ECO 5375-701 Prof. Tom Fomby

Eco and Bus Forecasting Fall 2014

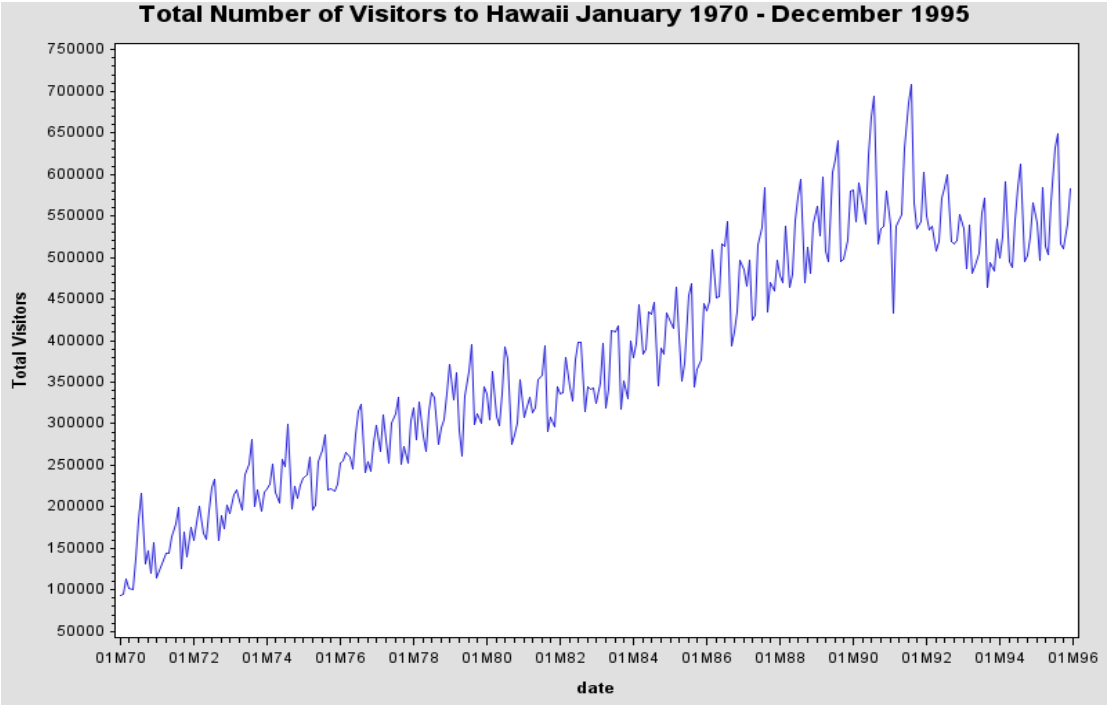
Take-Home Part of Mid-Term Exam

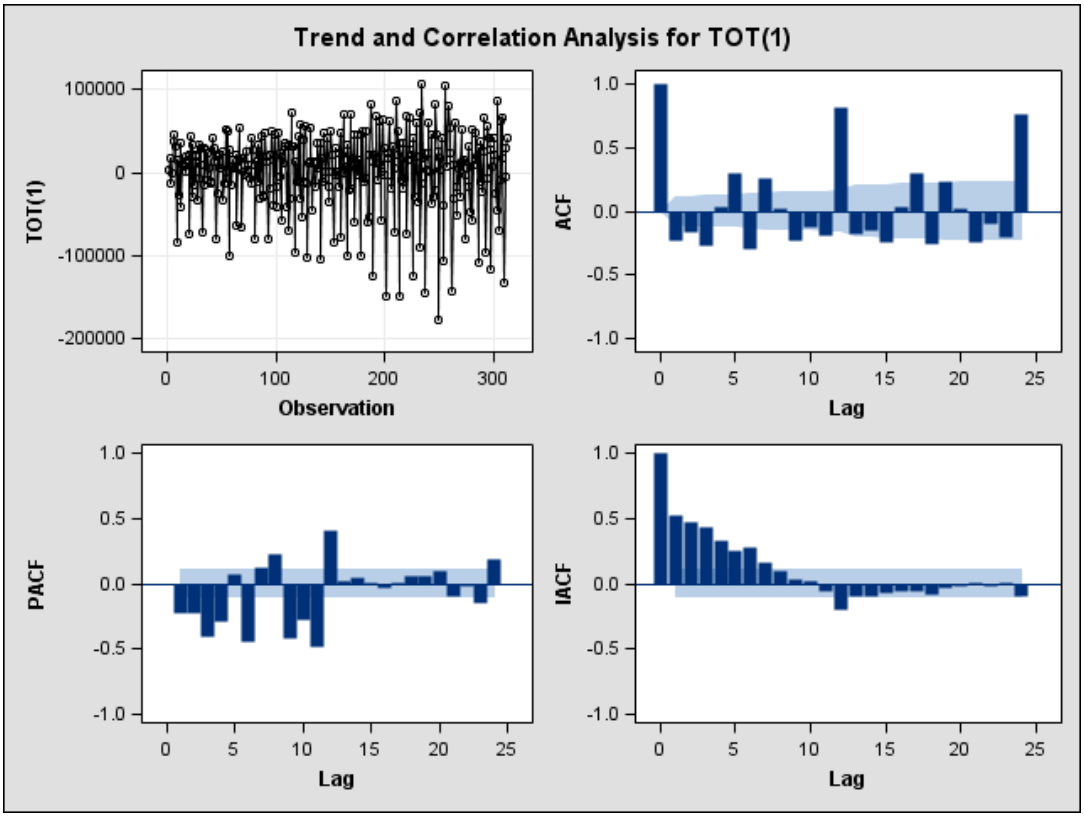
Answer Key

Assigned Points for the Take-Home Mid-Term Exam (total of 50 points):

- **a) 5 points**
- **b) 5 points**
- **c) 10 points = (5,5)**
- **d) 5 points**
- **e) 10 points = (5,5)**
- **f) 5 points**
- **g) 10 points = (5,5)**

a) Cut-and-paste the plot of the data into your report. Does the data appear to have seasonality in it? (Hint: Use Proc Arima to generate autocorrelations of the first difference of the data and focus on the autocorrelations at the seasonal lags. Cut-and-paste a graph of the autocorrelation function after the plot of the raw data. The appropriate statement in Proc Arima is: identify var=TOT(1);





Answer: Yes, the data appears to have seasonality. From the plot of the ACF of the first difference of the data (upper-right-hand-corner graph), the ACF has strong correlations at the seasonal lags 12 and 24 and they are slowly declining which indicates that seasonal modeling is probably called for.

b) Use OLS (Proc Reg) to estimate a DTDS model of the Hawaiian tourism data (TOT) including first and second-order trend terms and the seasonal dummies. Get the traditional first-order Durbin-Watson statistic using the OLS residuals. Cut-and-paste the appropriate table into your report. Does there appear to be autocorrelation in the errors of the model? Explain your reasoning. What is the implication of the DW test?

The REG Procedure
Model: MODEL1
Dependent Variable: TOT

Durbin-Watson D	0.432
Pr < DW	<.0001
Pr > DW	1.0000
Number of Observations	312
1st Order Autocorrelation	0.783

Answer: Yes. There is autocorrelation in the errors of the least square model. The Pr < DW is the P-value for testing positive autocorrelation. This represents the null hypothesis of no autocorrelation versus the alternative hypothesis of positively autocorrelated errors. Since the P-value of the DW test statistics is <.0001 we reject the null hypothesis of no autocorrelation and accept the alternative hypothesis of positive autocorrelation in the errors of the model. The results of this DW test indicate that we need to conduct all the following hypothesis tests using Generalized Least Squares which corrects for autocorrelated errors (via Proc Autoreg).

