Anexo 5

La serie de comandos que fueron necesarios para realizar el modelo ARMA(p, q) que considera la estacionalidad y que no presente tendencia fue:

a) serie1<-ts(scan("tesis2.txt"), start = c(2004, 1), frequency = 12)

b) ts.plot(serie1, main = "Ventas Totales de ABC")

serie2<-window(serie1, end = c(2007, 12))

tiempo<-time(serie2)

ciclo<-factor(cycle(serie2))

c) reg1<-lm(serie2~tiempo+ciclo)

summary(reg1)

```
Call:
lm(formula = serie2 ~ tiempo + ciclo)

Residuals:
    Min      1Q  Median      3Q     Max
-19353.2  -4994.7   -182.6   4269.8  17626.2

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -13988141    2380017  -5.877 1.12e-06 ***
tiempo          6998       1187   5.896 1.06e-06 ***
ciclo2         -7145       6501  -1.099  0.27924
ciclo3         15341       6503   2.359  0.02404 *
ciclo4         -1497       6507  -0.230  0.81937
ciclo5          9774       6512   1.501  0.14236
ciclo6         10602       6519   1.626  0.11284
ciclo7          4320       6527   0.662  0.51242
ciclo8         10166       6537   1.555  0.12892
ciclo9        -10121       6548  -1.546  0.13118
ciclo10        -3906       6561  -0.595  0.55540
ciclo11         1822       6575   0.277  0.78327
ciclo12        21236       6591   3.222  0.00275 **
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 9192 on 35 degrees of freedom
Multiple R-Squared: 0.713,      Adjusted R-squared: 0.6146
F-statistic: 7.246 on 12 and 35 DF,  p-value: 2.001e-06
```

d) pron1<-ts(predict(reg1), start = c(2004, 1), frequency = 12)

ts.plot(serie2,pron1,col=1:2)

e) predict(reg1, newdata = data.frame(tiempo = 2008+0:11/12, ciclo = factor(12)), interval = "prediction")

```
       fit      lwr      upr
1  84010.52 62800.26 105220.8
2  84593.64 63346.36 105840.9
3  85176.76 63890.62 106462.9
4  85759.89 64433.07 107086.7
5  86343.01 64973.71 107712.3
6  86926.13 65512.55 108339.7
7  87509.25 66049.61 108968.9
8  88092.38 66584.89 109599.9
9  88675.50 67118.40 110232.6
10 89258.62 67650.16 110867.1
11 89841.74 68180.19 111503.3
12 90424.87 68708.49 112141.2
```

f) plot(stl(serie2, "periodic"))

g) ce<-stl(serie2, "periodic")$time.series[,"seasonal"]

serie3<-serie2 - ce

h) ts.plot(serie3, main = "Serie sin el componente estacional")

i) acf(serie3, main = "Autocorrelaciones")

pacf(serie3, main = "Autocorrelaciones Parciales")

j) shapiro.test(serie3)

```
        Shapiro-Wilk normality test

data:  serie3
W = 0.9764, p-value = 0.4381
```

k) ARMA(0, 1)

```
mod01<-arima(serie3, order = c(0, 0, 1))

mod01
Call:
arima(x = serie3, order = c(0, 0, 1))

Coefficients:
         ma1  intercept
      0.2411  52712.965
s.e.  0.0995   1906.320

sigma^2 estimated as 114156188:  log likelihood = -513.41,  aic = 1032.83
```

ARMA(0, 2)

```
mod02<-arima(serie3, order = c(0, 0, 2))

mod02
Call:
arima(x = serie3, order = c(0, 0, 2))

Coefficients:
         ma1     ma2  intercept
      0.2743  0.3882  52919.630
s.e.  0.1739  0.1084   2247.110

sigma^2 estimated as 89954253:  log likelihood = -507.85,  aic = 1023.7
```

ARMA(0, 3)

```
mod03<-arima(serie3, order = c(0, 0, 3))

mod03
Call:
arima(x = serie3, order = c(0, 0, 3))

Coefficients:
        ma1     ma2     ma3  intercept
      0.250  0.5085  0.2134  53046.776
s.e.  0.137  0.1411  0.1131   2560.484

sigma^2 estimated as 83913380:  log likelihood = -506.33,  aic = 1022.66
```

ARMA(0, 12)

```
mod04<-arima(serie3, order = c(0, 0, 12))

mod04
Call:
arima(x = serie3, order = c(0, 0, 12))

Coefficients:
         ma1     ma2     ma3     ma4     ma5     ma6     ma7     ma8     ma9
      0.2611  0.7436  0.1966  0.7355  0.2534  0.5434  0.5115  0.4203  0.5151
s.e.  0.1729  0.1941  0.1947  0.2042  0.2051  0.2614  0.2687  0.2954
0.2591
        ma10    ma11     ma12  intercept
      0.5399  0.3320  -0.3267  54305.473
s.e.  0.2636  0.2034   0.1672   4321.338

sigma^2 estimated as 32109896:  log likelihood = -490.52,  aic = 1009.05
```

l) ARMA(1, 1)

```
mod11<-arima(serie3, order = c(1, 0, 1))

mod11
Call:
arima(x = serie3, order = c(1, 0, 1))

Coefficients:
      ar1      ma1   intercept
        1  -0.6887    52752.78
s.e.    0   0.0919  1973428.38

sigma^2 estimated as 73013242:  log likelihood = -503.49,  aic = 1014.98
```

