EE435assignment6.R

Phumj

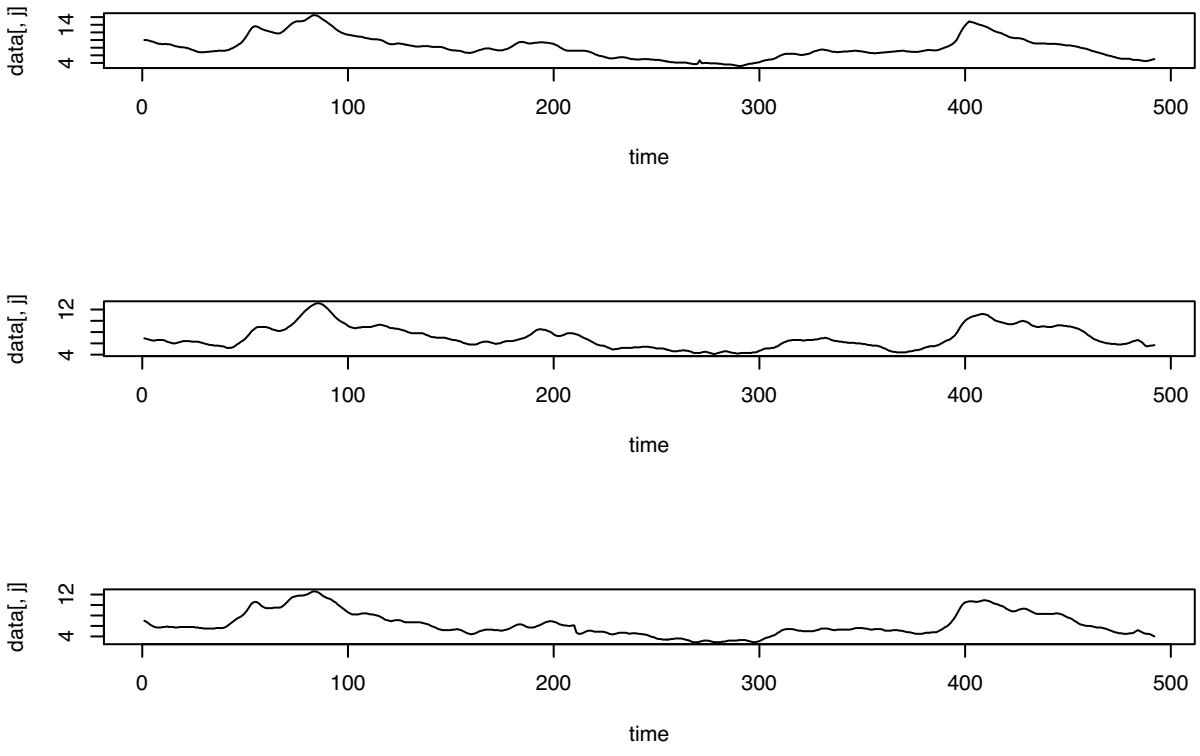
2021-05-19

```
#EE435 assignment6 by 6104641482
setwd("/Users/Phumj/Documents/EE435/435assignment6")
cat(rep("\n",50))
```

```
#question 1.1
#install.packages("MTS")
library('MTS')
```

```
## Warning: package 'MTS' was built under R version 4.0.5
```

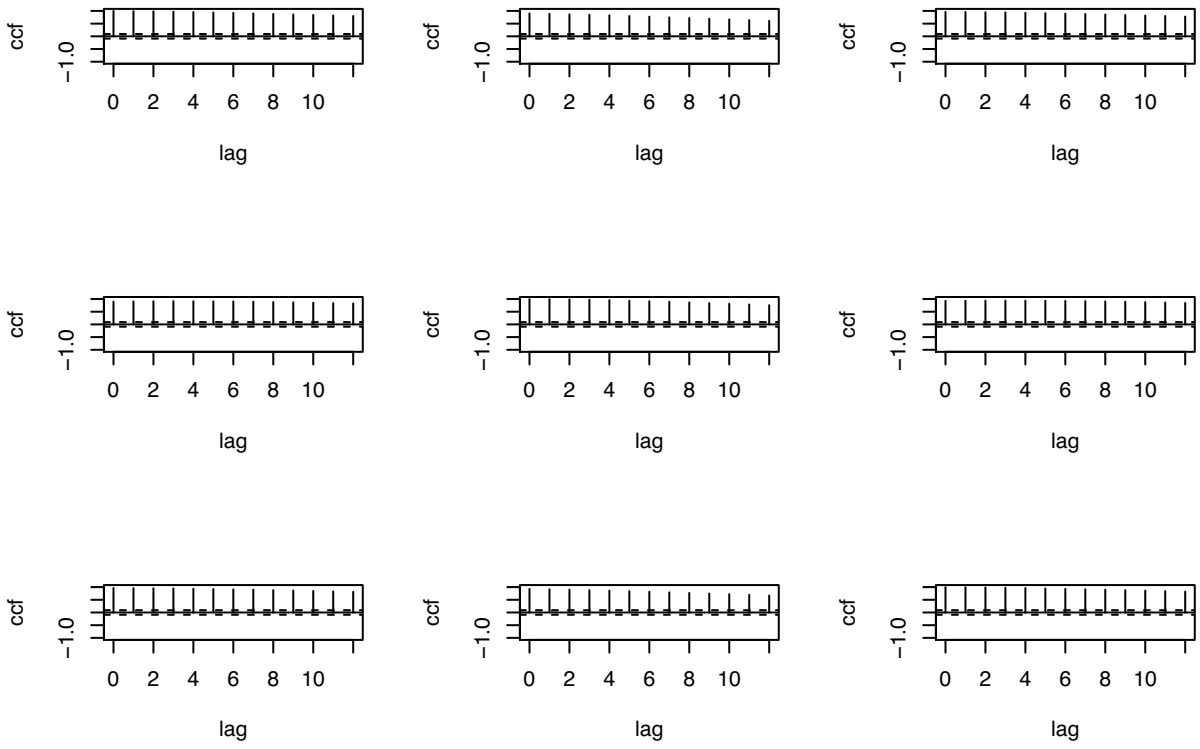
```
require(MTS)
da1=read.table("m-unrate-MIILIN.txt", header = T)
X=cbind(da1$MI,da1$IL,da1$IN)
MTSplot(X)
```



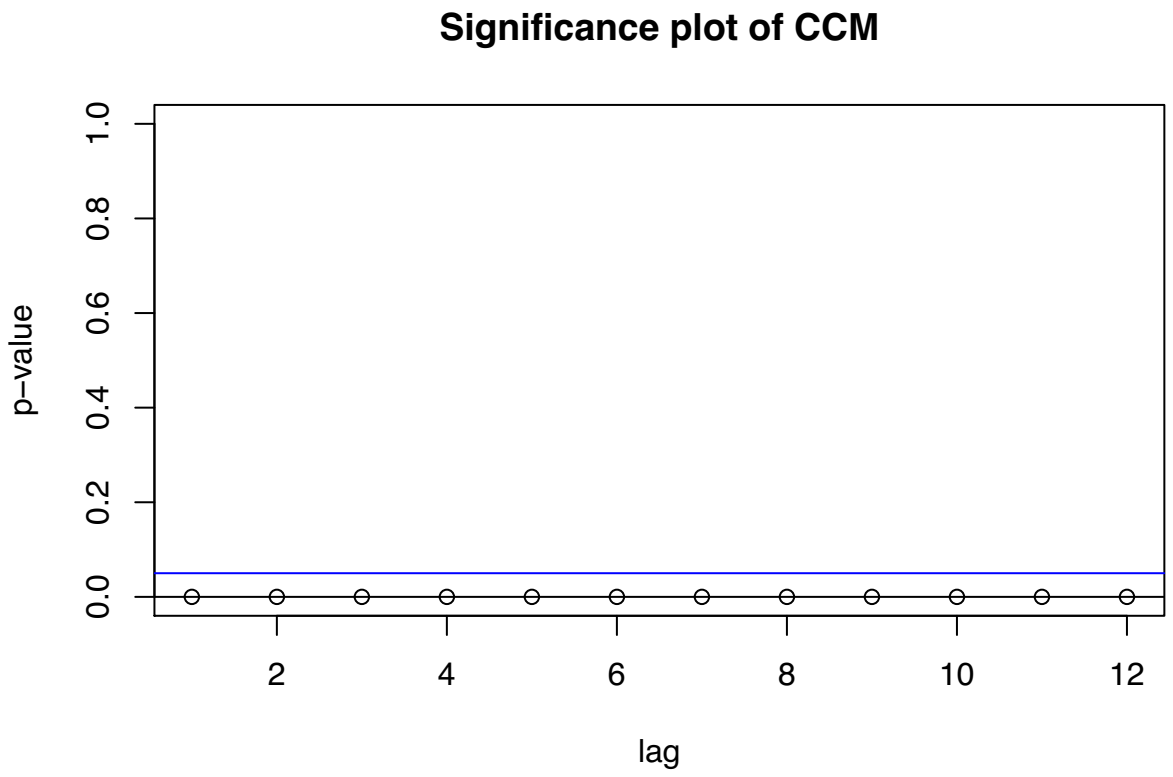
```
ccm(X)
```

```
## [1] "Covariance matrix:"
##      [,1] [,2] [,3]
## [1,] 8.52 5.17 6.43
## [2,] 5.17 3.87 4.17
## [3,] 6.43 4.17 5.22
## CCM at lag:  0
##       [,1]  [,2]  [,3]
## [1,] 1.000 0.901 0.964
## [2,] 0.901 1.000 0.928
## [3,] 0.964 0.928 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
```

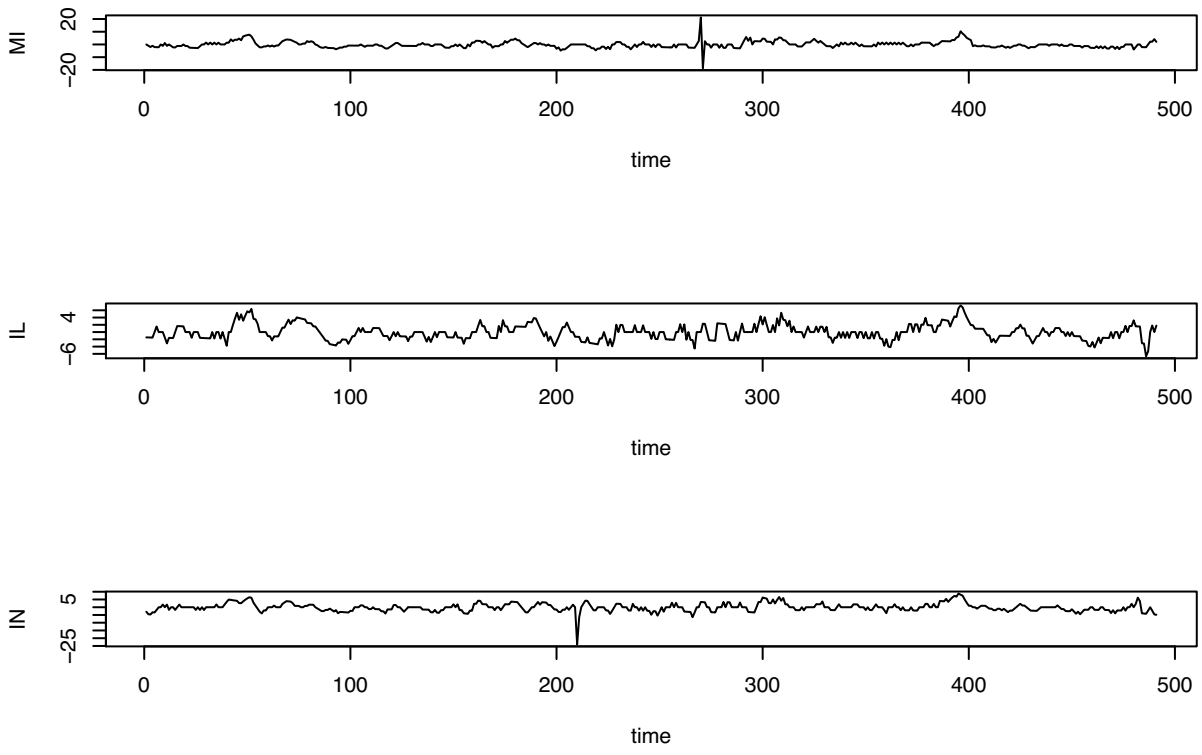
```
## + + +
## + + +
## + + +
## CCM at lag:  12
## + + +
## + + +
## + + +
```




```
## Hit Enter for p-value plot of individual ccm:
```



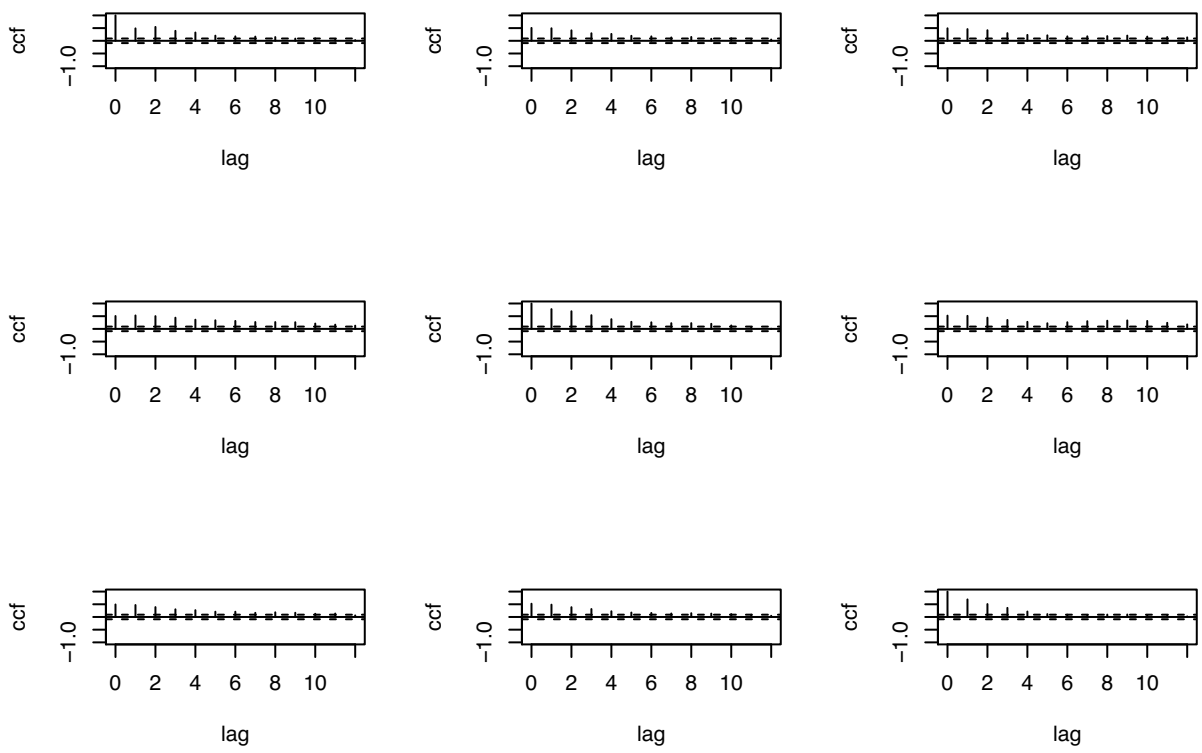

```
#since all positive value from matrices → signals the non stationarity
X=log(X)
diffrate=diff(X)*100
colnames(diffrate) <- c('MI','IL','IN')
MTSplot(diffrate)
```



