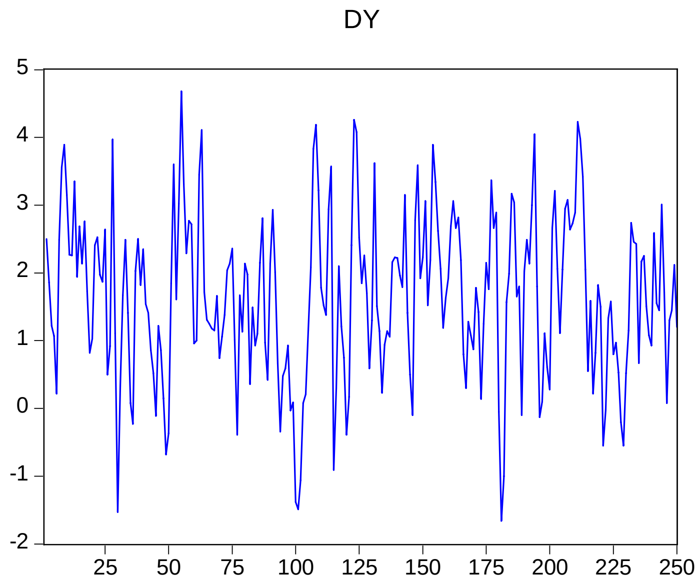
The Dickey-Fuller t-statistic for the y series is **-2.456943** with one-tailed p-value of **0.3494**.

The null hypothesis of this test is **y has a unit root and needs to be differenced**.
The alternative hypothesis of this test is **y is trend stationary data (and needs to be detrended).**

Given the results of this test on y, I conclude that <u>**Ho should be accepted and the data needs to be differenced (i.e. it has a "unit root").**</u>

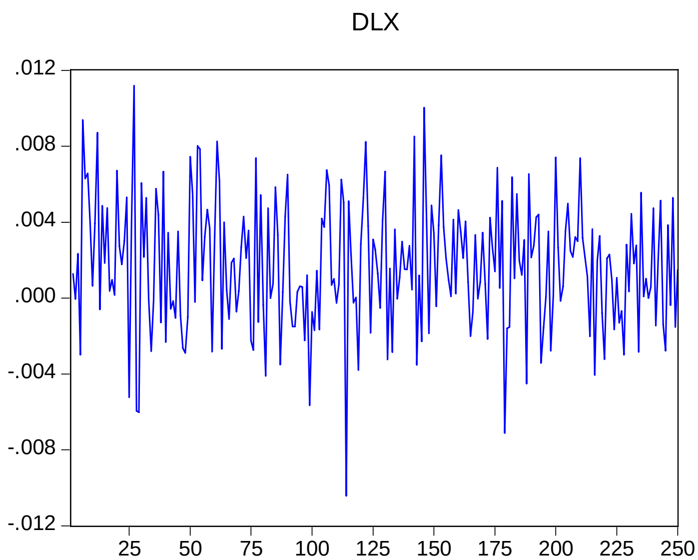
b) **STEP 2: Plot the stationary forms of the advertising and sales series before proceeding**. By the results of part a) above you should now know that the stationary form of the advertising and sales series are, respectively, dx = x – x(-1) and dy = y – y(-1), the differences (weekly changes in) the series. **Print out the graphs of these two series and hand them in with this exercise.** Do they appear to have a constant mean, constant variance, and constant covariance? Of course, one might have considered taking the log of the advertising expenditures (lx) and log of the sales series (ly) and then differenced them resulting in the weekly percentage change in the series as a possible stationary form (i.e. dlx and dly). **Print out the graphs of the dlx and dly series and hand them in with this exercise.** (To the discerning eye, you should notice that, though these series appear "almost" stationary, they are slightly downward-trending at the end of the dlx and dly series indicating the percentage change transformation for the x and y series is not quite right and thus we should stick with first differencing to achieve stationarity of the advertising and sales series.)