ARMA(1, 2)

```
mod12<-arima(serie3, order = c(1, 0, 2))

mod12
Call:
arima(x = serie3, order = c(1, 0, 2))
```

```
Coefficients:
        ar1     ma1     ma2  intercept
      0.9515  -0.7708  0.2400  54440.215
s.e.  0.0714   0.1684  0.1305   8743.599

sigma^2 estimated as 69011433:  log likelihood = -502.06,  aic = 1014.12
```

ARMA(1, 3)

```
mod13<-arima(serie3, order = c(1, 0, 3))

mod13
Call:
arima(x = serie3, order = c(1, 0, 3))

Coefficients:
        ar1     ma1     ma2     ma3  intercept
      0.9649  -0.8005  0.3424  -0.1401  54355.653
s.e.  0.0507   0.1576  0.1706   0.1332   9419.892

sigma^2 estimated as 67258912:  log likelihood = -501.49,  aic = 1014.98
```

ARMA(1, 12)

```
mod14<-arima(serie3, order = c(1, 0, 12))

mod14
Call:
arima(x = serie3, order = c(1, 0, 12))

Coefficients:
         ar1     ma1     ma2     ma3     ma4     ma5     ma6     ma7     ma8
      -0.6458  0.9736  0.9394  0.8152  0.9646  0.8122  0.8254  0.9644
0.8134
s.e.   0.1892  0.2914  0.2958  0.3290  0.3100  0.3107  0.3020  0.3305
0.3409
        ma9    ma10    ma11    ma12  intercept
      0.9531  0.9684  0.8963  -0.0962  54290.228
s.e.  0.3290  0.3539  0.3633   0.2605   4592.127

sigma^2 estimated as 27910695:  log likelihood = -489.38,  aic = 1008.76
```

m)
```
par(mfcol=c(1,2))

plot(ARMAacf(ar=c(0.9649),ma=c(-0.8005, 0.3424, -0.1401), lag.max=40),
type = "h", ylim = c(-1, 1), xlab = "Desfase", ylab = "Autocorrelaciones",
main = expression(phi==0.9649))
```

plot(ARMAacf(ar=c(0.9649),ma=c(-0.8005, 0.3424, -0.1401), lag.max=40, pacf=TRUE), type = "h", ylim = c(-1, 1), xlab = "Desfase", ylab = "Autocorrelaciones Parciales", main = expression(phi==0.9649))

n) pron.des<-predict(mod13, n.ahead=12)

```
pron.des
$pred
         Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
2008 71874.60 72255.98 70358.10 69796.13 69253.90 68730.71 68225.89
67738.80
         Sep      Oct      Nov      Dec
2008 67268.82 66815.34 66377.78 65955.59
$se
          Jan      Feb      Mar      Apr      May      Jun      Jul
2008  8201.153  8311.278  9271.700  9690.009 10063.836 10399.797
10703.101
          Aug      Sep      Oct      Nov      Dec
2008 10977.946 11227.781 11455.480 11663.472 11853.832
```

o) pron2<-pron.des$pred+ce[1:12]

```
pron2
         Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
2008 67988.13 61157.80 81678.58 64163.48 74776.67 75066.79 68264.65
73664.09
         Sep      Oct      Nov      Dec
2008 52948.29 58609.12 63799.81 82534.22
```

ts.plot(serie2, pron2,col=c("black","red"))

p) pron.des<-predict(mod13,n.ahead=24)

```
pron.des
$pred
         Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
2008 71874.60 72255.98 70358.10 69796.13 69253.90 68730.71 68225.89
67738.80
2009 65548.23 65155.17 64775.92 64409.98 64056.90 63716.21 63387.49
63070.32
         Sep      Oct      Nov      Dec
2008 67268.82 66815.34 66377.78 65955.59
2009 62764.28 62468.99 62184.07 61909.15
```

```
$se
         Jan      Feb      Mar      Apr      May      Jun      Jul
2008  8201.153  8311.278  9271.700  9690.009 10063.836 10399.797
10703.101
2009 12028.349 12188.579 12335.881 12471.456 12596.364 12711.550
12817.858
         Aug      Sep      Oct      Nov      Dec
2008 10977.946 11227.781 11455.480 11663.472 11853.832
2009 12916.043 13006.788 13090.705 13168.351 13240.231

pron3<-pron.des$pred+ce[1:12]

pron3
         Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
2008 67988.13 61157.80 81678.58 64163.48 74776.67 75066.79 68264.65
73664.09
2009 61661.76 54057.00 76096.40 58777.33 69579.67 70052.30 63426.25
68995.61
         Sep      Oct      Nov      Dec
2008 52948.29 58609.12 63799.81 82534.22
2009 48443.75 54262.78 59606.10 78487.78
```

q) ts.plot(serie2, pron3,col=c("black","red"))