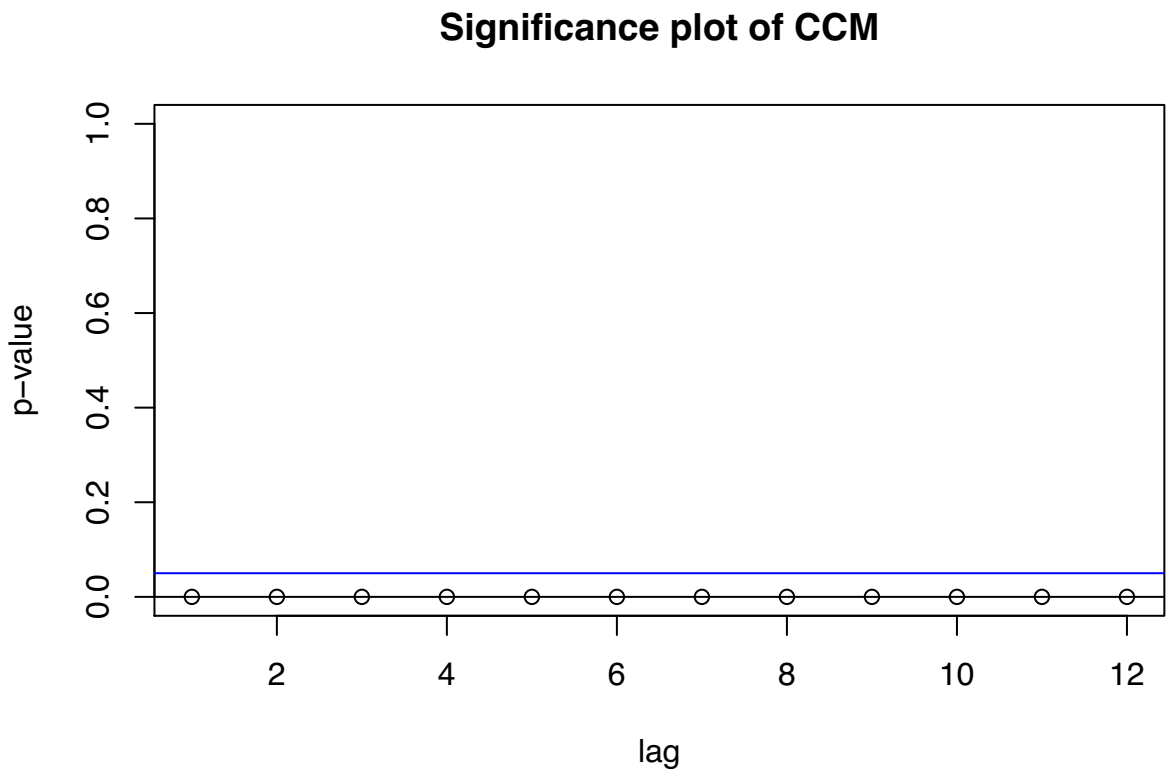

```
ccm(diffrate)
```

```
## [1] "Covariance matrix:"
##      MI   IL   IN
## MI 6.49 2.67 3.34
## IL 2.67 4.28 2.88
## IN 3.34 2.88 7.10
## CCM at lag:  0
##       [,1]  [,2]  [,3]
## [1,] 1.000 0.507 0.493
## [2,] 0.507 1.000 0.522
## [3,] 0.493 0.522 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:
```




```
VARorder(diffrate)
```

```
## selected order: aic =  6
## selected order: bic =  2
## selected order: hq =  6
## Summary table:
##        p    AIC    BIC     HQ     M(p) p-value
##  [1,]  0 4.5902 4.5902 4.5902   0.0000  0.0000
##  [2,]  1 3.1019 3.1788 3.1321 722.0353  0.0000
##  [3,]  2 2.9686 3.1225 3.0290  79.9726  0.0000
##  [4,]  3 2.9328 3.1636 3.0234  33.8750  0.0001
##  [5,]  4 2.9217 3.2294 3.0426  22.1688  0.0084
##  [6,]  5 2.9188 3.3034 3.0699  18.2649  0.0322
##  [7,]  6 2.8417 3.3033 3.0230  52.1535  0.0000
##  [8,]  7 2.8516 3.3900 3.0630  12.2266  0.2008
##  [9,]  8 2.8797 3.4951 3.1214   3.8389  0.9217
## [10,]  9 2.8736 3.5659 3.1455  19.2322  0.0233
## [11,] 10 2.8648 3.6340 3.1668  20.3222  0.0160
## [12,] 11 2.8775 3.7237 3.2098  10.5898  0.3049
## [13,] 12 2.8935 3.8165 3.2560   9.1179  0.4265
## [14,] 13 2.9094 3.9094 3.3021   9.0746  0.4304
```

```
#suppose I choose based on BIC
m1.MTS=VAR(diffrate,2)
```

```
## Constant term:
## Estimates:  -0.04308488 0.02069438 -0.01722694
```

final fitted model

```
## Std.Error:  0.08968027 0.05526058 0.08400675
## AR coefficient matrix
## AR( 1 )-matrix
##       [,1]  [,2]  [,3]
## [1,] 0.199 0.276 0.131
## [2,] 0.106 0.528 0.101
## [3,] 0.151 0.274 0.568
## standard error
##        [,1]   [,2]   [,3]
## [1,] 0.0445 0.0735 0.0497
## [2,] 0.0274 0.0453 0.0306
## [3,] 0.0417 0.0689 0.0466
## AR( 2 )-matrix
##          [,1]   [,2]     [,3]
## [1,]  0.30910 -0.106  0.00562
## [2,]  0.04956  0.183 -0.08484
## [3,] -0.00612 -0.170  0.01388
## standard error
##        [,1]   [,2]   [,3]
## [1,] 0.0454 0.0720 0.0501
## [2,] 0.0280 0.0444 0.0309
## [3,] 0.0425 0.0675 0.0470
##
## Residuals cov-mtx:
##           [,1]      [,2]      [,3]
## [1,] 3.8551679 0.3071579 0.7144333
## [2,] 0.3071579 1.4637954 0.4019971
## [3,] 0.7144333 0.4019971 3.3828113
##
## det(SSE) =  17.57694
## AIC =  2.939907
## BIC =  3.093748
## HQ  =  3.000321
```

$$\begin{bmatrix} MI_t \\ IL_t \\ IN_t \end{bmatrix} = \begin{bmatrix} 0 \\ (0) \\ 0 \\ (0) \\ 0 \\ (0) \end{bmatrix} + \begin{bmatrix} 0.192 & 0.206 & 0.130 \\ (0.044) & (0.036) & (0.043) \\ 0.105 & 0.528 & 0.101 \\ (0.027) & (0.045) & (0.031) \\ 0.152 & 0.273 & 0.574 \\ (0.041) & (0.068) & (0.039) \end{bmatrix} \begin{bmatrix} MI_{t-1} \\ IL_{t-1} \\ IN_{t-1} \end{bmatrix}$$

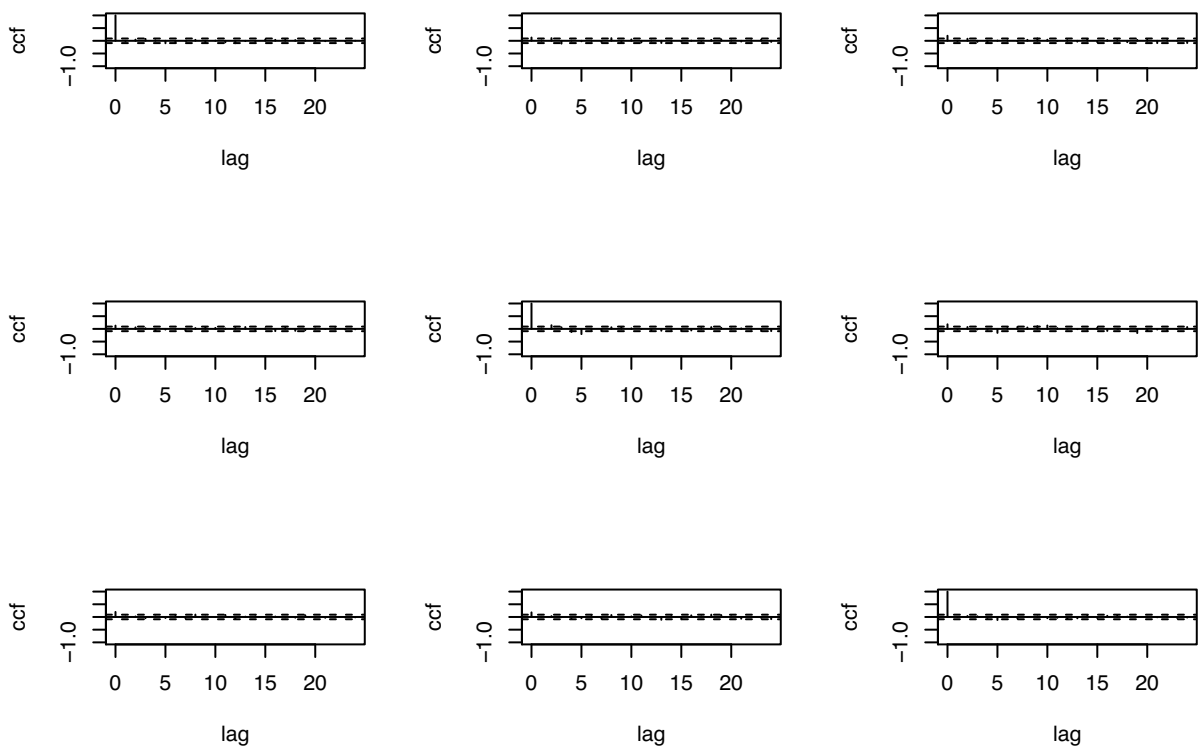
$$+ \begin{bmatrix} 0.3035 & 0 & 0 \\ (0.044) & (0) & (0) \\ 0.0491 & 0.183 & -0.0849 \\ (0.028) & (0.044) & (0.031) \\ 0 & -0.168 & 0 \\ (0) & (0.066) & (0) \end{bmatrix} \begin{bmatrix} MI_{t-2} \\ IL_{t-2} \\ IN_{t-2} \end{bmatrix}$$

```
MTSdiag(m1.MTS)
```

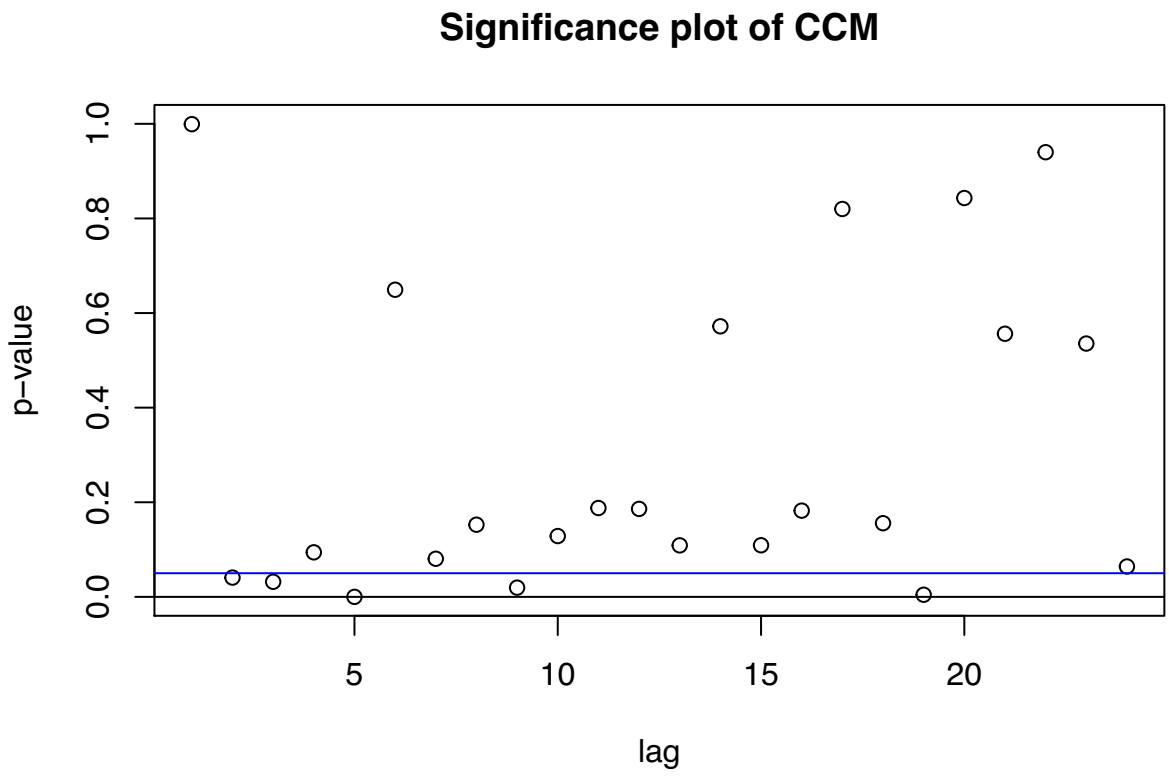
```
## [1] "Covariance matrix:"
##       MI    IL    IN
## MI 3.863 0.308 0.716
## IL 0.308 1.467 0.403
## IN 0.716 0.403 3.390
## CCM at lag:  0
##       [,1]  [,2]  [,3]
## [1,] 1.000 0.129 0.198
## [2,] 0.129 1.000 0.181
## [3,] 0.198 0.181 1.000
## Simplified matrix:
## CCM at lag:  1
## . . .
## . . .
## . . .
## 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
## - . .
## . . .
## . . .
## CCM at lag:  13
## . . .
## . . .
## . - .
## CCM at lag:  14
## . . .
## . . .
## . . .
## CCM at lag:  15
## . . .
## . - .
## . - .
## CCM at lag:  16
## . . .
```

```
## . . .
## . . .
## CCM at lag:  17
## . . .
## . . .
## . . .
## CCM at lag:  18
## . . .
## . . .
## . + .
## CCM at lag:  19
## . . .
## . . -
## . . .
## CCM at lag:  20
## . . .
## . . .
## . . .
## CCM at lag:  21
## . . -
## . . .
## . . .
## CCM at lag:  22
## . . .
## . . .
## . . .
## CCM at lag:  23
## . . .
## . . .
## . . .
## CCM at lag:  24
## . . .
## . . .
## . . .
```

