Hw9

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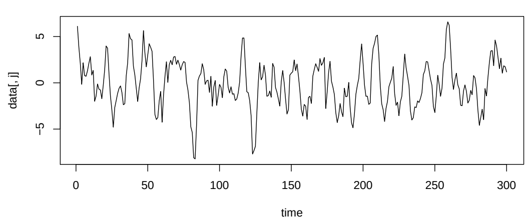
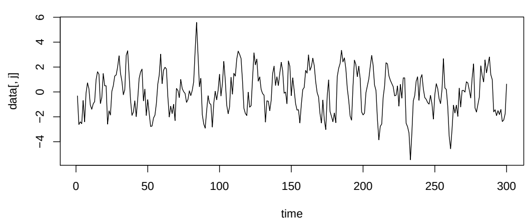
1 b-1-1

1.1 (a)

```
> ca=matrix(c(0.8,0.4,-0.3,0.6),nrow=2,ncol=2,byrow=TRUE)
> sa=matrix(c(2,0.5,0.5,1),nrow=2,ncol=2,byrow=TRUE)
> library(MTS)
> m1=VARMAsim(300,arlags=c(1),phi=ca,sigma=sa)
> zt=m1$series

> MTSplot(zt)
```





1.2 (b)

Using the lag l sample CCM equation

$$\hat{\rho}_l = \hat{D}^{-1}\hat{\Gamma}_l\hat{D}^{-1} \tag{1.1}$$

where

$$\hat{\Gamma}_l = \frac{1}{T-1}\sum_{t=l+1}^{T}(z_t - \hat{\mu_z})(z_{t-l} - \hat{\mu_z})' \tag{1.2}$$

$$\hat{D} = diag\{\hat{\Upsilon}_{0,11}^{1/2}, \ldots, \hat{\Upsilon}_{0,kk}^{1/2}\} \tag{1.3}$$

in which $\hat{\Upsilon}_{0,ii}^{1/2}$ is the (i,i)th element of $\hat{\Gamma}_0$ we could get

$$\hat{\rho}_0 = \begin{bmatrix} 1 & -0.24 \\ -0.24 & 1 \end{bmatrix}, \hat{\rho}_1 = \begin{bmatrix} 0.78 & 0.05 \\ -0.59 & 0.69 \end{bmatrix}, \hat{\rho}_2 = \begin{bmatrix} 0.5 & 0.23 \\ -0.69 & 0.4 \end{bmatrix} \tag{1.4}$$

$$\hat{\rho}_3 = \begin{bmatrix} 0.23 & 0.3 \\ -0.63 & 0.15 \end{bmatrix}, \hat{\rho}_4 = \begin{bmatrix} 0.02 & 0.31 \\ -0.5 & -0.06 \end{bmatrix}, \hat{\rho}_5 = \begin{bmatrix} -0.13 & 0.26 \\ -0.29 & -0.2 \end{bmatrix} \tag{1.5}$$

```
> cc=ccm(zt)
```

```
[1] "Covariance matrix:"
      [,1]  [,2]
[1,]  6.64 -1.05
[2,] -1.05  2.87
CCM at lag:  0
       [,1]   [,2]
[1,]  1.000 -0.242
[2,] -0.242  1.000
Simplified matrix:
CCM at lag:  1
+ .
- +
CCM at lag:  2
+ +
- +
CCM at lag:  3
+ +
- +
CCM at lag:  4
. +
- .
CCM at lag:  5
- +
- -
CCM at lag:  6
- +
. -
CCM at lag:  7
- .
. -
CCM at lag:  8
- .
+ -
CCM at lag:  9
- .
+ -
```

```
CCM at lag:  10
. .
+ .
CCM at lag:  11
. .
+ .
CCM at lag:  12
. .
. .
Hit Enter for p-value plot of individual ccm:
```

```
> options(digits=2)
> a1=cc$ccm[,1]
> a1=matrix(a1,nrow=2,ncol=2,byrow=FALSE)
> a1
```

```
      [,1]  [,2]
[1,]  1.00 -0.24
[2,] -0.24  1.00
```

```
> a2=cc$ccm[,2]
> a2=matrix(a2,nrow=2,ncol=2,byrow=FALSE)
> a2
```

```
      [,1]  [,2]
[1,]  0.78 0.053
[2,] -0.59 0.686
```

```
> a3=cc$ccm[,3]
> a3=matrix(a3,nrow=2,ncol=2,byrow=FALSE)
> a3
```

```
      [,1] [,2]
[1,]  0.50 0.23
[2,] -0.69 0.40
```

```
> a4=cc$ccm[,4]
> a4=matrix(a4,nrow=2,ncol=2,byrow=FALSE)
> a4
```

```
      [,1] [,2]
[1,]  0.23 0.30
[2,] -0.63 0.15
```

```
> a5=cc$ccm[,5]
> a5=matrix(a5,nrow=2,ncol=2,byrow=FALSE)
> a5
```

```
        [,1]   [,2]
[1,]  0.018  0.309
[2,] -0.495 -0.058
```

```
> a6=cc$ccm[,6]
> a6=matrix(a6,nrow=2,ncol=2,byrow=FALSE)
> a6
```

```
      [,1]  [,2]
[1,] -0.13  0.26
[2,] -0.29 -0.20
```