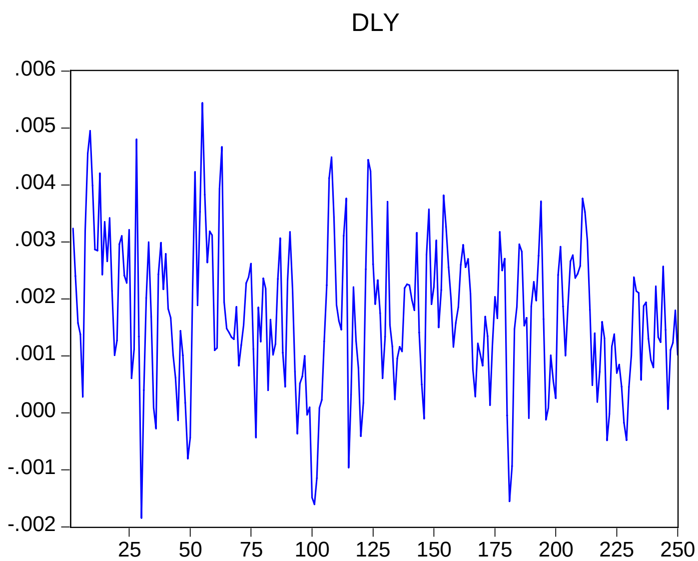




Do they appear to have a constant mean, constant variance, and constant covariance? **Yes, they appear to have a constant mean, constant variance, and constant covariance. Therefore, we should be working with dx and dy in our regression equation.**

Of course, one might have considered taking the log of the advertising expenditures (lx) and log of the sales series (ly) and then differenced them resulting in the weekly percentage change in the series as a possible stationary form (i.e. dlx and dly). **Print out the graphs of the dlx and dly series and hand them in with this exercise.** (To the discerning eye, you should notice that, though these series appear "almost" stationary, they are slightly downward-trending at the end of the dlx and dly series indicating the percentage change transformation for the x and y series is not quite right and thus we should stick with first differencing to achieve stationarity of the advertising and sales series.)





c) **STEP 3: Build the Autoregressive Core of the ARDL model.**

Use OLS to estimate the following autoregressive equations:

(i) $dy_t = \phi_0 + \phi_1 dy_{t-1} + a_t$

(ii) $dy_t = \phi_0 + \phi_1 dy_{t-1} + \phi_2 dy_{t-2} + a_t$

(iii) $dy_t = \phi_0 + \phi_1 dy_{t-1} + \phi_2 dy_{t-2} + \phi_3 dy_{t-3} + a_t$

(iv) $dy_t = \phi_0 + \phi_1 dy_{t-1} + \phi_2 dy_{t-2} + \phi_3 dy_{t-3} + \phi_4 dy_{t-4} + a_t$

(Notice that in model (i), the Box-Pierce Q-statistic that you obtain from the "Residual Tests / Correlogram-Q-Statistics" view of the OLS estimation output has a Q(16) statistic with a p-value < 0.05 thus we need to use the Newey-West standard error in constructing the t-statistic for $\hat{\phi}_1$ in order to get a consistent test of the significance of the dy_{t-1} variable. Thereafter, the usual t-statistic on the last autoregressive term is OK as the Q-statistics of the residuals have p-values greater than 0.05. Thus, from this step you should see that the "core" autoregressive model is model (iii) with 3 autoregressive terms.)