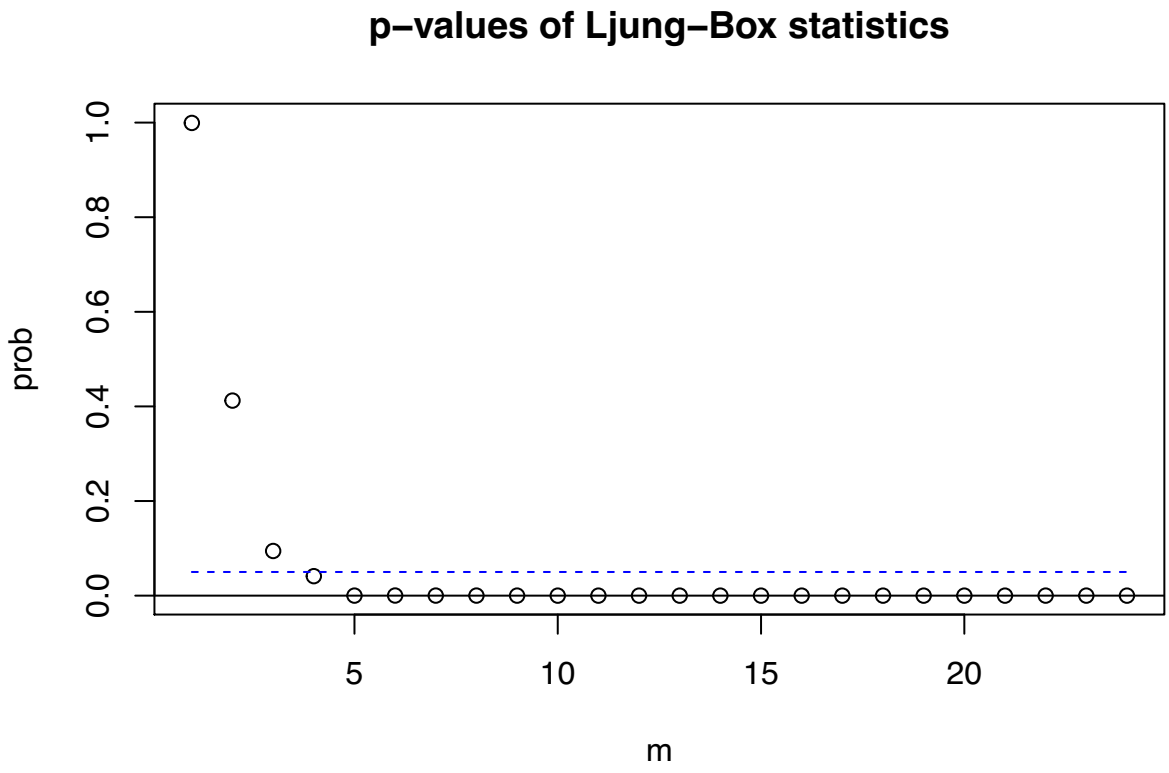



```
## Hit Enter for p-value plot of individual ccm:
```

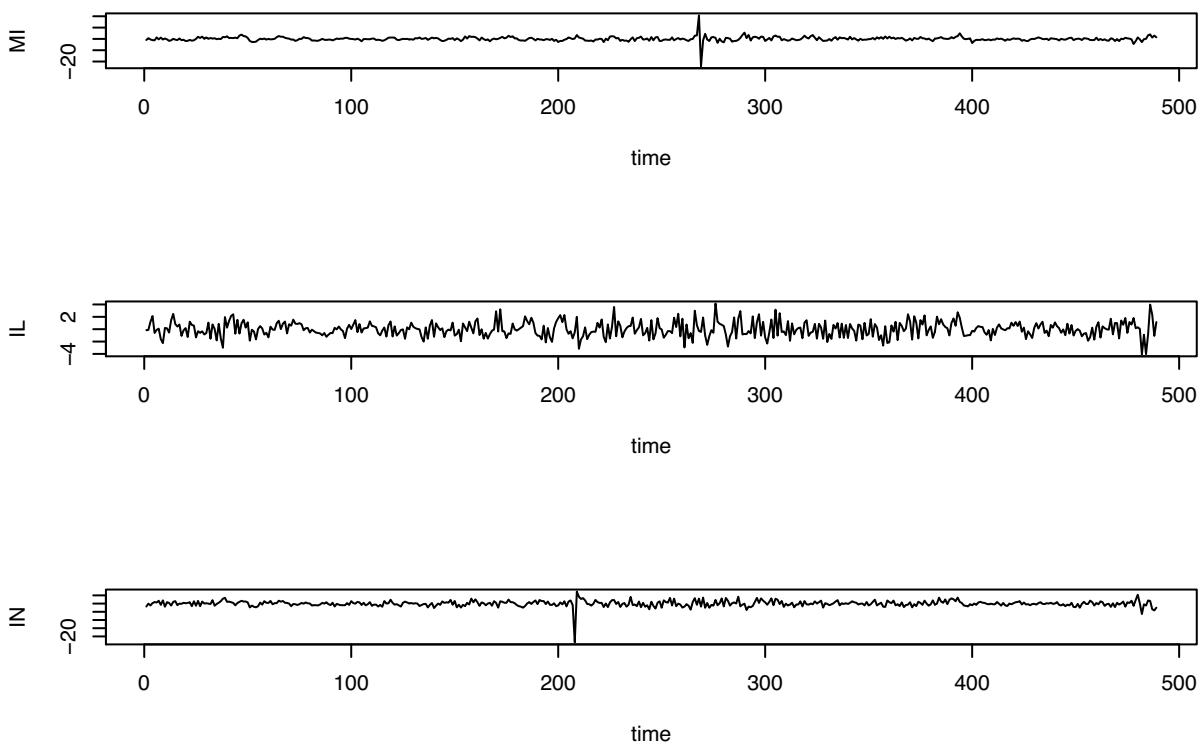



```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##          m       Q(m)     df    p-value
##  [1,]   1.00      1.05    9.00     1.00
##  [2,]   2.00     18.67   18.00     0.41
##  [3,]   3.00     37.04   27.00     0.09
##  [4,]   4.00     52.00   36.00     0.04
##  [5,]   5.00     91.25   45.00     0.00
##  [6,]   6.00     98.16   54.00     0.00
##  [7,]   7.00    113.64   63.00     0.00
##  [8,]   8.00    126.92   72.00     0.00
##  [9,]   9.00    146.75   81.00     0.00
## [10,]  10.00    160.63   90.00     0.00
## [11,]  11.00    173.15   99.00     0.00
## [12,]  12.00    185.71  108.00     0.00
## [13,]  13.00    200.17  117.00     0.00
## [14,]  14.00    207.83  126.00     0.00
## [15,]  15.00    222.28  135.00     0.00
## [16,]  16.00    234.92  144.00     0.00
## [17,]  17.00    240.10  153.00     0.00
## [18,]  18.00    253.31  162.00     0.00
## [19,]  19.00    277.28  171.00     0.00
## [20,]  20.00    282.19  180.00     0.00
## [21,]  21.00    290.01  189.00     0.00
## [22,]  22.00    293.54  198.00     0.00
```

```
## [23,]  23.00    301.58  207.00     0.00
## [24,]  24.00    317.81  216.00     0.00
```




```
## Hit Enter to obtain residual plots:
```




```
#looking on p-value, the model is adequate
#refine the model by removing insignificant paremeters with threshold of t-ration= 1.645
m2.MTS=refVAR(m1.MTS, thres = 1.645)
```

```
## Constant term:
## Estimates:  0 0 0
## Std.Error:  0 0 0
## AR coefficient matrix
## AR( 1 )-matrix
##       [,1]  [,2]  [,3]
## [1,] 0.192 0.206 0.130
## [2,] 0.105 0.528 0.101
## [3,] 0.152 0.273 0.574
## standard error
##        [,1]   [,2]   [,3]
## [1,] 0.0441 0.0563 0.0427
## [2,] 0.0274 0.0453 0.0306
## [3,] 0.0405 0.0678 0.0392
## AR( 2 )-matrix
##        [,1]   [,2]    [,3]
## [1,] 0.3035  0.000  0.0000
## [2,] 0.0491  0.183 -0.0849
## [3,] 0.0000 -0.168  0.0000
## standard error
##        [,1]   [,2]   [,3]
## [1,] 0.0444 0.0000 0.0000
```

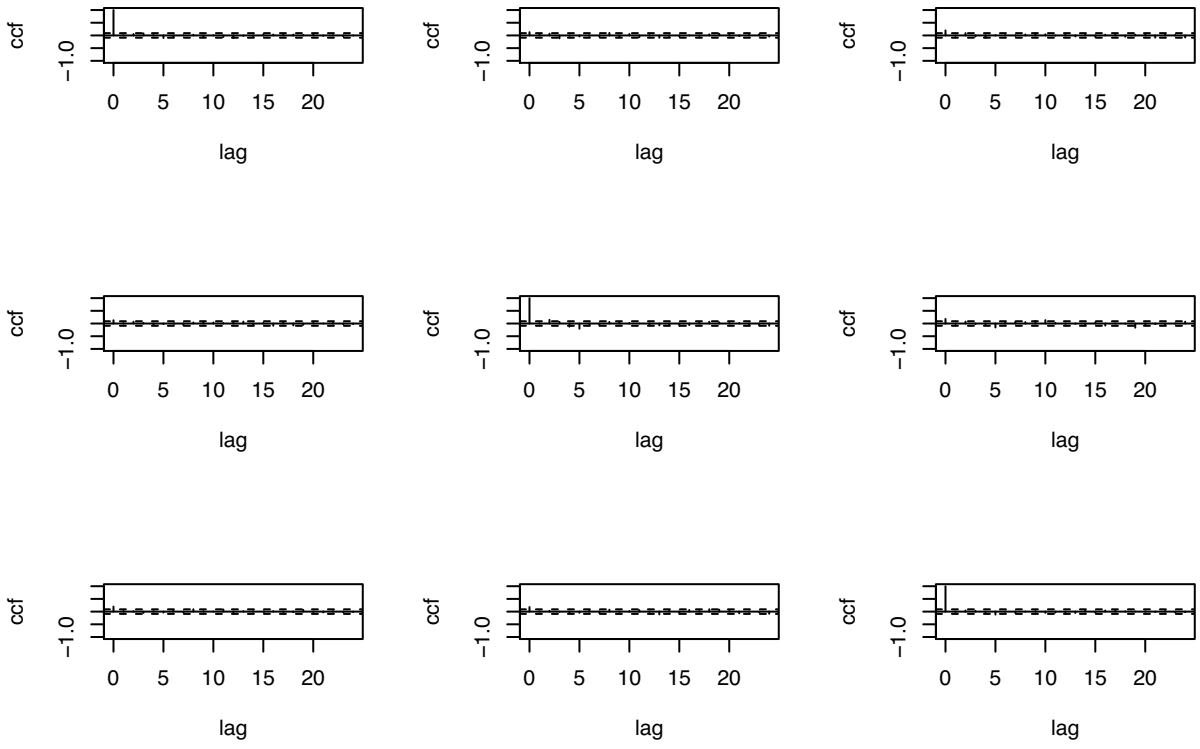
```
## [2,] 0.0279 0.0443 0.0309
## [3,] 0.0000 0.0661 0.0000
##
## Residuals cov-mtx:
##           [,1]      [,2]      [,3]
## [1,] 3.8745260 0.3062712 0.7153133
## [2,] 0.3062712 1.4642213 0.4016425
## [3,] 0.7153133 0.4016425 3.3837769
##
## det(SSE) =  17.68107
## AIC =  2.929521
## BIC =  3.049175
## HQ  =  2.976509
```

```
#final fitted model
MTSdiag(m2.MTS)
```