c) Use Proc Autoreg and GLS to determine if the Hawaiian tourism data has a trend with curvature. Cut-and-paste output into your notebook that addresses this issue. (Be sure to use the nlag = 12 option so that the AR fit of the residuals will allow for seasonal effects remaining even after the adjustment of the data by the seasonal dummies.) If there is curvature in the data, use the estimated output to get the point of the maximum or minimum of the implied trend. Give me the date or observation number at which the trend turns. (Hint: Use the calculus on the estimated trend.)

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	108160	28166	3.84	0.0002
t	1	2197	380.0081	5.78	<.0001
t2	1	-2.3581	1.1592	-2.03	0.0428
d2	1	-13603	5248	-2.59	0.0100
d3	1	26528	6700	3.96	<.0001
d4	1	-19559	7308	-2.68	0.0079
d5	1	-27417	7317	-3.75	0.0002
d6	1	23676	7454	3.18	0.0016
d7	1	49498	7512	6.59	<.0001
d8	1	68258	7465	9.14	<.0001
d9	1	-38426	7336	-5.24	<.0001
d10	1	-22235	7331	-3.03	0.0026
d11	1	-27777	6744	-4.12	<.0001
d12	1	11731	5325	2.20	0.0284
AR1	1	-0.5884	0.0444	-13.24	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
AR4	1	-0.1216	0.0429	-2.83	0.0049
AR12	1	-0.2234	0.0415	-5.38	<.0001

Answer: The coefficient estimate of t^2 variable is -2.3581. The T-statistic on the t^2 variable is -2.03 with P-value being 0.0428 < 0.05. Therefore, the coefficient estimate on t^2 is statistically significant and the data has a trend with curvature.

From the output of parameter estimates, we know that TOT = $2197t - 2.3581t^2 + \ldots$ .Then use the calculus to find the point of maximum of implied trend.

$$dTOT/dt = 2197 - 2.3581*2t = 0$$

$$t^* = 465.84$$

Therefore, when t = 466 (assume t is an integer), $2197t - 2.3581t^2$ has the maximum value. It indicates that on **October 2008** (when t =466), the trend turns.

d) Conduct a joint test of seasonality by using an F-test of the joint significance of the seasonal dummies in Proc Autoreg. Cut-and-paste the F-test result into your report and explain the meaning of the test.

