Economic Forecasting
Exercise Sheet 6 Solutions

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1. (a) The estimates for the additive seasonal dummy model are:

```
Dependent Variable: LIQUOR
Method: Least Squares
Date: 04/13/13   Time: 22:50
Sample: 1967M01 1994M12
Included observations: 336
===============================================================
Variable    Coefficient     Std. Error    t-Statistic  Prob.
===============================================================
C            762.3564        26.54320      28.72135    0.0000
@TREND       4.394609        0.063857      68.81926    0.0000
@SEAS(1)    -643.9093        30.33220     -21.22857    0.0000
@SEAS(2)    -705.8039        30.33079     -23.27021    0.0000
@SEAS(3)    -607.1628        30.32951     -20.01888    0.0000
@SEAS(4)    -603.4146        30.32837     -19.89604    0.0000
@SEAS(5)    -520.6306        30.32736     -17.16703    0.0000
@SEAS(6)    -512.6681        30.32649     -16.90496    0.0000
@SEAS(7)    -451.7055        30.32575     -14.89512    0.0000
@SEAS(8)    -491.2787        30.32514     -16.20038    0.0000
@SEAS(9)    -570.4590        30.32467     -18.81171    0.0000
@SEAS(10)   -545.3536        30.32434     -17.98403    0.0000
@SEAS(11)   -507.3554        30.32413     -16.73108    0.0000
===============================================================
R-squared            0.945286     Mean dependent var    1301.554
Adjusted R-squared   0.943253     S.D. dependent var    476.3007
S.E. of regression   113.4623     Akaike info criterion 12.33874
Sum squared resid     4158201.    Schwarz criterion     12.48643
Log likelihood      -2059.908     Hannan-Quinn criter.  12.39761
F-statistic          465.0357     Durbin-Watson stat    0.674007
Prob(F-statistic)    0.000000
```

The estimates for the seasonal trend model are:

```
Dependent Variable: LIQUOR
Method: Least Squares
Sample: 1967M01 1994M12
Included observations: 336
==============================================================
Variable    Coefficient     Std. Error    t-Statistic  Prob.
==============================================================
C                  413.4283    53.41600     7.739783    0.0000
@TREND             5.818806    0.202734     28.70172    0.0000
@SEAS(1)          -180.2608    74.09438    -2.432854    0.0155
@SEAS(2)          -206.9361    74.22435    -2.787981    0.0056
@SEAS(3)          -194.8221    74.35464    -2.620174    0.0092
@SEAS(4)          -211.4416    74.48526    -2.838704    0.0048
@SEAS(5)          -181.4680    74.61619    -2.432020    0.0156
@SEAS(6)          -180.0001    74.74745    -2.408110    0.0166
@SEAS(7)          -184.1193    74.87903    -2.458890    0.0145
@SEAS(8)          -174.5266    75.01092    -2.326682    0.0206
@SEAS(9)          -182.6003    75.14313    -2.430033    0.0157
@SEAS(10)         -159.9720    75.27565    -2.125149    0.0344
@SEAS(11)         -130.0761    75.40849    -1.724954    0.0855
@TREND*@SEAS(1)  -1.914454    0.286709    -6.677349    0.0000
@TREND*@SEAS(2)  -2.062238    0.286709    -7.192797    0.0000
@TREND*@SEAS(3)  -1.692894    0.286709    -5.904576    0.0000
@TREND*@SEAS(4)  -1.605820    0.286709    -5.600876    0.0000
@TREND*@SEAS(5)  -1.383165    0.286709    -4.824284    0.0000
@TREND*@SEAS(6)  -1.356162    0.286709    -4.730104    0.0000
@TREND*@SEAS(7)  -1.085272    0.286709    -3.785276    0.0002
@TREND*@SEAS(8)  -1.290686    0.286709    -4.501732    0.0000
@TREND*@SEAS(9)  -1.585067    0.286709   -5.528490     0.0000
@TREND*@SEAS(10) -1.574211    0.286709   -5.490627     0.0000
@TREND*@SEAS(11) -1.540390    0.286709   -5.372663     0.0000
==============================================================
R-squared            0.955608     Mean dependent var     1301.554
Adjusted R-squared 0.952336     S.D. dependent var     476.3007
S.E. of regression 103.9864     Akaike info criterion  12.19515
Sum squared resid  3373708.     Schwarz criterion      12.46780
Log likelihood    -2024.785     Hannan-Quinn criter.   12.30383
F-statistic          292.0158     Durbin-Watson stat     0.284128
Prob(F-statistic)   0.000000
```

Comparing the two sets of results, it can be seen that the interactive dummy terms, which allow the seasonal pattern to change with the trend, are individually significant and both *Akaike* and *Schwarz* information criteria favour the seasonal trend model.