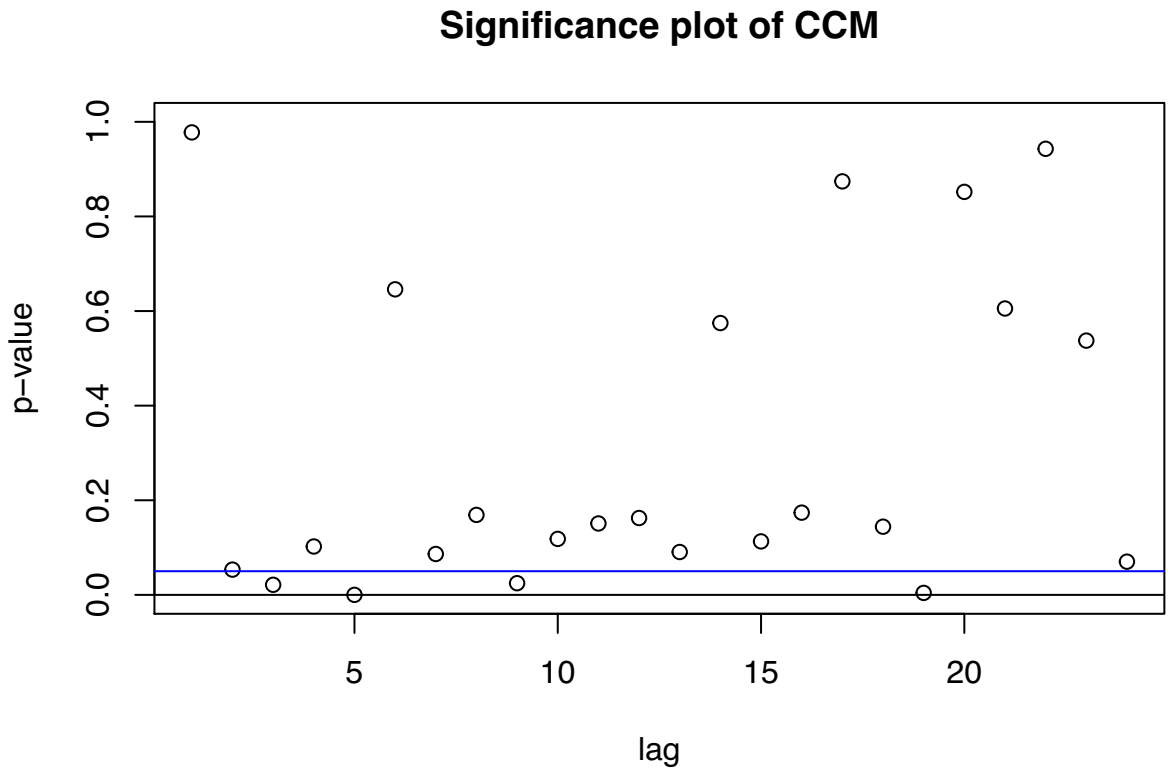
```
## [1] "Covariance matrix:"
##       MI    IL    IN
## MI 3.881 0.308 0.716
## IL 0.308 1.467 0.403
## IN 0.716 0.403 3.390
## CCM at lag:  0
##       [,1]  [,2]  [,3]
## [1,] 1.000 0.129 0.197
## [2,] 0.129 1.000 0.181
## [3,] 0.197 0.181 1.000
## Simplified matrix:
## CCM at lag:  1
## . . .
## . . .
## . . .
## 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
## - . .
## . . .
## . . .
## CCM at lag:  13
## . - .
## . . .
## . - .
## CCM at lag:  14
## . . .
## . . .
## . . .
## CCM at lag:  15
## . . .
## . - .
## . - .
## CCM at lag:  16
## . . .
## - . .
## . . .
## CCM at lag:  17
## . . .
## . . .
## . . .
## CCM at lag:  18
## . . .
## . . .
## . + .
## CCM at lag:  19
## . . .
## . . -
## . . .
## CCM at lag:  20
## . . .
## . . .
## . . .
## CCM at lag:  21
```

```
## . . .
## . . .
## . . .
## CCM at lag:  22
## . . .
## . . .
## . . .
## CCM at lag:  23
## . . .
## . . .
## . . .
## CCM at lag:  24
## . . .
## . . .
## . . .
```

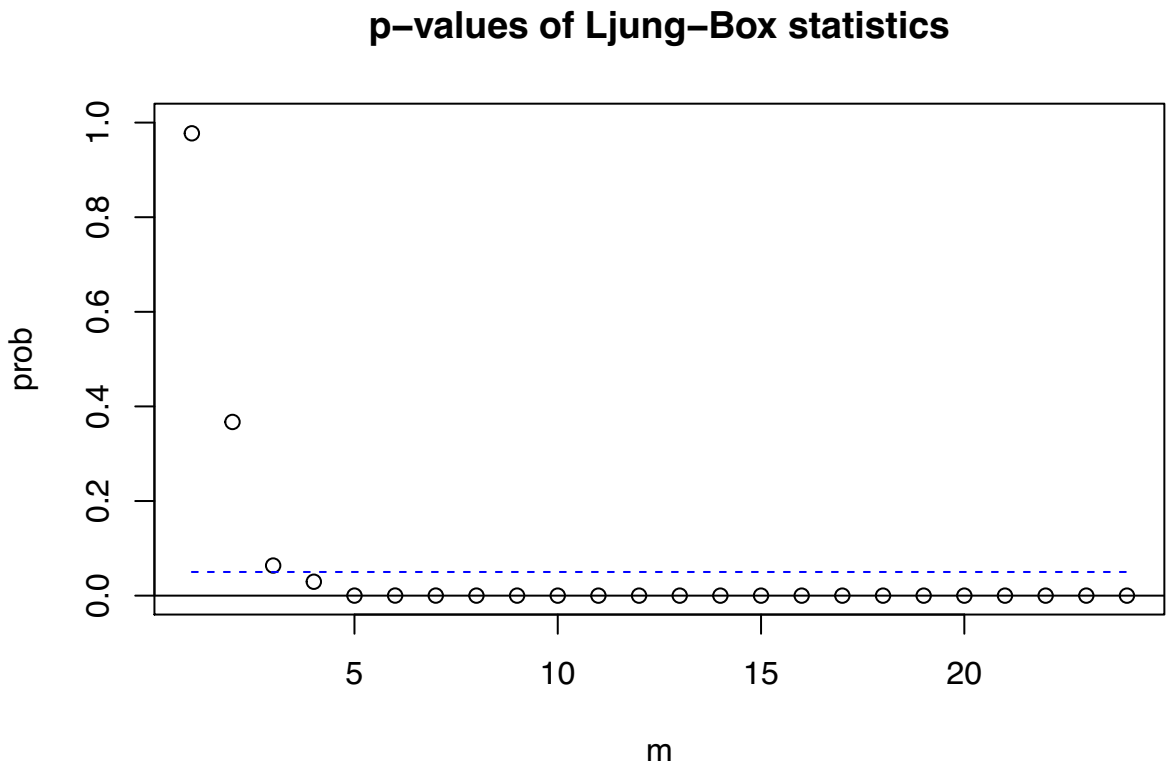



```
## Hit Enter for p-value plot of individual ccm:
```




```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##          m       Q(m)     df    p-value
##  [1,]   1.00      2.62    9.00      0.98
##  [2,]   2.00     19.41   18.00      0.37
##  [3,]   3.00     38.98   27.00      0.06
##  [4,]   4.00     53.66   36.00      0.03
##  [5,]   5.00     92.77   45.00      0.00
##  [6,]   6.00     99.71   54.00      0.00
##  [7,]   7.00    114.95   63.00      0.00
##  [8,]   8.00    127.87   72.00      0.00
##  [9,]   9.00    147.00   81.00      0.00
## [10,]  10.00    161.17   90.00      0.00
## [11,]  11.00    174.49   99.00      0.00
## [12,]  12.00    187.54  108.00      0.00
## [13,]  13.00    202.61  117.00      0.00
## [14,]  14.00    210.24  126.00      0.00
## [15,]  15.00    224.58  135.00      0.00
## [16,]  16.00    237.39  144.00      0.00
## [17,]  17.00    241.92  153.00      0.00
## [18,]  18.00    255.42  162.00      0.00
## [19,]  19.00    279.58  171.00      0.00
## [20,]  20.00    284.39  180.00      0.00
## [21,]  21.00    291.74  189.00      0.00
## [22,]  22.00    295.21  198.00      0.00
```

```
## [23,]  23.00    303.22  207.00     0.00
## [24,]  24.00    319.17  216.00     0.00
```

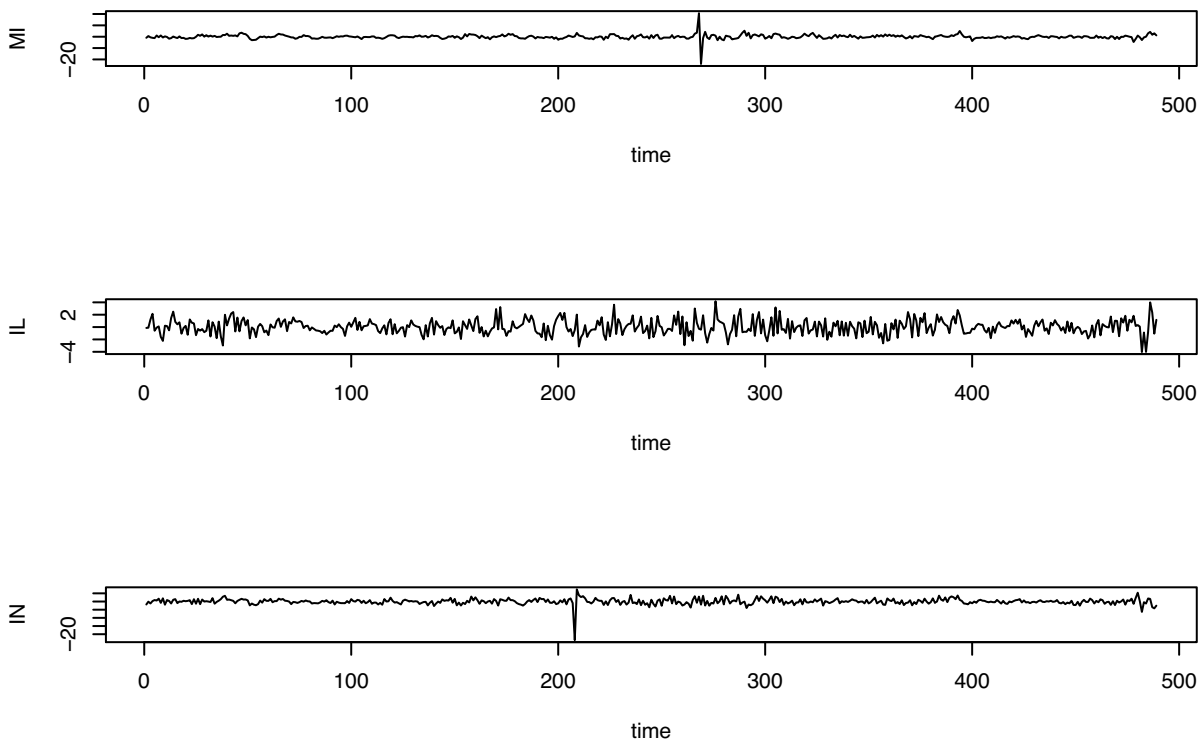



```
## Hit Enter to obtain residual plots:
```

```
#question 1.2
detach_package <- function(pkg, character.only = FALSE)
{
  if(!character.only)
  {
    pkg <- deparse(substitute(pkg))
  }
  search_item <- paste("package", pkg, sep = ":")
  while(search_item %in% search())
  {
    detach(search_item, unload = TRUE, character.only = TRUE)
  }
}
detach_package("MTS", TRUE)
#install.packages('vars')
library(vars)
```

```
## Warning: package 'vars' was built under R version 4.0.5
## Loading required package: MASS
## Warning: package 'MASS' was built under R version 4.0.5
## Loading required package: strucchange
```

```
## Warning: package 'strucchange' was built under R version 4.0.5
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
## Loading required package: sandwich
## Loading required package: urca
## Loading required package: lmtest
```




```
require(vars)
VARselect(diffrate,lag.max = 10)
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##      6      3      2      6
##
## $criteria
##                1         2         3         4         5         6         7
## AIC(n)  3.112657  2.979041  2.945646  2.937146  2.933030  2.855568  2.866452
## HQ(n)   3.153604  3.050699  3.048014  3.070225  3.096818  3.050067  3.091661
## SC(n)   3.216836  3.161356  3.206095  3.275730  3.349748  3.350421  3.439440
## FPE(n) 22.480718 19.669073 19.023285 18.862689 18.785840 17.386456 17.577920
```

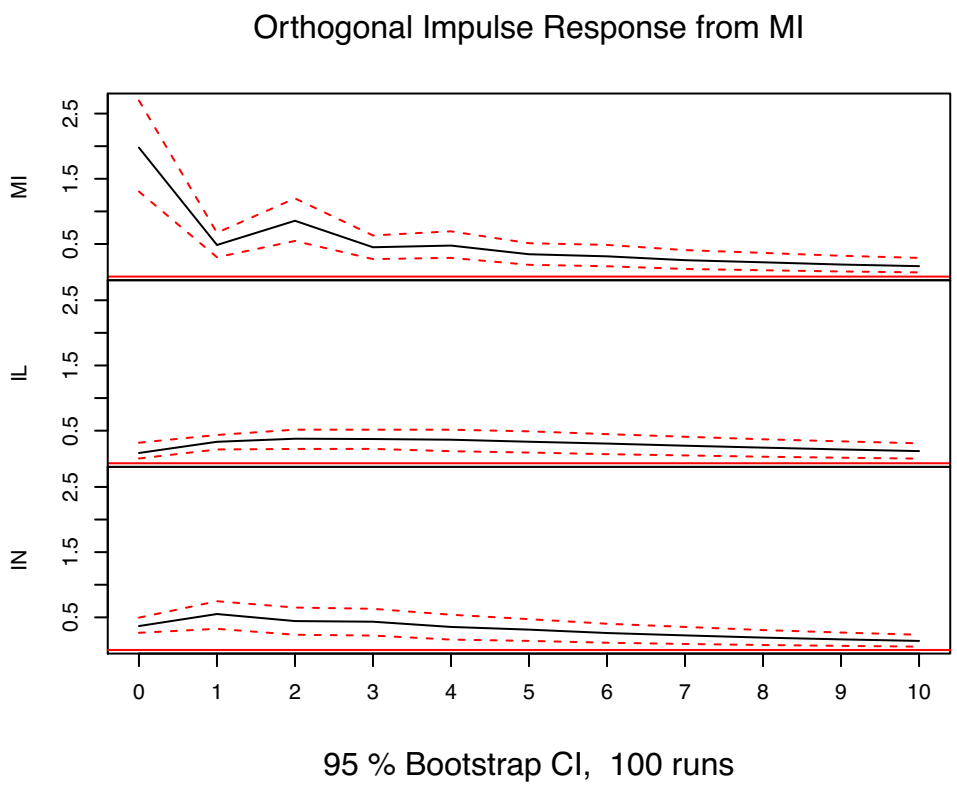
```
##                8         9        10
## AIC(n)  2.895279  2.889482  2.881564
## HQ(n)   3.151199  3.176112  3.198904
## SC(n)   3.546402  3.618740  3.688956
## FPE(n) 18.093635 17.991107 17.851734
```