The four EVIEWS outputs generating the results for the four models are as follows:
In model (i): $\hat{\phi}_1 =$ <u>0.546530</u> Q(16) = <u>27.373</u> (p-value = <u>0.038</u>),

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:42
Sample (adjusted): 3 250
Included observations: 248 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.741869	0.109341	6.784938	0.0000
DY(-1)	0.546530	0.053338	10.24650	0.0000

R-squared	0.299127	Mean dependent var	1.642298
Adjusted R-squared	0.296278	S.D. dependent var	1.221380
S.E. of regression	1.024593	Akaike info criterion	2.894500
Sum squared resid	258.2487	Schwarz criterion	2.922834
Log likelihood	-356.9180	Hannan-Quinn criter.	2.905906
F-statistic	104.9907	Durbin-Watson stat	1.722224
Prob(F-statistic)	0.000000		

Newey-West t-statistic for $\hat{\phi}_1 =$ <u>9.982881</u> (p-value = <u>0.0000</u>).

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:44
Sample (adjusted): 3 250
Included observations: 248 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.741869	0.112704	6.582460	0.0000
DY(-1)	0.546530	0.054747	9.982881	0.0000

R-squared	0.299127	Mean dependent var	1.642298
Adjusted R-squared	0.296278	S.D. dependent var	1.221380

S.E. of regression	1.024593	Akaike info criterion	2.894500
Sum squared resid	258.2487	Schwarz criterion	2.922834
Log likelihood	-356.9180	Hannan-Quinn criter.	2.905906
F-statistic	104.9907	Durbin-Watson stat	1.722224
Prob(F-statistic)	0.000000		

In model (ii): $\hat{\phi}_2$ = <u>-0.251247</u>, Q(16) = <u>13.516</u> (p-value = <u>0.635</u>),

OLS t-statistic for $\hat{\phi}_2$ = <u>-4.054011</u> (p-value = <u>0.001</u>).

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:44
Sample (adjusted): 4 250
Included observations: 247 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.928945	0.115837	8.019413	0.0000
DY(-1)	0.684835	0.062017	11.04264	0.0000
DY(-2)	-0.251247	0.061975	-4.054011	0.0001

R-squared	0.343429	Mean dependent var	1.641417
Adjusted R-squared	0.338047	S.D. dependent var	1.223781
S.E. of regression	0.995674	Akaike info criterion	2.841278
Sum squared resid	241.8936	Schwarz criterion	2.883902
Log likelihood	-347.8978	Hannan-Quinn criter.	2.858439
F-statistic	63.81382	Durbin-Watson stat	1.920541
Prob(F-statistic)	0.000000		

In model (iii): $\hat{\phi}_3$ = <u>0.153272</u>, Q(16) = <u>6.6560</u> (p-value = <u>0.979</u>),

OLS t-statistic for $\hat{\phi}_3$ = <u>2.411073</u> (p-value = <u>0.0167</u>).

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:45
Sample (adjusted): 5 250
Included observations: 246 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.786251	0.129326	6.079606	0.0000
DY(-1)	0.723249	0.063596	11.37264	0.0000
DY(-2)	-0.355583	0.075479	-4.711005	0.0000
DY(-3)	0.153272	0.063570	2.411073	0.0167

R-squared	0.358856	Mean dependent var	1.643130

Adjusted R-squared	0.350908	S.D. dependent var	1.225979
S.E. of regression	0.987725	Akaike info criterion	2.829303
Sum squared resid	236.0956	Schwarz criterion	2.886300
Log likelihood	-344.0042	Hannan-Quinn criter.	2.852253
F-statistic	45.15010	Durbin-Watson stat	1.988644
Prob(F-statistic)	0.000000		

In model (iv): $\hat{\phi}_4$ = -0.029841, Q(16) = 6.1884 (p-value = 0.986),
OLS t-statistic for $\hat{\phi}_4$ = -0.462274 (p-value = 0.6443).