Joint Test of Seasonality

Source	DF	Mean Square	F Value	Pr > F
Numerator	11	23084800762	57.52	<.0001
Denominator	295	401312981		

Answer: The purpose of this F-test is to test the following hypothesis: (denoting the coefficients on seasonal dummies as $\beta_2, \beta_3, \ldots, \beta_{12}$)

H_0: $\beta_2 = \beta_3 = \ldots = \beta_{12} = 0$ (No seasonality)

H_1: At least one of the above β's is not equal to zero (Seasonality is present)

The F-statistics is 57.52 with p-value being <.0001, therefore we can reject the null hypothesis of no seasonality. Seasonality is present in the data.

e) Write out the estimated form of the DTDS model for Hawaiian Tourism that you have chosen. Include the coefficient estimates, their standard errors, and the same for the coefficients of the autocorrelated errors. Provide a DW report on the white noise of the residuals of your fitted model. Are the residuals of your fitted model white noise? What is the meaning of "white noise?"

Estimated form of the DTDS model:

$$TOT = 108160 + 2197t - 2.3581t^2 - 13603D2 + 26528D3 - 19559D4 - 27417D5 + 23676D6$$

(28166) (380) (1.1592) (5248) (6700) (7308) (7317) (7454)

$$+ 49498D7 + 68258D8 - 38426D9 - 22235D10 - 27777D11 + 11731D12 + E(t)$$

(7512) (7465) (7336) (7331) (6744) (5325)

$$E(t) = 0.5884E(t-1) + 0.1216E(t-4) + 0.2234E(t-12) + a(t)$$

(0.0444) (0.0429) (0.0415)

Durbin-Watson Statistics based on the GLS Residuals

Order	DW	Pr < DW	Pr > DW
1	1.9101	0.2003	0.7997
2	1.8923	0.1735	0.8265
3	1.9430	0.3283	0.6717
4	1.9810	0.4773	0.5227
5	1.8139	0.0728	0.9272
6	2.1367	0.9243	0.0757
7	1.8405	0.1331	0.8669
8	1.8605	0.1889	0.8111
9	1.8542	0.1893	0.8107
10	1.8938	0.3156	0.6844
11	1.8024	0.1113	0.8887
12	1.6760	0.0014	0.9986

Answer: The above table shows the DW statistics with p-values for orders through 1 to 12 for the GLS residuals. The p-values from order 1 to 11 are greater than 0.05, indicating no

autocorrelation from first order to the 11th order. But the 12th order DW statistics has a p-value 0.0014 < 0.05. But overall, given all of the autocorrelation results, the residuals are essentially white noise.

f) Construct standardized seasonal effects and tell me (i) the "weak" months and the "strong" months, apart from trend, of the Hawaiian tourism year and (ii) the weakest tourism month and the strongest tourism month. Cut-and-paste the standardized seasonal effects output into your report.

d1a	d2a	d3a	d4a	d5a	d6a
-0.023087	-0.14595	0.21651	-0.19974	-0.27072	0.19076
d7a	**d8a**	**d9a**	**d10a**	**d11a**	**d12a**
0.42398	0.59343	-0.37016	-0.22391	-0.27397	0.082865

Answer:
The "weak" months are January, February, April, May, September, October and November.
The "strong" months are March, June, July, August and December.
The weakest tourism month is September.
The strongest tourism month is August.

g) Using your DTDS model, calculate forecasts of Hawaiian tourism for the months of January 1996 through December 1996. Include the 95% confidence intervals of these forecasts. How does the 1996 annual forecast compare with the 1995 actual tourism? What is the forecasted percentage change in Hawaiian tourism from 1995 to 1996?

Obs	p_ar	l_ar	u_ar	t
1	564601.65	524023.84	605179.46	313
2	537925.49	490440.09	585410.88	314
3	584959.33	535066.85	634851.81	315
4	537853.49	487001.57	588705.42	316
5	528335.31	476188.39	580482.24	317
6	579450.47	526235.05	632665.89	318
7	615165.43	561216.01	669114.84	319
8	639137.15	584709.07	693565.24	320
9	529528.65	474717.35	584339.96	321
10	539297.72	484164.49	594430.95	322

Obs	p_ar	l_ar	u_ar	t
11	538937.23	483554.63	594319.83	323
12	582823.47	527250.25	638396.69	324

Answer: The forecasted total number of visitors visiting Hawaii in 1996 is 6,778,015. And the actual total number of visitors in 1995 is 6,633,840. The percentage increase in Hawaiian tourism from 1995 to 1996, as projected by the DTDS model is

(6,778,015 - 6,633,840)/ 6,633,840 = **2.17%**