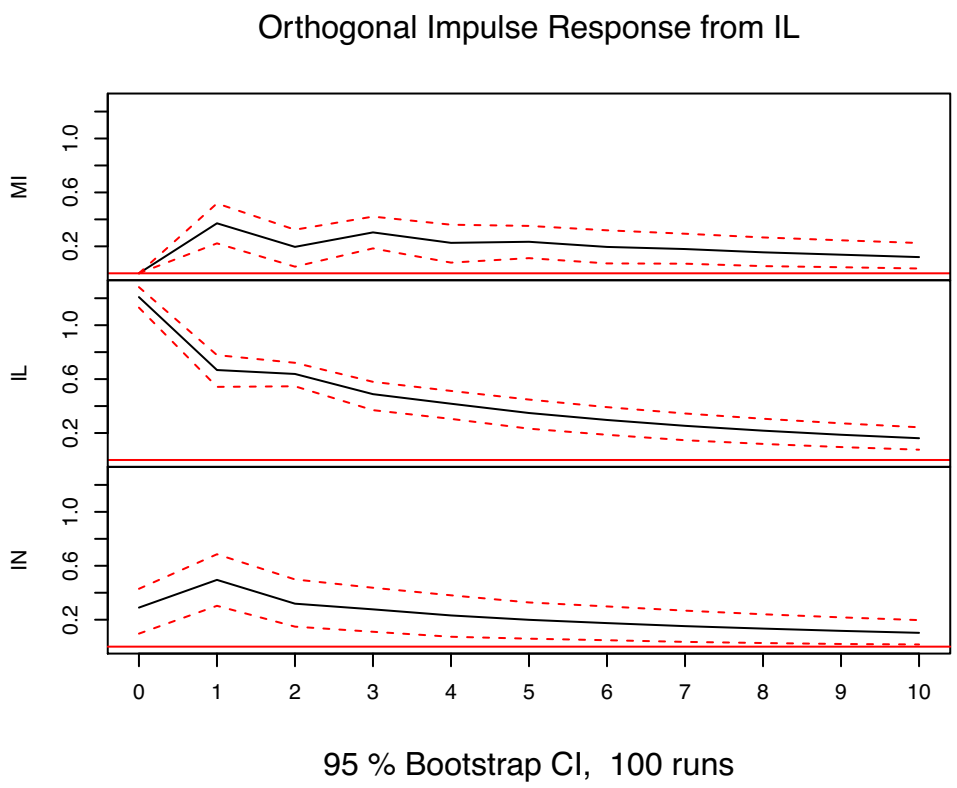
```
m1.vars=VAR(diffrate,p=2)
summary(m1.vars)
```

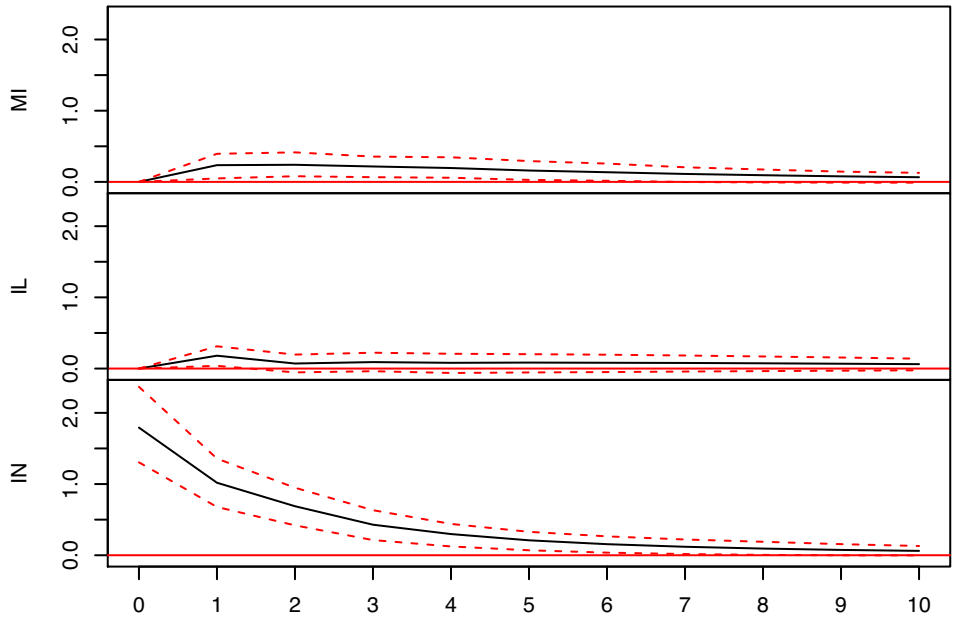
```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: MI, IL, IN
## Deterministic variables: const
## Sample size: 489
## Log Likelihood: -2782.463
## Roots of the characteristic polynomial:
## 0.8686 0.6789 0.4943 0.4486 0.3738 0.0756
## Call:
## VAR(y = diffrate, p = 2)
##
##
## Estimation results for equation MI:
## ===================================
## MI = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const
##
##        Estimate Std. Error t value Pr(>|t|)
## MI.l1  0.198967   0.044522   4.469 9.81e-06 ***
## IL.l1  0.275604   0.073512   3.749 0.000199 ***
## IN.l1  0.130995   0.049704   2.635 0.008673 **
## MI.l2  0.309097   0.045360   6.814 2.84e-11 ***
## IL.l2 -0.106027   0.072016  -1.472 0.141604
## IN.l2  0.005618   0.050137   0.112 0.910836
## const -0.043085   0.089680  -0.480 0.631141
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 1.978 on 482 degrees of freedom
## Multiple R-Squared: 0.4075,  Adjusted R-squared: 0.4001
## F-statistic: 55.24 on 6 and 482 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation IL:
## ===================================
## IL = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const
##
##       Estimate Std. Error t value Pr(>|t|)
## MI.l1  0.10580    0.02743   3.856 0.000131 ***
## IL.l1  0.52800    0.04530  11.656  < 2e-16 ***
## IN.l1  0.10090    0.03063   3.294 0.001059 **
## MI.l2  0.04956    0.02795   1.773 0.076841 .
## IL.l2  0.18303    0.04438   4.125 4.37e-05 ***
## IN.l2 -0.08484    0.03089  -2.746 0.006255 **
## const  0.02069    0.05526   0.374 0.708207
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 1.219 on 482 degrees of freedom
## Multiple R-Squared: 0.6581,  Adjusted R-squared: 0.6539
## F-statistic: 154.7 on 6 and 482 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation IN:
## ===================================
## IN = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const
##
##        Estimate Std. Error t value Pr(>|t|)
## MI.l1  0.151449   0.041706   3.631 0.000312 ***
## IL.l1  0.273801   0.068861   3.976 8.08e-05 ***
## IN.l1  0.568094   0.046560  12.201  < 2e-16 ***
## MI.l2 -0.006117   0.042490  -0.144 0.885584
## IL.l2 -0.169976   0.067460  -2.520 0.012069 *
## IN.l2  0.013880   0.046965   0.296 0.767705
## const -0.017227   0.084007  -0.205 0.837607
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 1.853 on 482 degrees of freedom
## Multiple R-Squared: 0.5205,  Adjusted R-squared: 0.5145
## F-statistic:  87.2 on 6 and 482 DF,  p-value: < 2.2e-16
##
##
##
## Covariance matrix of residuals:
##        MI     IL     IN
## MI 3.9112 0.3116 0.7248
## IL 0.3116 1.4851 0.4078
## IN 0.7248 0.4078 3.4319
##
## Correlation matrix of residuals:
##        MI     IL     IN
## MI 1.0000 0.1293 0.1978
## IL 0.1293 1.0000 0.1807
## IN 0.1978 0.1807 1.0000
```

```
imp1=irf(m1.vars)
plot(imp1)
```


Orthogonal Impulse Response from MI
MI
IL
IN
0.5
1.5
2.5
0
1
2
3
4
5
6
7
8
9
10
95 % Bootstrap CI, 100 runs

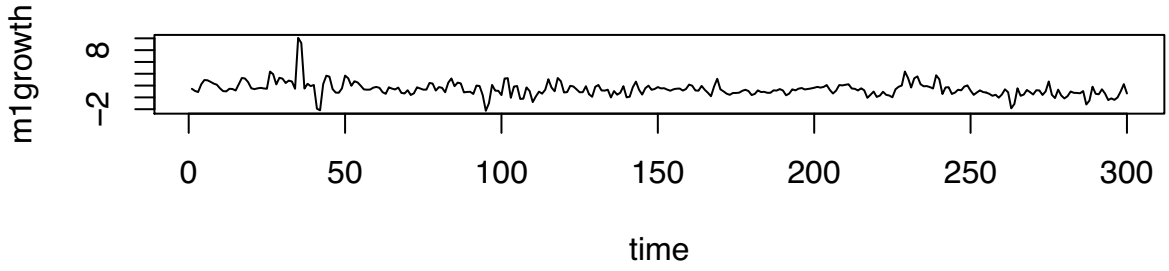

Orthogonal Impulse Response from IL
MI
IL
IN
0.2
0.6
1.0
0
1
2
3
4
5
6
7
8
9
10
95 % Bootstrap CI, 100 runs

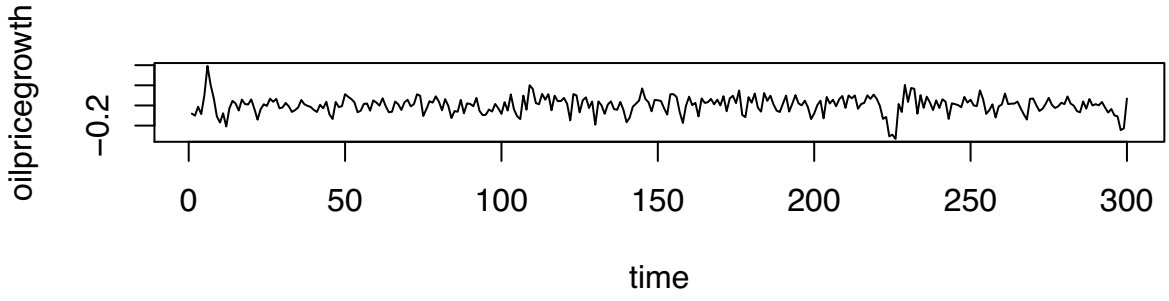



```
# 1 unit change in shocks of MI impacts on MI the most so do IL and IN impact the most in themselves
#no con current effect from IN to MI and IL



#question 2.1
da2=read.table("m-m1cnwti.txt",header = F)
detach_package("vars", TRUE)
library('MTS')
```

```
## Warning: package 'MTS' was built under R version 4.0.5
```

```
require(MTS)
zt=da2
colnames(zt) <- c('m1growth','oilpricegrowth')
MTSplot(zt)
```