1.3 (c)

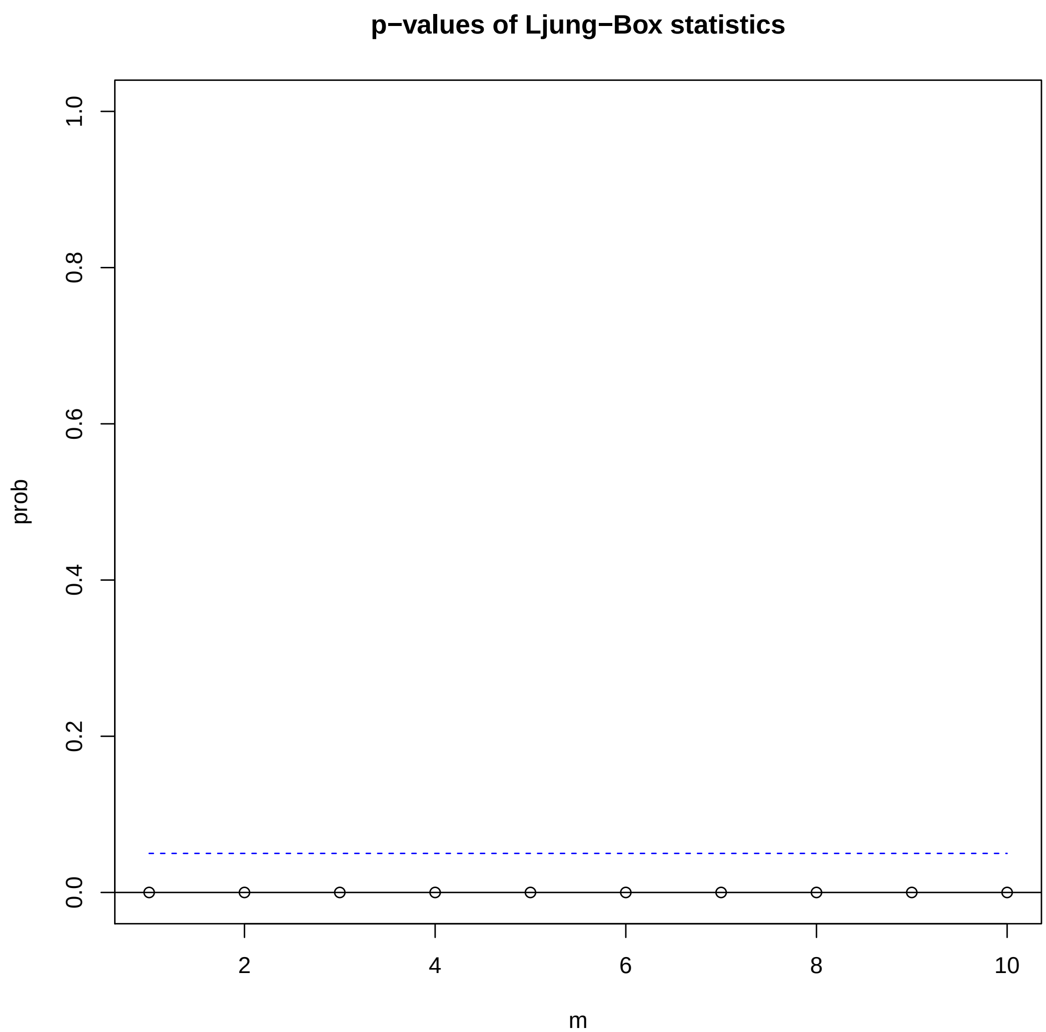
We use the multivariate Ljung-Box test statistic to test the null hypothesis of no cross-correlations, which is defined as

$$Q_k(m) = T^2 \sum_{l=1}^{m} \frac{1}{T-l} tr(\hat{\Gamma}_l' \hat{\Gamma}_0^{-1} \hat{\Gamma}_l \hat{\Gamma}_0^{-1}) \tag{1.6}$$

