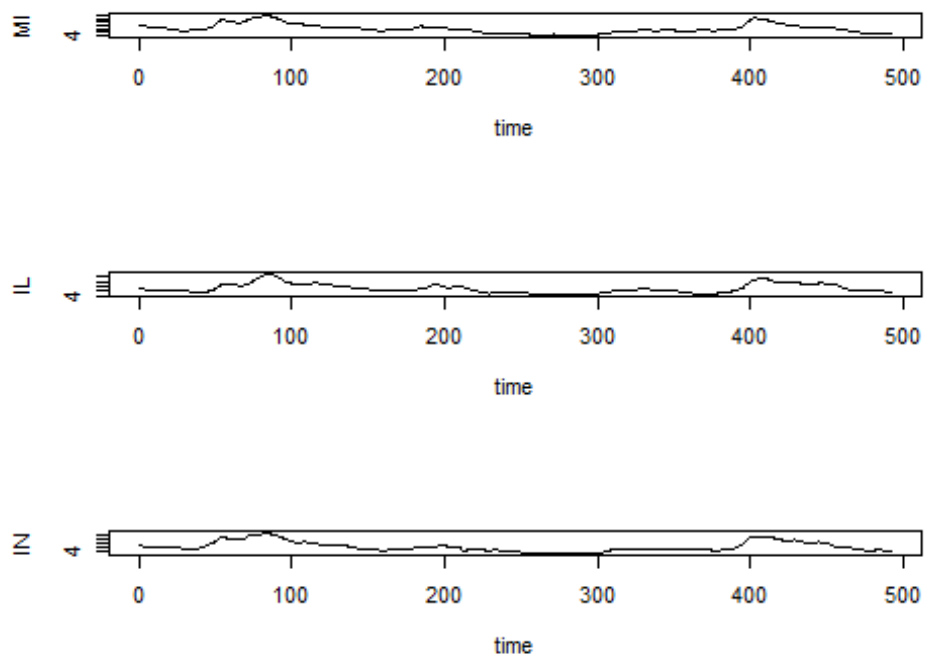
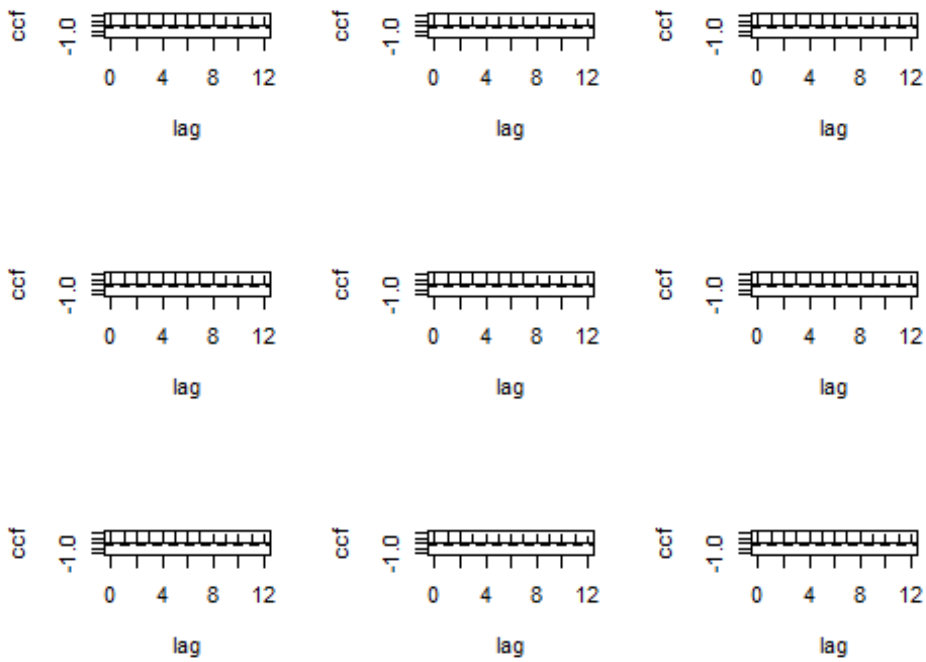
```r
m.unrate.MIILIN <- read.csv("~/EE 435/HW/m-unrate-MIILIN.txt", sep="")
require(MTS)

y=cbind(m.unrate.MIILIN[,2],m.unrate.MIILIN[,3],m.unrate.MIILIN[,4])
colnames(y) <- c("MI","IL","IN")
MTSplot(y)
```

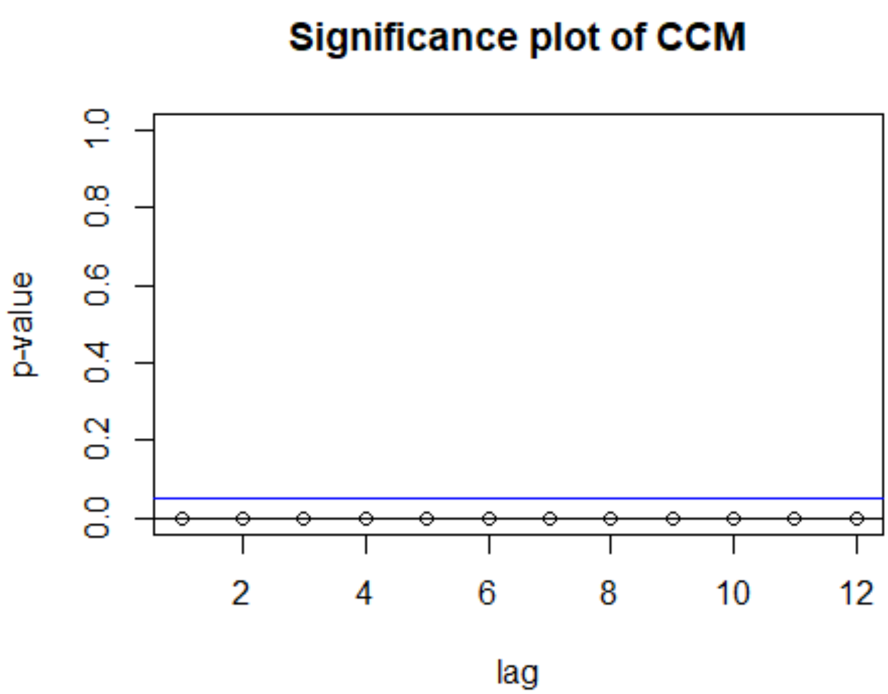



```r
ccm(y)