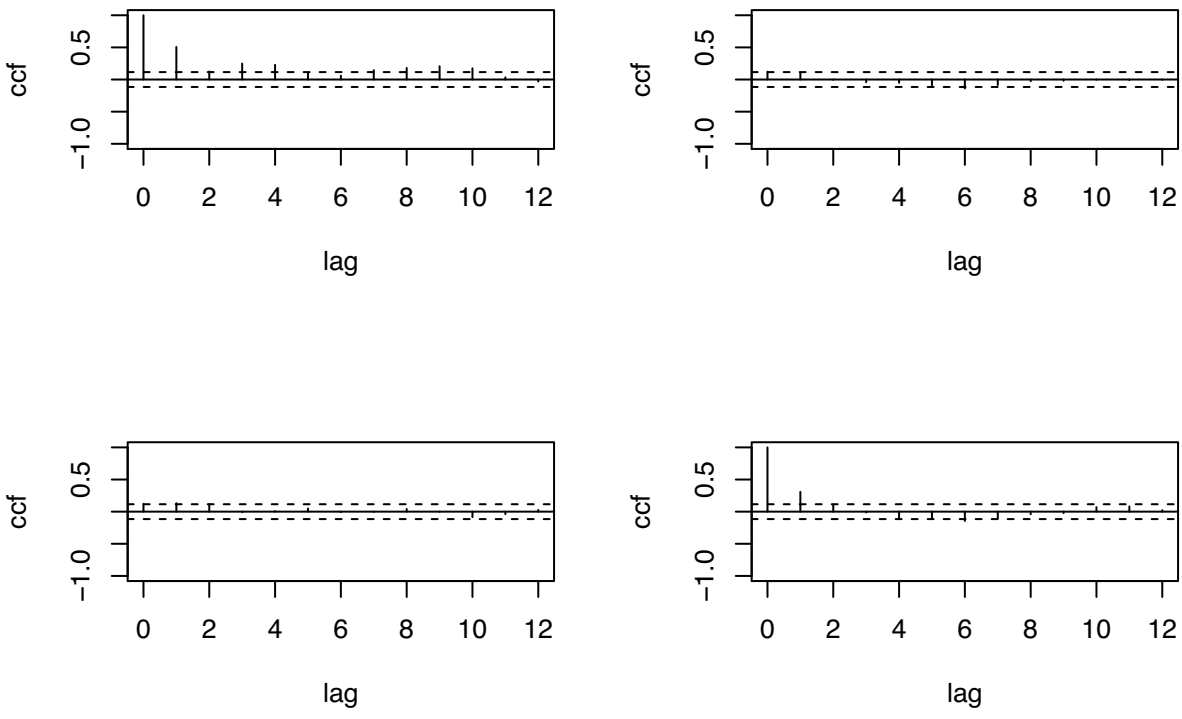




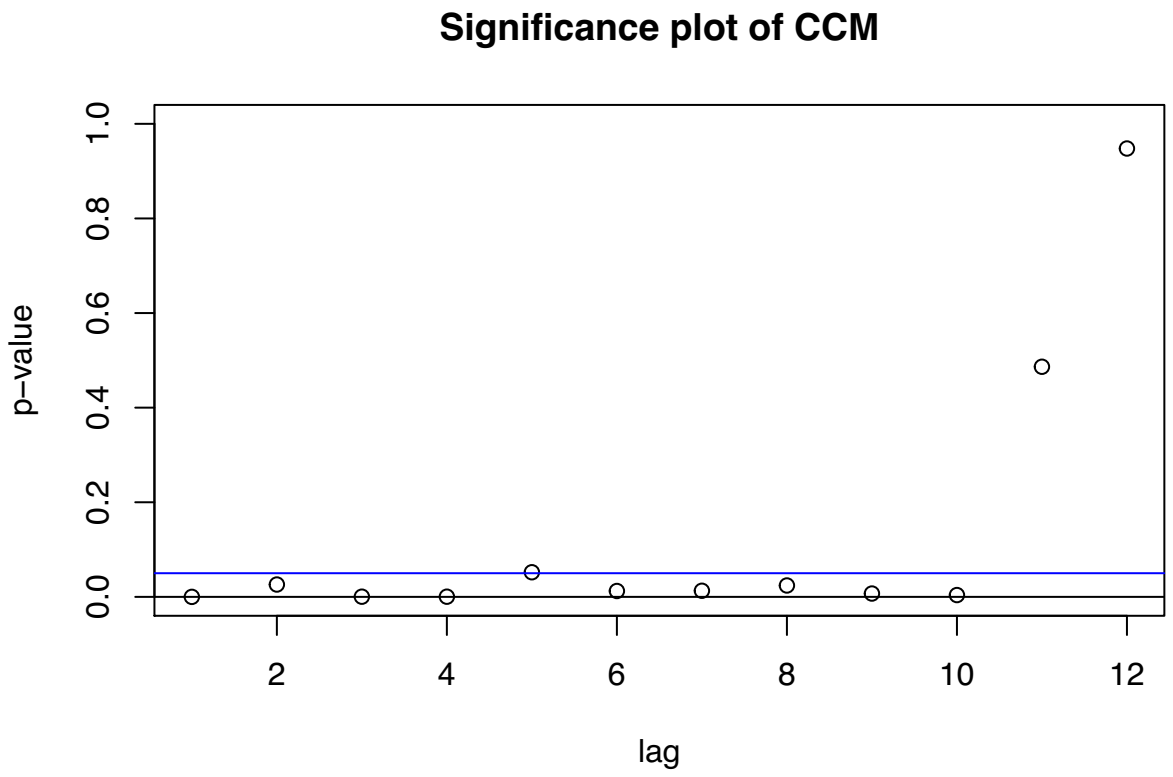

```
ccm(zt)
```

```
## [1] "Covariance matrix:"
##                m1growth oilpricegrowth
## m1growth         1.4767        0.01254
## oilpricegrowth   0.0125        0.00718
## CCM at lag:  0
##       [,1]  [,2]
## [1,] 1.000 0.122
## [2,] 0.122 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:
```




```
#question 2.2
VARorder(zt)
```

```
## selected order: aic =  13
## selected order: bic =  3
## selected order: hq =  3
## Summary table:
##         p     AIC     BIC      HQ     M(p) p-value
##  [1,]  0 -4.6600 -4.6600 -4.6600   0.0000  0.0000
##  [2,]  1 -4.9979 -4.9485 -4.9781 103.3453  0.0000
##  [3,]  2 -5.0163 -4.9175 -4.9768  12.6928  0.0129
##  [4,]  3 -5.1555 -5.0073 -5.0962  46.3600  0.0000
##  [5,]  4 -5.1507 -4.9532 -5.0717   6.0751  0.1936
##  [6,]  5 -5.1371 -4.8902 -5.0383   3.5990  0.4630
##  [7,]  6 -5.1348 -4.8385 -5.0162   6.6570  0.1552
##  [8,]  7 -5.1516 -4.8059 -5.0132  11.7915  0.0190
##  [9,]  8 -5.1278 -4.7327 -4.9696   0.7736  0.9420
## [10,]  9 -5.1665 -4.7220 -4.9886  17.4902  0.0016
## [11,] 10 -5.1692 -4.6753 -4.9715   7.7943  0.0994
## [12,] 11 -5.1484 -4.6051 -4.9310   1.5447  0.8187
## [13,] 12 -5.1491 -4.5565 -4.9119   7.1662  0.1274
## [14,] 13 -5.1824 -4.5404 -4.9255  15.5661  0.0037
```

```
#suppose I choose based on BIC
m3.MTS=VAR(zt,3)
```

```
## Constant term:
```

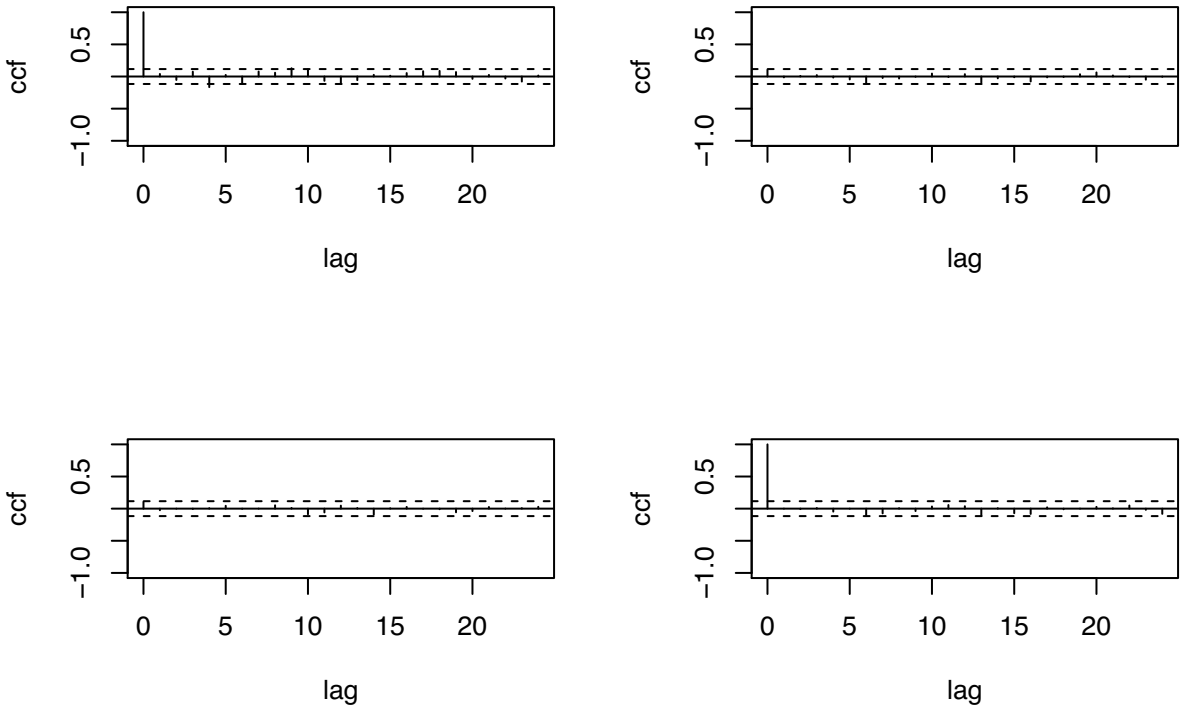
```
## Estimates:  0.4973633 -0.002715112
## Std.Error:  0.1030757 0.008624222
## AR coefficient matrix
## AR( 1 )-matrix
##         [,1]  [,2]
## [1,] 0.66841 0.701
## [2,] 0.00347 0.297
## standard error
##         [,1]   [,2]
## [1,] 0.05465 0.7026
## [2,] 0.00457 0.0588
## AR( 2 )-matrix
##         [,1]    [,2]
## [1,] -0.4045 -1.0184
## [2,]  0.0075  0.0298
## standard error
##         [,1]   [,2]
## [1,] 0.06295 0.7365
## [2,] 0.00527 0.0616
## AR( 3 )-matrix
##          [,1]    [,2]
## [1,]  0.37999 -0.4399
## [2,] -0.00712 -0.0572
## standard error
##         [,1]   [,2]
## [1,] 0.05474 0.7154
## [2,] 0.00458 0.0599
##
## Residuals cov-mtx:
##             [,1]        [,2]
## [1,] 0.906072927 0.007912593
## [2,] 0.007912593 0.006342935
##
## det(SSE) =  0.005684552
## AIC =  -5.090003
## BIC =  -4.941852
## HQ  =  -5.030713
```

```
MTSdiag(m3.MTS)
```

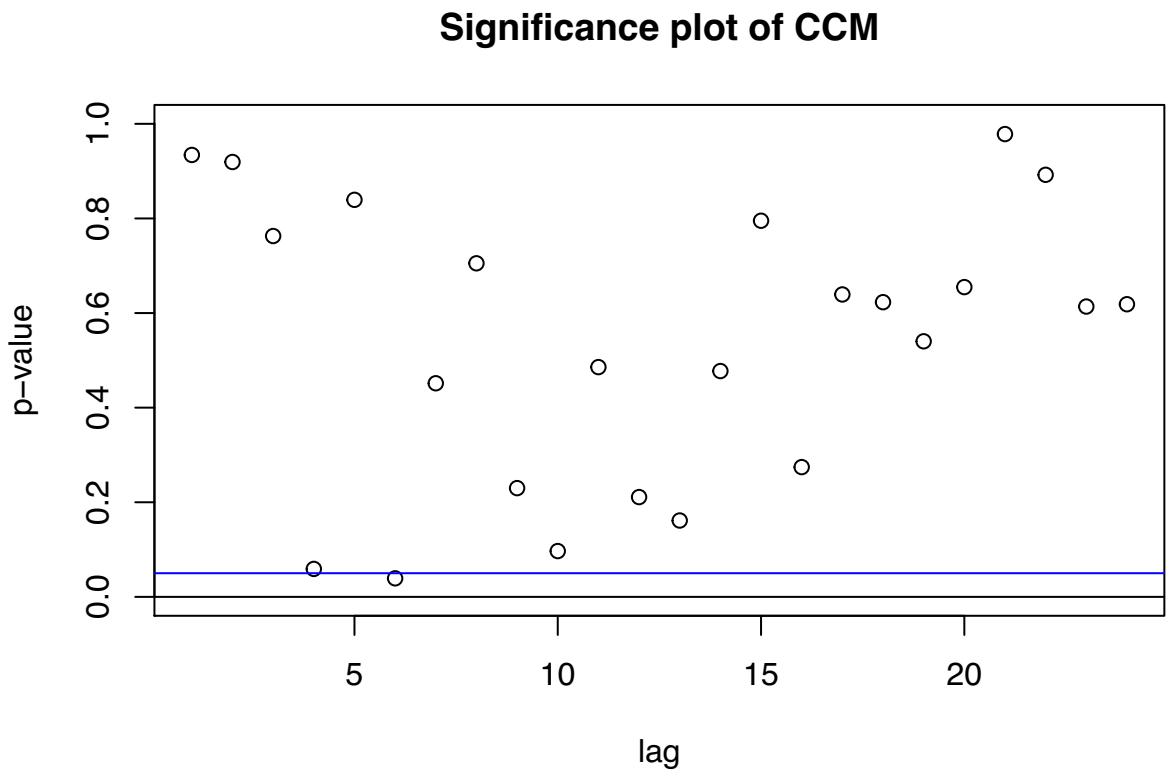
```
## [1] "Covariance matrix:"
##                m1growth oilpricegrowth
## m1growth        0.90913        0.00794
## oilpricegrowth  0.00794        0.00636
## CCM at lag:  0
##       [,1]  [,2]
## [1,] 1.000 0.104
## [2,] 0.104 1.000
## Simplified matrix:
## CCM at lag:  1
## . .
## . .
## CCM at lag:  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
## . .
## . .
## CCM at lag:  13
## . .
## . .
## CCM at lag:  14
## . .
## . .
## CCM at lag:  15
## . .
## . .
## CCM at lag:  16
## . .
## . .
## CCM at lag:  17
## . .
## . .
## CCM at lag:  18
## . .
## . .
## CCM at lag:  19
## . .
## . .
## CCM at lag:  20
## . .
## . .
```

```
## CCM at lag:  21
## . .
## . .
## CCM at lag:  22
## . .
## . .
## CCM at lag:  23
## . .
## . .
## CCM at lag:  24
## . .
## . .
```

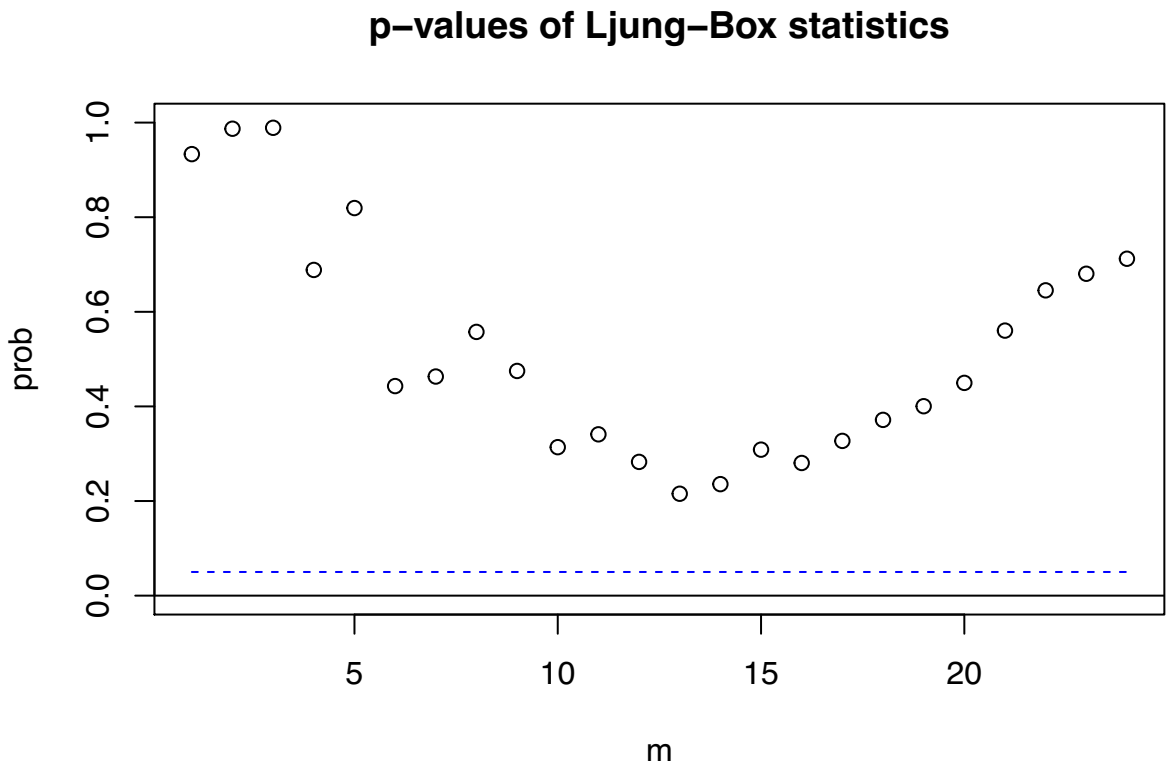



```
## Hit Enter for p-value plot of individual ccm:
```