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:46
Sample (adjusted): 6 250
Included observations: 245 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.810608	0.139476	5.811794	0.0000
DY(-1)	0.727342	0.064596	11.25992	0.0000
DY(-2)	-0.366246	0.079186	-4.625109	0.0000
DY(-3)	0.175727	0.079185	2.219175	0.0274
DY(-4)	-0.029841	0.064554	-0.462274	0.6443

R-squared	0.359133	Mean dependent var	1.645469
Adjusted R-squared	0.348452	S.D. dependent var	1.227939
S.E. of regression	0.991174	Akaike info criterion	2.840344
Sum squared resid	235.7823	Schwarz criterion	2.911798
Log likelihood	-342.9421	Hannan-Quinn criter.	2.869119
F-statistic	33.62314	Durbin-Watson stat	1.995348
Prob(F-statistic)	0.000000		

Therefore, we can see that the order of the autoregressive core is 3.

d) **STEP 4: Use the Cross-Correlation Function to get the "beginning" specification of the distributed lag part of our ARDL model.**

Go to the group symbol of your ARDL.wf1 program. Here I have already generated a so-called **cross-correlation function (ccf)**. Print out this graph and turn it in with this exercise. On the left-hand-side of the ccf graph notice that the cross-correlation at lag 0 is insignificant, while the cross-correlations at lags 1, 2, and, possibility, lag 3 are statistically significant.

Here is the CCF:

Date: 12/03/07 Time: 15:52
Sample: 1 250
Included observations: 249
Correlations are asymptotically consistent approximations

DY,DX(-i)	DY,DX(+i)	i	lag	lead
*|.	*|.	0	-0.1021	-0.1021
.|*******	*|.	1	0.7177	-0.0770
.|*****	.|.	2	0.5466	0.0281
.|**	.|.	3	0.1274	0.0377
.|.	.|.	4	0.0195	-0.0032
.|*	.|.	5	0.0728	0.0118
.|.	.|.	6	0.0166	0.0236
.|.	.|.	7	-0.0030	-0.0205
.|.	*|.	8	0.0062	-0.0961
.|.	*|.	9	0.0403	-0.0442
.|.	.|.	10	-0.0033	-0.0343
*|.	*|.	11	-0.0537	-0.0699
*|.	*|.	12	-0.0561	-0.0480
*|.	.|.	13	-0.0530	0.0228
*|.	.|*	14	-0.0996	0.0629
*|.	.|*	15	-0.0867	0.0557
.|.	.|*	16	0.0129	0.0694
.|.	.|.	17	-0.0036	-0.0184
.|.	*|.	18	0.0468	-0.0667
.|*	.|.	19	0.0774	-0.0405
.|.	.|.	20	-0.0035	-0.0028
*|.	.|.	21	-0.0498	-0.0324
.|.	.|.	22	-0.0240	0.0487
*|.	.|.	23	-0.0579	0.0125
.|.	*|.	24	-0.0341	-0.0548
.|.	*|.	25	0.0281	-0.0636
.|.	*|.	26	0.0030	-0.0900
.|.	.|.	27	-0.0273	-0.0315
*|.	.|.	28	-0.0547	0.0348
*|.	.|.	29	-0.0835	0.0285
*|.	.|.	30	-0.0455	0.0276
.|.	.|.	31	0.0190	-0.0327
.|*	.|.	32	0.0529	0.0001
.|.	.|.	33	0.0129	0.0198
.|.	.|.	34	-0.0004	-0.0364
.|.	.|.	35	0.0361	0.0075
.|.	.|.	36	0.0122	-0.0287

e) **STEP 5: Use the "top-down" approach to finalize our ARDL model for the advertising to sales relationship.**

The above ccf of STEP 4 above suggests the following **initial** model to estimate in EVIEWS: "dy c dy(-1) dy(-2) dy(-3) dx(-1) dx(-2) dx(-3). Starting with this model, successively eliminate the variable with the highest p-value greater than 0.05 until you have a final model whose variables are all statistically significant at the 0.05 level.