## [1] "Covariance matrix:"
##      MI   IL   IN
## MI 8.52 5.17 6.43
## IL 5.17 3.87 4.17
## IN 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
## + + +
## + + +
```

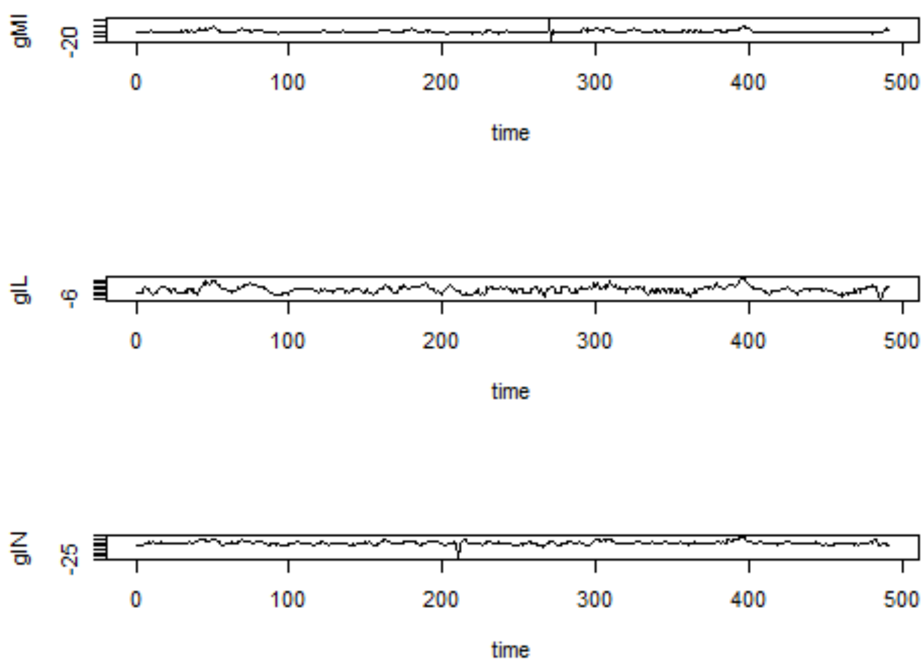
```
## + + +
## CCM at lag:  3
## + + +
## + + +
## + + +
## CCM at lag:  4
## + + +
## + + +
## + + +
## CCM at lag:  5
## + + +
## + + +
## + + +
## CCM at lag:  6
## + + +
## + + +
## + + +
## CCM at lag:  7
## + + +
## + + +
## + + +