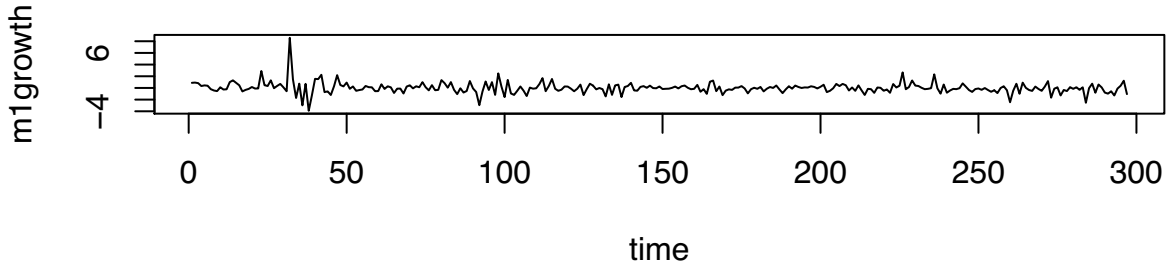


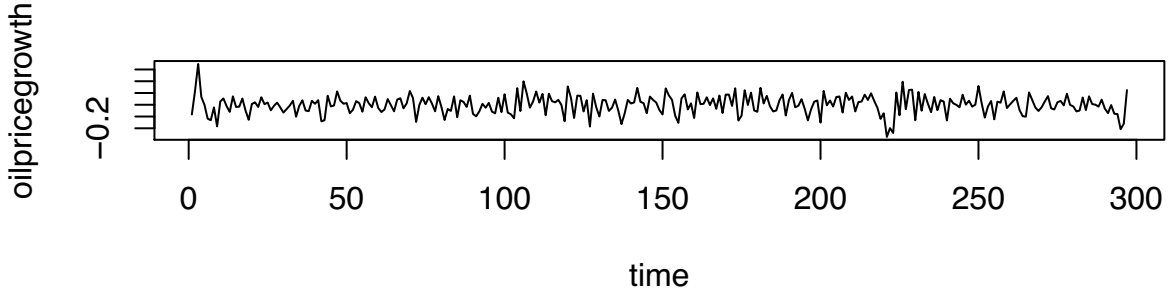

```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##          m       Q(m)     df    p-value
##  [1,]  1.000     0.838   4.000     0.93
##  [2,]  2.000     1.780   8.000     0.99
##  [3,]  3.000     3.646  12.000     0.99
##  [4,]  4.000    12.783  16.000     0.69
##  [5,]  5.000    14.217  20.000     0.82
##  [6,]  6.000    24.328  24.000     0.44
##  [7,]  7.000    28.024  28.000     0.46
##  [8,]  8.000    30.207  32.000     0.56
##  [9,]  9.000    35.865  36.000     0.47
## [10,] 10.000    43.789  40.000     0.31
## [11,] 11.000    47.257  44.000     0.34
## [12,] 12.000    53.144  48.000     0.28
## [13,] 13.000    59.729  52.000     0.22
## [14,] 14.000    63.254  56.000     0.24
## [15,] 15.000    64.941  60.000     0.31
## [16,] 16.000    70.101  64.000     0.28
## [17,] 17.000    72.663  68.000     0.33
## [18,] 18.000    75.318  72.000     0.37
## [19,] 19.000    78.471  76.000     0.40
## [20,] 20.000    80.935  80.000     0.45
## [21,] 21.000    81.394  84.000     0.56
## [22,] 22.000    82.501  88.000     0.65
```

```
## [23,] 23.000    85.145  92.000     0.68
## [24,] 24.000    87.817  96.000     0.71
```




```
## Hit Enter to obtain residual plots:
```






```
#refine
m4.MTS=refVAR(m3.MTS)
```

fitted model

```
## Constant term:
## Estimates:  0.4891295 0
## Std.Error:  0.1025398 0
## AR coefficient matrix
## AR( 1 )-matrix
##       [,1]  [,2]
## [1,] 0.675 0.000
## [2,] 0.000 0.303
## standard error
##        [,1]   [,2]
## [1,] 0.0543 0.0000
## [2,] 0.0000 0.0554
## AR( 2 )-matrix
##          [,1]   [,2]
## [1,] -0.40569 -0.932
## [2,]  0.00964  0.000
## standard error
##        [,1]  [,2]
## [1,] 0.0628 0.675
## [2,] 0.0041 0.000
## AR( 3 )-matrix
##          [,1] [,2]
## [1,]  0.38094    0
## [2,] -0.00794    0
```

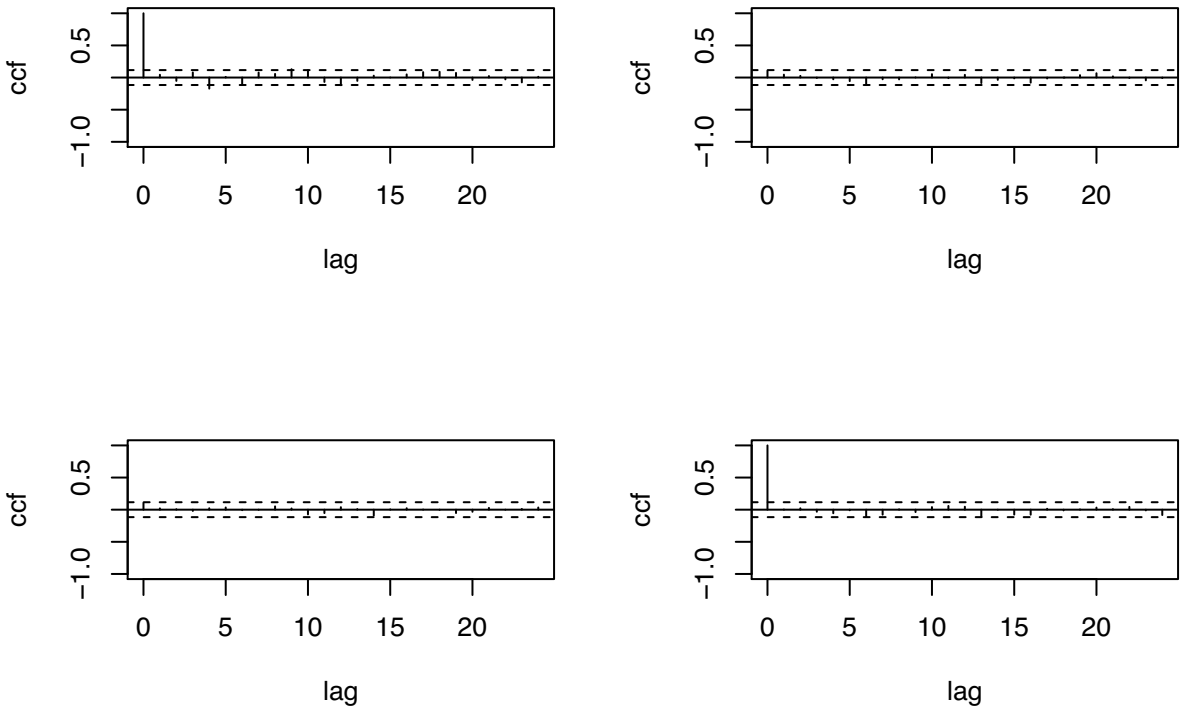
$$\begin{bmatrix} m1\,growth_t \\ oilpricegrowth_t \end{bmatrix} = \begin{bmatrix} 0.4891295 \\ (0.1025) \\ 0 \\ (0) \end{bmatrix} + \begin{bmatrix} 0.675 & 0 \\ (0.054) & (0) \\ 0 & 0.303 \\ (0) & (0.055) \end{bmatrix} \begin{bmatrix} m1\,growth_{t-1} \\ oilpricegrowth_{t-1} \end{bmatrix} + \begin{bmatrix} -0.40569 & -0.932 \\ (0.063) & (0.675) \\ 0.00964 & 0 \\ (0.004) & (0) \end{bmatrix} \begin{bmatrix} m1\,growth_{t-2} \\ oilpricegrowth_{t-2} \end{bmatrix} + \begin{bmatrix} 0.38094 & 0 \\ (0.055) & (0) \\ -0.00794 & 0 \\ (0.004) & (0) \end{bmatrix} \begin{bmatrix} m1\,growth_{t-3} \\ oilpricegrowth_{t-3} \end{bmatrix}$$

```
## standard error
##        [,1] [,2]
## [1,] 0.0545    0
## [2,] 0.0041    0
##
## Residuals cov-mtx:
##             [,1]        [,2]
## [1,] 0.910272862 0.008033071
## [2,] 0.008033071 0.006379513
##
## det(SSE) =  0.005742567
## AIC =  -5.113182
## BIC =  -5.026761
## HQ  =  -5.078596
```

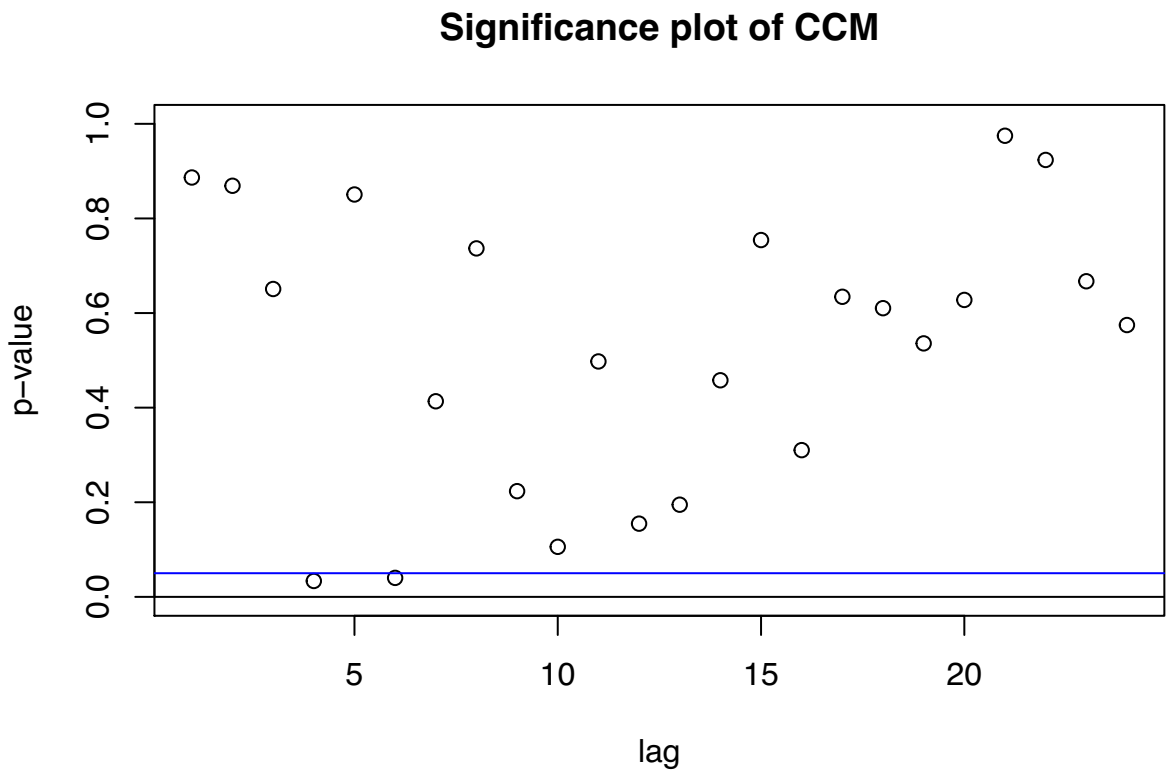
```
#fitted model
MTSdiag(m4.MTS)
```

```
## [1] "Covariance matrix:"
##                m1growth oilpricegrowth
## m1growth        0.91335        0.00806
## oilpricegrowth  0.00806        0.00640
## CCM at lag:  0
##       [,1]  [,2]
## [1,] 1.000 0.105
## [2,] 0.105 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
## - .
## . .
## CCM at lag:  13
## . .
## . .
## CCM at lag:  14
## . .
## . .
## CCM at lag:  15
## . .
## . .
## CCM at lag:  16
## . .
## . .
## CCM at lag:  17
## . .
## . .
## CCM at lag:  18
## . .
## . .
## CCM at lag:  19
## . .
## . .
## CCM at lag:  20
## . .
## . .
## CCM at lag:  21
## . .
## . .
## CCM at lag:  22
## . .
## . .
## CCM at lag:  23
## . .
## . .
## CCM at lag:  24
## . .
## . .
```

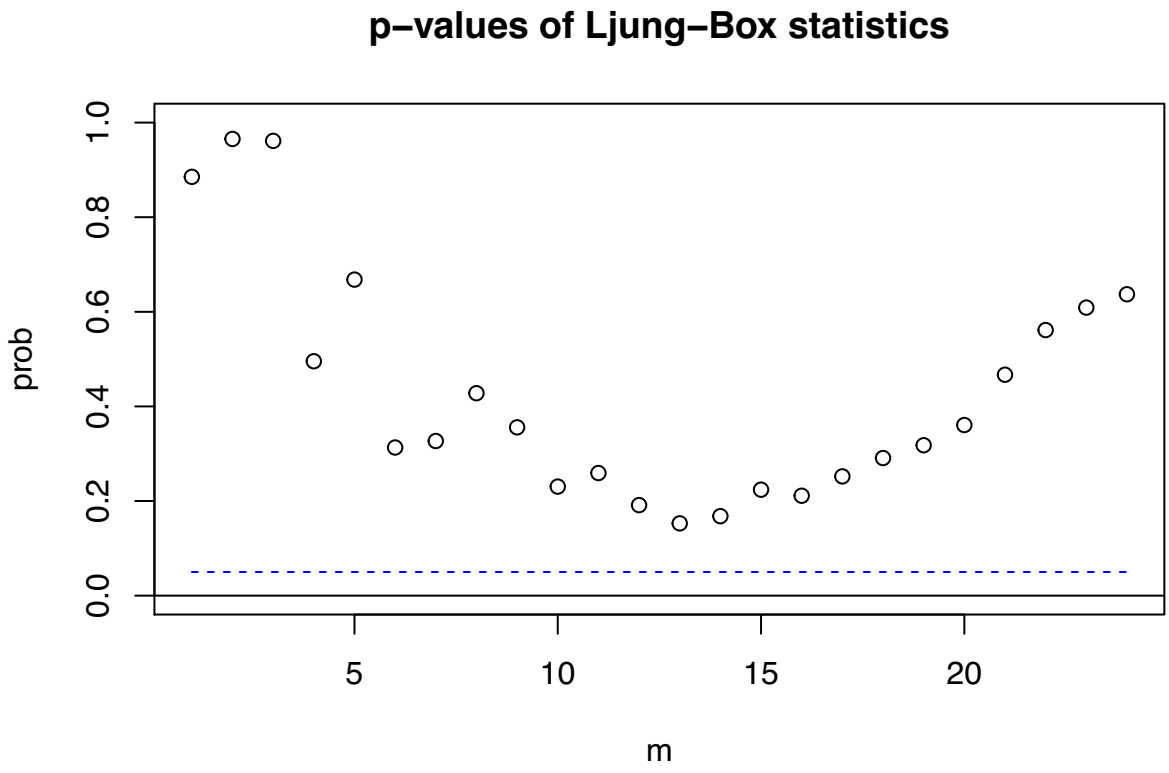



```
## Hit Enter for p-value plot of individual ccm:
```