(b) The estimates for the *Dickey-Hasza-Fuller* regression are

```
Dependent Variable: D(LIQUOR,0,12)
Method: Least Squares
Date: 04/14/13   Time: 00:16
Sample (adjusted): 1968M01 1994M12
Included observations: 324 after adjustments
```

Variable	Coefficient	Std. Error	t-Statistic	Prob.
@SEAS(1)	97.11756	19.36997	5.013821	0.0000
@SEAS(2)	92.84727	19.02236	4.880955	0.0000
@SEAS(3)	103.6765	19.62676	5.282406	0.0000
@SEAS(4)	105.8577	19.67032	5.381597	0.0000
@SEAS(5)	111.9269	20.23354	5.531752	0.0000
@SEAS(6)	112.9638	20.31206	5.561416	0.0000
@SEAS(7)	120.9650	20.73504	5.833847	0.0000
@SEAS(8)	114.8660	20.51900	5.598031	0.0000
@SEAS(9)	109.2567	20.01825	5.457855	0.0000
@SEAS(10)	110.8587	20.22045	5.482503	0.0000
@SEAS(11)	112.8699	20.50072	5.505657	0.0000
@SEAS(12)	154.0239	24.19368	6.366289	0.0000
LIQUOR(-12)	-0.052620	0.010210	-5.153808	0.0000

R-squared	0.082684	Mean dependent var	44.67593
Adjusted R-squared	0.047289	S.D. dependent var	82.66691
S.E. of regression	80.68860	Akaike info criterion	11.65837
Sum squared resid	2024812.	Schwarz criterion	11.81006
Log likelihood	-1875.656	Hannan-Quinn criter.	11.71892
Durbin-Watson stat	0.674884		

The deterministic seasonal dummies allow the mean to be different in each season but the available tabulated critical values for the *Dickey-Hasza-Fuller* test do not allow for the inclusion of a deterministic trend. The t-ratio on the lagged level term **LIQUOR(-12)** is -5.153808 which is not negative enough to reject the null hypothesis of seasonal roots, the critical values being -6.47 (1%), -5.82 (5%) and -5.49 (10%). We must therefore conclude that the series has seasonal unit roots which means that in building a seasonal *ARMA* model in the next section, we must work with the seasonal difference Δ_{12} of **LIQUOR**.

(c) The estimates of the *multiplicative seasonal ARMA(2,0)(2,0)* model are

```
Dependent Variable: D(LIQUOR,0,12)
Method: Least Squares
Date: 04/14/13   Time: 00:52
Sample (adjusted): 1968M05 1994M12
Included observations: 320 after adjustments
Convergence achieved after 11 iterations
===============================================================
Variable    Coefficient     Std. Error    t-Statistic  Prob.
===============================================================
C              44.91174      17.19184       2.612387    0.0094
AR(1)         -0.881564      0.066816      -13.19393    0.0000
AR(2)         -0.543238      0.059488      -9.131894    0.0000
SAR(1)         1.277611      0.075227       16.98351    0.0000
SAR(2)        -0.350586      0.074485      -4.706824    0.0000
===============================================================
R-squared              0.577357      Mean dependent var    44.74063
Adjusted R-squared 0.571990      S.D. dependent var    83.18023
S.E. of regression 54.41857      Akaike info criterion 10.84679
Sum squared resid  932834.9      Schwarz criterion     10.90567
Log likelihood    -1730.486      Hannan-Quinn criter.  10.87030
F-statistic        107.5774      Durbin-Watson stat    2.003745
Prob(F-statistic)  0.000000
===============================================================
Inverted AR Roots       .88           .40   -.44-.59i -.44+.59i
===============================================================
```

Both seasonal and non-seasonal *AR* terms appear to be significant but these seasonal *ARMA* models are quite fragile and it is easy to find models that *EViews* can't estimate.

The estimated model has quite complex dynamics and can be written as

$$(1-1.277611L^{12}+0.350586L^{24})(1+0.881564L+0.543238L^2)\Delta_{12}(y_t-c) = \epsilon_t$$

which has non-zero coefficients at lags 0,1,2,12,13,14,24,25,26,36,37,38 and 48.

(d) Figure 1 graphs the seasonally adjusted liquor series produced by the *X-12* and the *TRAMO/ SEATS* seasonal adjustment procedures. The two series look very similar and it is difficult to distinguish between them.

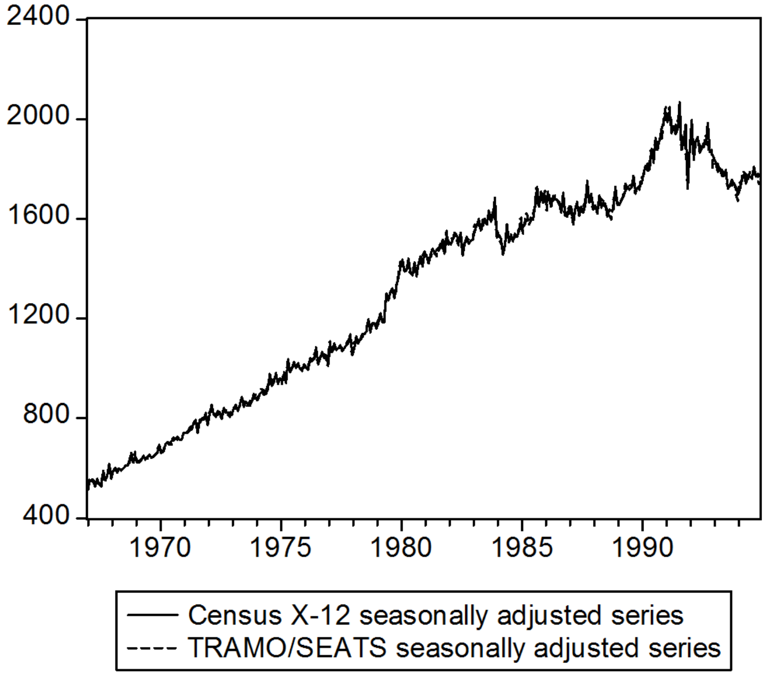

Figure 1: US Liquor sales: seasonally adjusted with *X-12* and *TRAMO/SEATS*