## CCM at lag:  8
## + + +
## + + +
## + + +
## CCM at lag:  9
## + + +
## + + +
## + + +
## CCM at lag:  10
## + + +
## + + +
## + + +
## CCM at lag:  11
## + + +
## + + +
## + + +
## CCM at lag:  12
## + + +
## + + +
## + + +
```




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

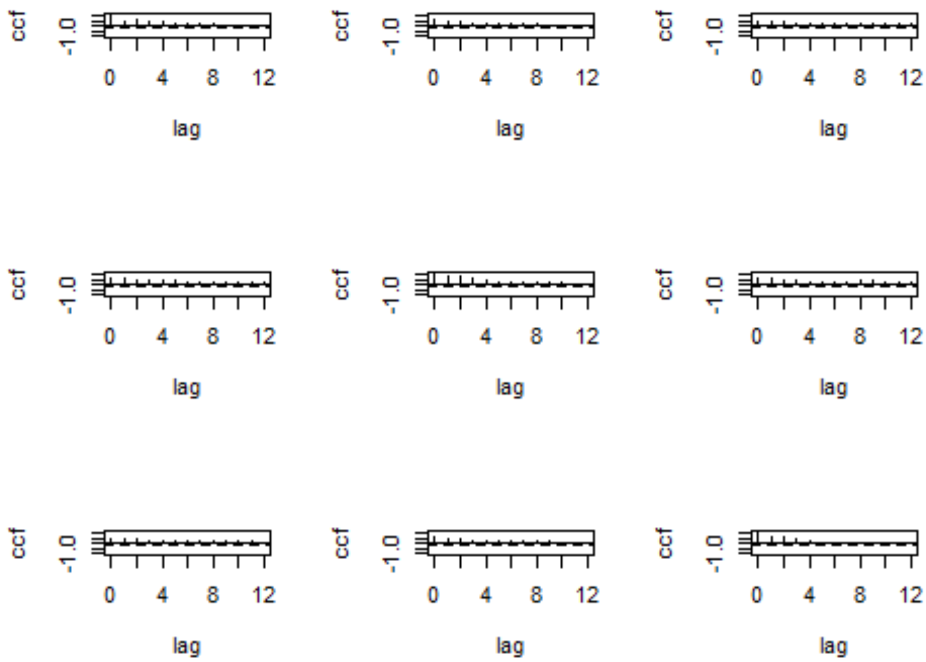


```
#Series are non-stationary. First difference is required.