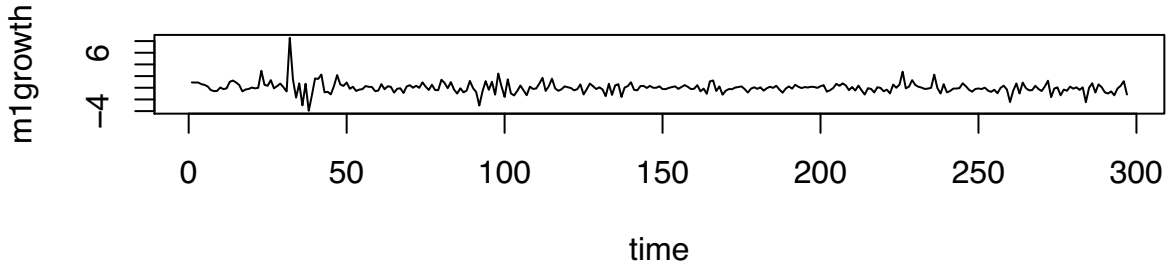


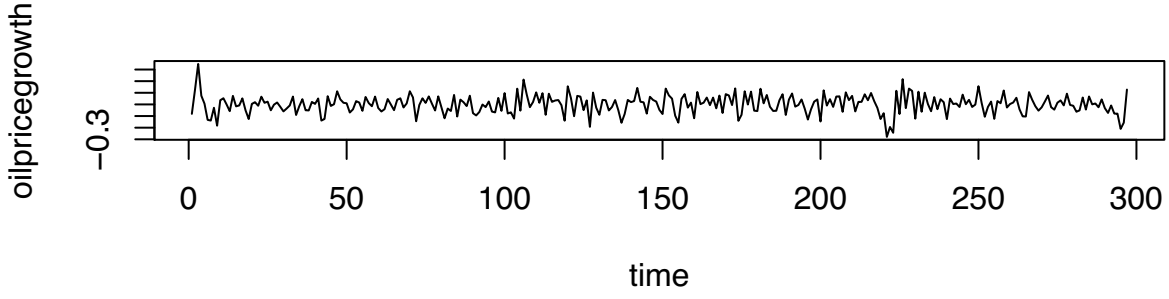

```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##         m       Q(m)     df    p-value
##  [1,]  1.00      1.16    4.00     0.89
##  [2,]  2.00      2.42    8.00     0.97
##  [3,]  3.00      4.90   12.00     0.96
##  [4,]  4.00     15.40   16.00     0.50
##  [5,]  5.00     16.77   20.00     0.67
##  [6,]  6.00     26.82   24.00     0.31
##  [7,]  7.00     30.78   28.00     0.33
##  [8,]  8.00     32.79   32.00     0.43
##  [9,]  9.00     38.53   36.00     0.36
## [10,] 10.00     46.23   40.00     0.23
## [11,] 11.00     49.62   44.00     0.26
## [12,] 12.00     56.33   48.00     0.19
## [13,] 13.00     62.42   52.00     0.15
## [14,] 14.00     66.07   56.00     0.17
## [15,] 15.00     67.98   60.00     0.22
## [16,] 16.00     72.79   64.00     0.21
## [17,] 17.00     75.38   68.00     0.25
## [18,] 18.00     78.11   72.00     0.29
## [19,] 19.00     81.29   76.00     0.32
## [20,] 20.00     83.91   80.00     0.36
## [21,] 21.00     84.41   84.00     0.47
## [22,] 22.00     85.31   88.00     0.56
```

```
## [23,] 23.00     87.65   92.00     0.61
## [24,] 24.00     90.58   96.00     0.64
```




```
## Hit Enter to obtain residual plots:
```






```
#question 2.3
detach_package("MTS", TRUE)
library('vars')
```

```
## Warning: package 'vars' was built under R version 4.0.5
```

```
require(vars)
VARselect(zt,lag.max = 10)
```

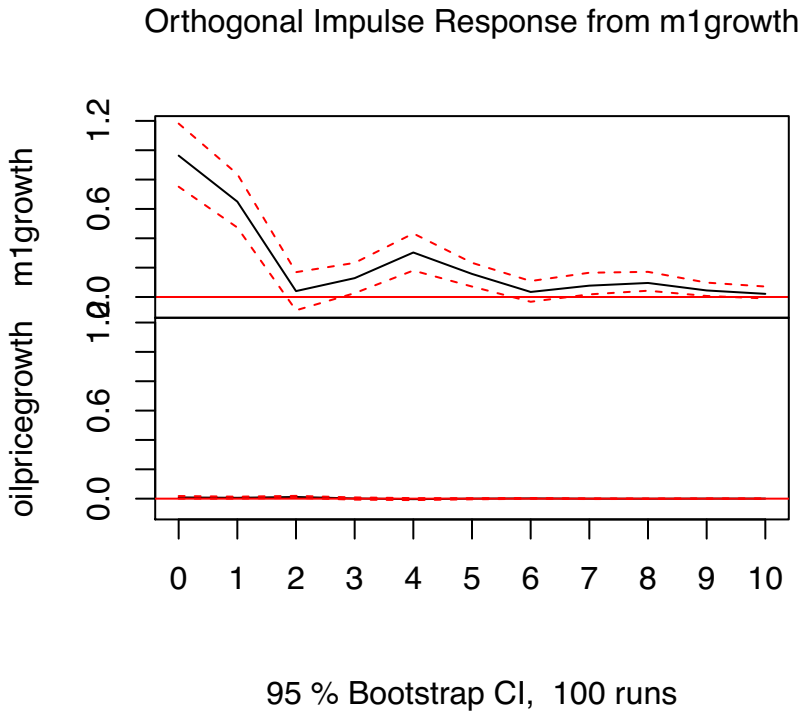
```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##     10      3      3     10
##
## $criteria
##                  1            2            3          4            5
## AIC(n) -4.981203511 -4.999832079 -5.138250646 -5.1336059 -5.120954677
## HQ(n)  -4.950782762 -4.949130830 -5.067268897 -5.0423436 -5.009411928
## SC(n)  -4.905274941 -4.873284461 -4.961083981 -4.9058202 -4.842549917
## FPE(n)  0.006865805  0.006739125  0.005868056  0.0058955  0.005970755
##                  6            7            8           9           10
## AIC(n) -5.122862589 -5.137715694 -5.113114433 -5.150621360 -5.153027938
## HQ(n)  -4.991039341 -4.985611946 -4.940730185 -4.957956612 -4.940082690
## SC(n)  -4.793838782 -4.758072840 -4.682852531 -4.669740411 -4.621527942
## FPE(n)  0.005959657  0.005872171  0.006018933  0.005797982  0.005784808
```

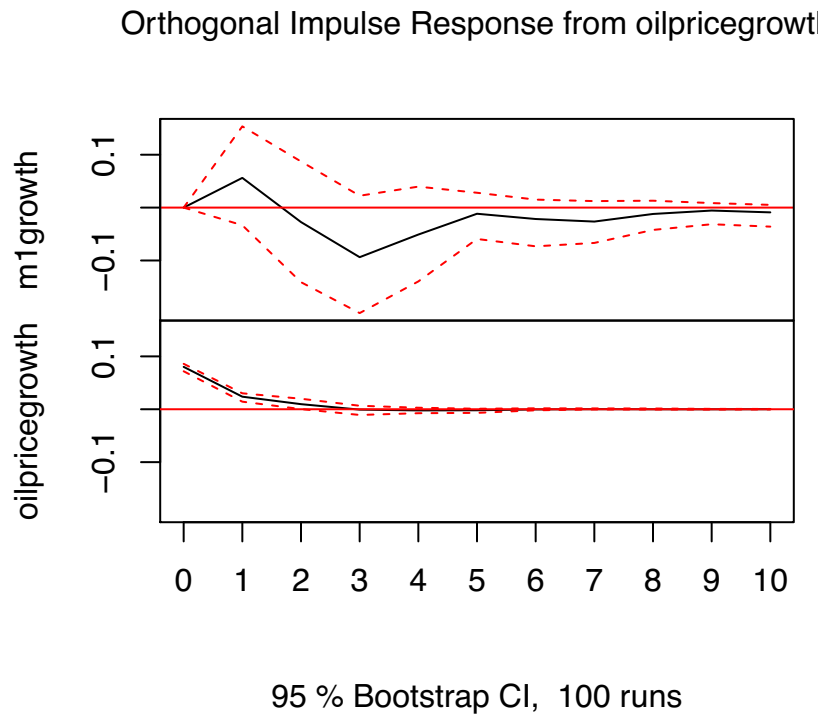
```
m2.vars=VAR(zt,p=3)
summary(m2.vars)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: m1growth, oilpricegrowth
## Deterministic variables: const
## Sample size: 297
## Log Likelihood: -75.104
## Roots of the characteristic polynomial:
## 0.7754 0.6964 0.6964 0.4487 0.4487 0.3284
## Call:
## VAR(y = zt, p = 3)
##
##
## Estimation results for equation m1growth:
## ==========================================
## m1growth = m1growth.l1 + oilpricegrowth.l1 + m1growth.l2 + oilpricegrowth.l2 + m1growth.l3 + oilpric
##
##                   Estimate Std. Error t value Pr(>|t|)
## m1growth.l1        0.66841    0.05465  12.230  < 2e-16 ***
## oilpricegrowth.l1  0.70145    0.70262   0.998    0.319
## m1growth.l2       -0.40451    0.06295  -6.426 5.37e-10 ***
## oilpricegrowth.l2 -1.01842    0.73654  -1.383    0.168
## m1growth.l3        0.37999    0.05474   6.942 2.53e-11 ***
## oilpricegrowth.l3 -0.43989    0.71537  -0.615    0.539
## const              0.49736    0.10308   4.825 2.26e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.9633 on 290 degrees of freedom
## Multiple R-Squared: 0.3901,  Adjusted R-squared: 0.3775
## F-statistic: 30.91 on 6 and 290 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation oilpricegrowth:
## ================================================
## oilpricegrowth = m1growth.l1 + oilpricegrowth.l1 + m1growth.l2 + oilpricegrowth.l2 + m1growth.l3 + o
##
##                    Estimate Std. Error t value Pr(>|t|)
## m1growth.l1        0.003467   0.004573   0.758    0.449
## oilpricegrowth.l1  0.296716   0.058787   5.047 7.93e-07 ***
## m1growth.l2        0.007504   0.005267   1.425    0.155
## oilpricegrowth.l2  0.029814   0.061626   0.484    0.629
## m1growth.l3       -0.007121   0.004580  -1.555    0.121
## oilpricegrowth.l3 -0.057191   0.059854  -0.956    0.340
## const             -0.002715   0.008624  -0.315    0.753
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.0806 on 290 degrees of freedom
## Multiple R-Squared: 0.1153,  Adjusted R-squared: 0.09701
## F-statistic:   6.3 on 6 and 290 DF,  p-value: 3.049e-06
##
```

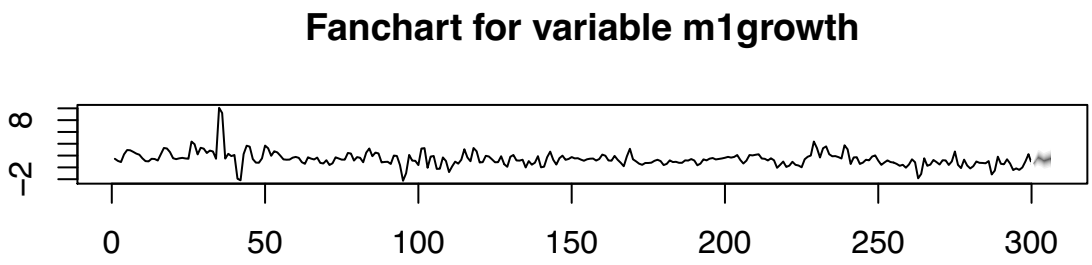
```
##
##
## Covariance matrix of residuals:
##                 m1growth oilpricegrowth
## m1growth       0.927944       0.008104
## oilpricegrowth 0.008104       0.006496
##
## Correlation matrix of residuals:
##                 m1growth oilpricegrowth
## m1growth          1.0000         0.1044
## oilpricegrowth    0.1044         1.0000
```

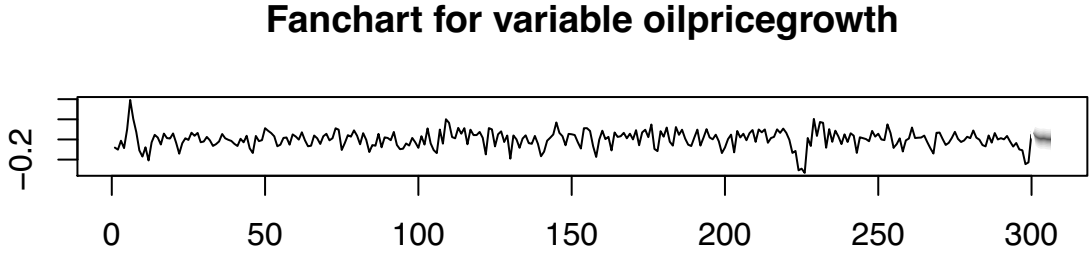
```
imp2=irf(m2.vars)
plot(imp2)
```






```
#no concurrent effect from m1growth to oilpricegrowth
#1 unit change in shocks of m1 impact on m1 the most as well as the shocks of oilprice impact on oilpri



#question 2.4
m2.vars.prd <- predict(m2.vars, n.ahead = 6, ci= 0.95)
fanchart(m2.vars.prd)
```


Fanchart for variable m1growth
8
−2
0
50
100
150
200
250
300


Fanchart for variable oilpricegrowth
−0.2
0
50
100
150
200
250
300