Here are the models (in order) resulting from following the top-down approach. You should note in each case that the Box-Pierce Q-statistic at lag 16 is greater than 0.05 and thus, when dropping variables, we can use the usual t-statistics and their probability values:

Initial Model suggested by CCF:

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:49
Sample (adjusted): 5 250
Included observations: 246 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.315257	0.036964	8.528697	0.0000
DY(-1)	0.283503	0.064889	4.369065	0.0000
DY(-2)	0.062509	0.047474	1.316700	0.1892
DY(-3)	-0.009203	0.029625	-0.310652	0.7563
DX(-1)	1.009467	0.016717	60.38608	0.0000
DX(-2)	0.535438	0.067514	7.930721	0.0000
DX(-3)	0.024403	0.055590	0.438983	0.6611

R-squared	0.960584	Mean dependent var	1.643130
Adjusted R-squared	0.959594	S.D. dependent var	1.225979
S.E. of regression	0.246436	Akaike info criterion	0.064616
Sum squared resid	14.51466	Schwarz criterion	0.164361
Log likelihood	-0.947711	Hannan-Quinn criter.	0.104778
F-statistic	970.7495	Durbin-Watson stat	1.990411
Prob(F-statistic)	0.000000		

We should drop DY(-3) as its t-statistic has the highest probability value and the probability value is greater than 0.05.

Second Model:

Dependent Variable: DY
Method: Least Squares

Date: 11/24/07 Time: 16:50
Sample (adjusted): 5 250
Included observations: 246 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.314247	0.036752	8.550560	0.0000
DY(-1)	0.281741	0.064518	4.366823	0.0000
DY(-2)	0.051339	0.030941	1.659265	0.0984
DX(-1)	1.008986	0.016614	60.73230	0.0000
DX(-2)	0.537507	0.067058	8.015508	0.0000
DX(-3)	0.037314	0.036850	1.012587	0.3123

R-squared	0.960568	Mean dependent var	1.643130
Adjusted R-squared	0.959746	S.D. dependent var	1.225979
S.E. of regression	0.245972	Akaike info criterion	0.056889
Sum squared resid	14.52052	Schwarz criterion	0.142385
Log likelihood	-0.997367	Hannan-Quinn criter.	0.091314
F-statistic	1169.282	Durbin-Watson stat	1.986606
Prob(F-statistic)	0.000000		

We should drop DX(-3) as its t-statistic has the highest probability value and the probability value is greater than 0.05.

Third Model:

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:51
Sample (adjusted): 4 250
Included observations: 247 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.293662	0.030440	9.647108	0.0000
DY(-1)	0.331416	0.041549	7.976572	0.0000
DY(-2)	0.041127	0.029074	1.414575	0.1585
DX(-1)	1.007210	0.016499	61.04788	0.0000
DX(-2)	0.487299	0.044872	10.85969	0.0000

R-squared	0.960403	Mean dependent var	1.641417
Adjusted R-squared	0.959748	S.D. dependent var	1.223781
S.E. of regression	0.245525	Akaike info criterion	0.049198
Sum squared resid	14.58835	Schwarz criterion	0.120238
Log likelihood	-1.075970	Hannan-Quinn criter.	0.077799
F-statistic	1467.388	Durbin-Watson stat	2.090086
Prob(F-statistic)	0.000000		

We should drop DY(-2) as its t-statistic has the highest probability value and the probability value is greater than 0.05.

And the Final Model:

Dependent Variable: DY
Method: Least Squares
Date: 11/24/07 Time: 16:51
Sample (adjusted): 4 250
Included observations: 247 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.302258	0.029889	10.11263	0.0000
DY(-1)	0.384089	0.018471	20.79379	0.0000
DX(-1)	1.005510	0.016489	60.98161	0.0000
DX(-2)	0.433307	0.023643	18.32677	0.0000

R-squared	0.960075	Mean dependent var	1.641417
Adjusted R-squared	0.959583	S.D. dependent var	1.223781
S.E. of regression	0.246030	Akaike info criterion	0.049336
Sum squared resid	14.70898	Schwarz criterion	0.106168
Log likelihood	-2.092954	Hannan-Quinn criter.	0.072217
F-statistic	1947.827	Durbin-Watson stat	2.198984
Prob(F-statistic)	0.000000		