Using the cpmmand mq of the MTS package to perform the test.We can see from the graph, the null hypothesis is rejected.

```
> mq(zt,10)

Ljung-Box Statistics:
        m      Q(m)     df    p-value
 [1,]     1      381      4         0
 [2,]     2      635      8         0
 [3,]     3      802     12         0
 [4,]     4      916     16         0
 [5,]     5      986     20         0
 [6,]     6     1030     24         0
 [7,]     7     1064     28         0
 [8,]     8     1096     32         0
 [9,]     9     1124     36         0
[10,]    10     1145     40         0
```



2 b-1-4

2.1 (a)

```
> temp=tempfile()
> download.file("http://faculty.chicagobooth.edu/ruey.tsay/teaching/mtsbk/data-ch1.zip",temp)
> da=read.table(unz(temp, "Users/rst/Documents/backup/mts/y2012/data/ch1/m-pgspabt.txt"),header=T)
> n1=nrow(da)
> ra=log(da[,2:4]+1)
> t=1962+1:600/12
```

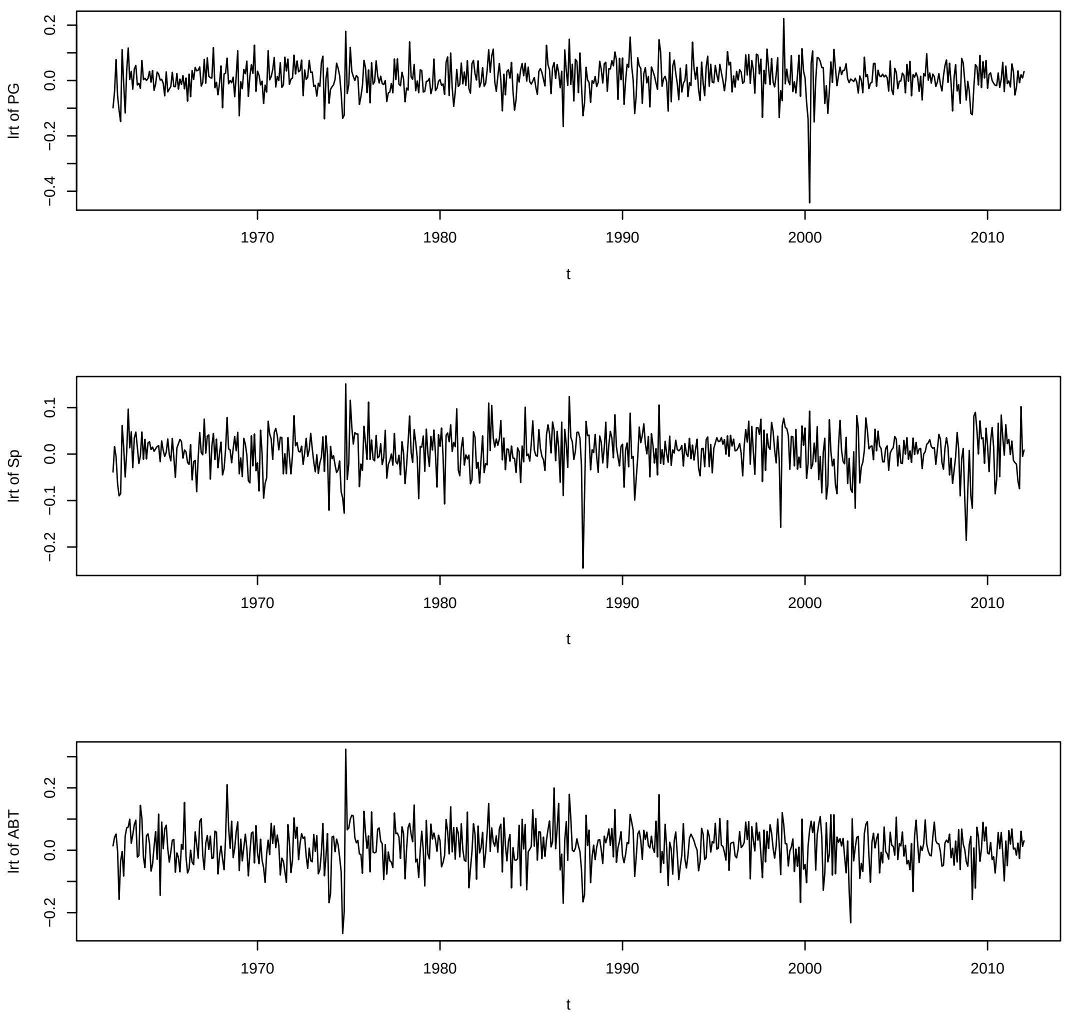
2.2 (b)

