

EXERCISE 1

KEY

Purpose: To learn how to use an SSP model to forecast a seasonal time series (the Plano Sales Tax data set) and to test for the presence or absence of seasonality based on a test of equal proportions. This exercise is due **Tuesday, September 6**. Use the Excel spreadsheet `Plano_Data_Transposed.xlsx` on the class website to finish this exercise.

For the numbers calculated in this Key see the EXCEL spreadsheet `Exercise_1_Key.xlsx` on the class website.

(a) Using the complete years data from 1991 – 2004, obtain the 1991 – 2004 yearly totals. Then calculate the 13 year-to-year differences in the yearly totals and take the average of these differences. Call the average of these differences \overline{diff} . Then compute your estimate of the 2005 total by adding \overline{diff} to the 2004 year total.

Answer: $\overline{diff} = 2517292.69$

Projected year total 2005 = year total 2004 + \overline{diff} = 49453998 + 2517292.69 = 51971290.7

(b) Given your projected 2005 year total, you should get the December 2005 number by subtracting the sum of the monthly numbers from January, 2005 through November, 2005 from your projected 2005 total. (The hope here is that this estimated December number makes some sense in that the implied proportion that December takes up of the 2005 year total is not too far from the overall proportion that you have calculated for December using your whole year calculations. The nice thing about this approach for filling in the December, 2005 number is that the monthly numbers for 2005 are forced to add up to the total you have projected for 2005.)

Answer: December 2005 = projected year total 2005 – sum(Jan 2005 thru Nov 2005)
3033167 = 51971290.7 - 48938124

Recall we calculate the monthly proportions by summing up the numbers by month over **all complete years** and the dividing these monthly totals by an overall total obtained by summing up the yearly totals over all complete years (or for that matter summing up the monthly totals). (To motivate things here, I supervised an intern to the office of the City Manager of Plano in the winter of 2005. He was presented with the data you have in December of 2005. The City Manager then asked the intern to forecast not only what Plano sale tax revenue should be in December of 2005 but the expected monthly

sales tax revenue for all of the months of 2006. The City Manager was preparing a budget plan for the coming year, 2006.)

(c) Adding \overline{diff} to your estimated 2005 total you can get an estimate of the 2006 total of tax revenues that the city of Plano could expect to garner for that year. By applying your previously determined whole-year monthly proportions to your estimated 2006 total, you can correspondingly get monthly estimates of sales tax revenues for 2006.

Answer: $\overline{diff} = 2517292.69$

$$\begin{aligned} \text{Projected year total 2006} &= \text{projected year total 2005} + \overline{diff} = \\ 51971290.7 + 2517292.69 &= 54488583.4 \end{aligned}$$

(d) Finally, using the above information, calculate **the expected percentage growth** in sales tax revenue for Plano in going from 2005 to 2006.

Answer: Projected % increase in tax revenue from 2005 to 2006 =
 $100 * (\text{Proj 2006} - \text{Proj 2005}) / \text{Proj 2005} = 100 * (54488583.4 - 51971290.7) / 51971290.7 = 4.8436217\%$

(e) Using only the whole years (1991 – 2004), I want you to test the null hypothesis of no seasonality versus the alternate hypothesis of seasonality in the Plano data using Friedman's two-way ANOVA on ranks. I will describe in detail how to do this in class.

Answer: The answer for this part has been generated by the SAS program Plano_data_Friedman_test.sas that is posted on the class website. The output produced by the program is as follows:

Friedman Two-Way Nonparametric Anova
Testing Seasonality in Plano Sales Tax Revenue Data

The ANOVA Procedure

Dependent Variable: Rtaxrev Rank for Variable taxrev

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	1603.000000	66.791667	23.94	<.0001
Error	143	399.000000	2.790210		
Corrected Total	167	2002.000000			

R-Square	Coeff Var	Root MSE	Rtaxrev Mean
0.800699	25.69834	1.670392	6.500000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
year	13	0.000000	0.000000	0.00	1.0000
month	11	1603.000000	145.727273	52.23	<.0001

The Friedman Two-Way Anova test on ranks which we have adapted to testing seasonality in the Plano Tax Revenue data produces an F-statistic of 52.23 with a p-value less than 0.0001. Therefore, we reject the null hypothesis of no seasonality in the Plano data and accept the alternative hypothesis of seasonality in the data. What we have done here is essentially test that the ranks of the data by season are random as compared to being systematic by season.