This model is the final model because all of its variables are statistically significant and as in the previous models the Box-Pierce Q-statistic (here for example Q(16) = 18.567 with p-value = 0.288. We have established a "balanced" and "dynamically complete" model for our data. It can be written in classic form as

$$
\begin{aligned}
d\hat{y}_t &= 0.302258 + 0.384089\, dy_{t-1} + 1.005510\, dx_{t-1} + 0.433307\, dx_{t-2} \\
&\quad\ (0.0298) \quad (0.01847) \qquad (0.01648) \qquad (0.02364)
\end{aligned}
$$

f) **Some conclusions from the final model.**

Given your final model, answer the following questions: The number of weeks before advertising expenditure affects the sales of the 100 stores is ___**one (1)**____. A change in advertising expenditures has a (finite period effect / **infinite but diminishing effect**) on sales. If there had been no autoregressive term in the final model, a change in advertising expenditures would have a (**finite period effect** / infinite but diminishing effect) on sales. **The total cumulative effect** on sales in the 100 stores from **a temporary one-period increase** of $1,000 in newspaper advertising is $ **<u>2,336</u>**. (Report your answer **in dollars**.) Be sure you show me how you got your answer.

The computation: In general the cumulative effect of a temporary change in x, say Δx, is given by the formula

Total cumulative effect = (sum of distributed lag coefficients / (1 – sum of the autoregressive coefficients)) times Δx.

In our case suppose, without loss of generality, that dx (the change in Advertising) has been held at zero for a long, long time. That is, for a long time the Advertising budget, though possibly non-zero, has been held constant and then for one period it is increased by one thousand dollars (i.e., $dx = 1$) and then returned to its previous level so that $dx = 0$. Then the additional sales that are generated as a result of this one time increase of \$1,000 is $\frac{(1.005510 + 0.433307)\cdot 1}{(1 - 0.384089)} = 2.336$ or, in thousands of dollars, \$2,336.

Furthermore, suppose that the average profit rate for each dollar of sales for the 100 stores is \$0.20. Is newspaper advertising profitable for ABC corporation? Explain your answer. (Notice we are abstracting from the fact that the cumulative effect of the temporary one-time \$1,000 increase in advertising **occurs over time** and should be calculated as **a present value** with a certain discount factor. That is, the PV of the temporary one-time \$1,000 increase in advertising on sales is less than the amount you have calculated above but, in this problem, let's not worry about PV comparisons.)

ANSWER: At a 20% profit rate on the dollar, the temporary one thousand dollar increase in newspaper advertising generates \$2,336(0.20) = \$467.20 in additional profit. That is not enough to finance the additional expenditure of \$1000 so it is a losing proposition.

Finally, suppose that ABC Corporation picks out randomly 100 other stores to try an **internet advertising campaign** on. Furthermore, suppose the final ARDL equation for this experiment was determined to be

$$d\hat{y}_t = 0.3 + 0.2dy_{t-1} + 6.0dz_{t-1} + 2.0dz_{t-2} \quad ,$$

where $dz_t = z_t - z_{t-1}$ represents the change in the internet advertising expenses (in thousands of dollars) from one week to the next of the 100 randomly chosen stores. Given this information, is internet advertising, again abstracting from any PV calculations, profitable for ABC corporation? Again, assume a 20% profit rate on sales. Explain your answer.

ANSWER: Following the same logic as applied in the newspaper advertising case, the additional sales that are generated as a result of a one time increase in internet advertising by \$1,000 is $\frac{(6.0 + 2.0)\cdot 1}{(1 - 0.2)} = 10$, or, in thousands of dollars, \$10,000. At a 20% profit rate on the dollar, the one thousand dollar increase in internet

advertising generates \$10,000(0.20) = \$2,000 in additional profit. This is enough to finance the additional expenditure of \$1,000 so it is a winning proposition unlike the newspaper advertising.