$$\hat{\rho}_0 = \begin{bmatrix} 1 & 0.49 & 0.42 \\ 0.49 & 1 & 0.5 \\ 0.42 & 0.5 & 1 \end{bmatrix}, \hat{\rho}_1 = \begin{bmatrix} -0.02 & -0.03 & 0.02 \\ 0.03 & 0.06 & 0.03 \\ 0.04 & 0.03 & 0 \end{bmatrix}, \hat{\rho}_2 = \begin{bmatrix} -0.04 & -0.03 & -0.01 \\ -0.05 & -0.04 & 0.05 \\ -0.06 & -0.03 & -0.02 \end{bmatrix} \quad (2.1)$$

```
> library(MTS)
> cc=ccm(ra)
```

```
[1] "Covariance matrix:"
         pg      sp     abt
pg  0.00329 0.00124 0.00154
sp  0.00124 0.00195 0.00141
abt 0.00154 0.00141 0.00414
CCM at lag:  0
      [,1]  [,2]  [,3]
[1,] 1.000 0.488 0.416
[2,] 0.488 1.000 0.497
[3,] 0.416 0.497 1.000
Simplified matrix:
CCM at lag:  1
. . .
. . .
. . .
CCM at lag:  2
. . .
. . .
. . .
CCM at lag:  3
. . .
. . .
. . .
CCM at lag:  4
. . .
. . .
```

```
> par(mfrow=c(3,1))
> plot(t,ra[,1],type="l",ylab=("lrt of PG"))
> plot(t,ra[,2],type="l",ylab=("lrt of Sp"))
> plot(t,ra[,3],type="l",ylab=("lrt of ABT"))
```



```
. . .
CCM at lag:  5
. . .
. . .
. . .
CCM at lag:  6
- . .
. . .
. . .
CCM at lag:  7
. . .
. . .
. . .
CCM at lag:  8
. . .
. . .
. . .
CCM at lag:  9
. . .
. . .
. . .
CCM at lag:  10
. . .
. . .
. . .
CCM at lag:  11
. . .
. . .
. . .
CCM at lag:  12
. . .
+ . .
+ . +
Hit Enter for p-value plot of individual ccm:
```

```
> options(digits=2)
> a1=cc$ccm[,1]
> a1=matrix(a1,nrow=3,ncol=3,byrow=FALSE)
> a1
```

```
     [,1] [,2] [,3]
[1,] 1.00 0.49 0.42
[2,] 0.49 1.00 0.50
[3,] 0.42 0.50 1.00
```

```
> a2=cc$ccm[,2]
```

```
> a2=matrix(a2,nrow=3,ncol=3,byrow=FALSE)
> a2

       [,1]   [,2]   [,3]
[1,] -0.022 -0.028 0.0189
[2,]  0.032  0.058 0.0316
[3,]  0.039  0.033 0.0033

> a3=cc$ccm[,3]
> a3=matrix(a3,nrow=3,ncol=3,byrow=FALSE)
> a3

       [,1]   [,2]   [,3]
[1,] -0.039 -0.027 -0.011
[2,] -0.053 -0.037  0.053
[3,] -0.065 -0.033 -0.022
```

2.3 (c)

As we can see the point all above the line, so the statistic does not reject the null hypothesis of zero cross-correlations.

```
> mq(ra,5)

Ljung-Box Statistics:
        m       Q(m)     df    p-value
[1,]  1.00      7.65    9.00     0.57
[2,]  2.00     17.84   18.00     0.47
[3,]  3.00     23.68   27.00     0.65
[4,]  4.00     25.31   36.00     0.91
[5,]  5.00     34.58   45.00     0.87
```