x=log(y)
zt=diffM(x)*100
colnames(zt) <- c("gMI","gIL","gIN")
MTSplot(zt)
```

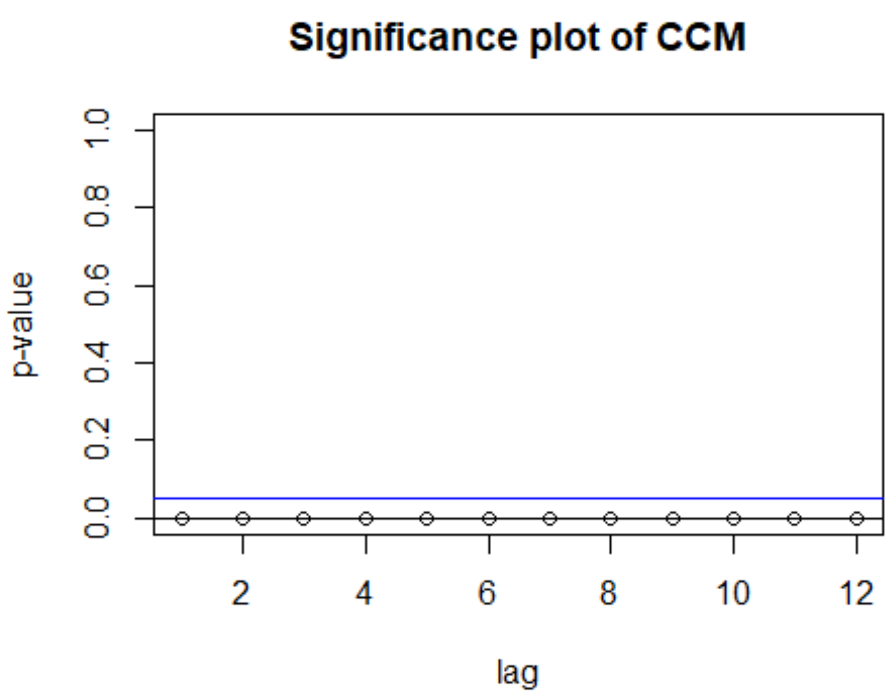



```
ccm(zt)

## [1] "Covariance matrix:"
##      gMI  gIL  gIN
## gMI 6.49 2.67 3.34
## gIL 2.67 4.28 2.88
## gIN 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:
```



```
#Question 1.1

VARorder(zt)

## 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

m1 <- VAR(zt,2)

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

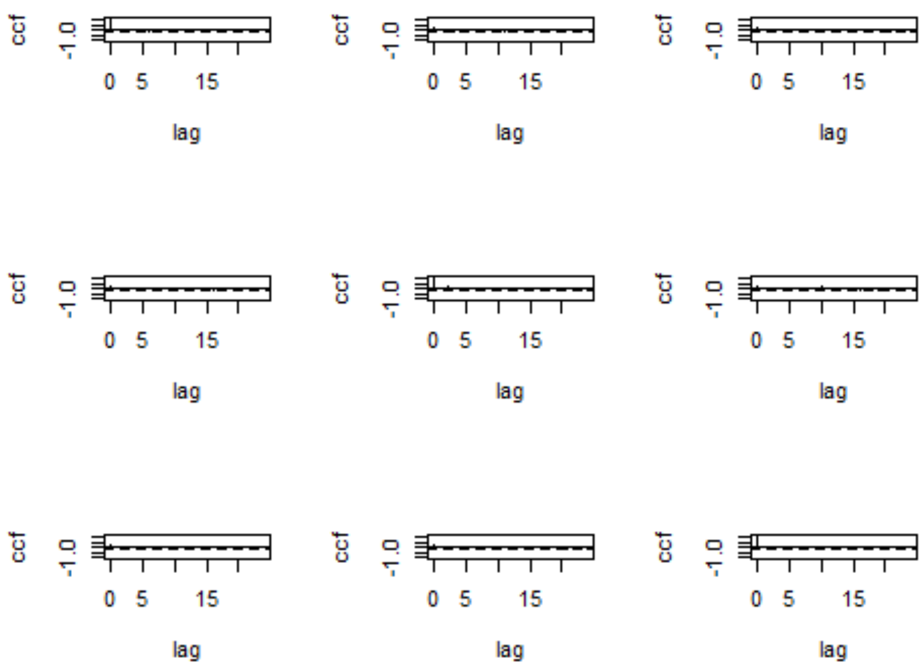
```
## Residuals cov-mtx:
##           [,1]      [,2]      [,3]
## [1,] 3.8551679 0.3071579 0.7144333
## [2,] 0.3071579 1.4637954 0.4019971
## [3,] 0.7144333 0.4019971 3.3828113
##
## det(SSE) =  17.57694
## AIC =  2.939907
## BIC =  3.093748
## HQ  =  3.000321
```

```
MTSdiag(m1)
```

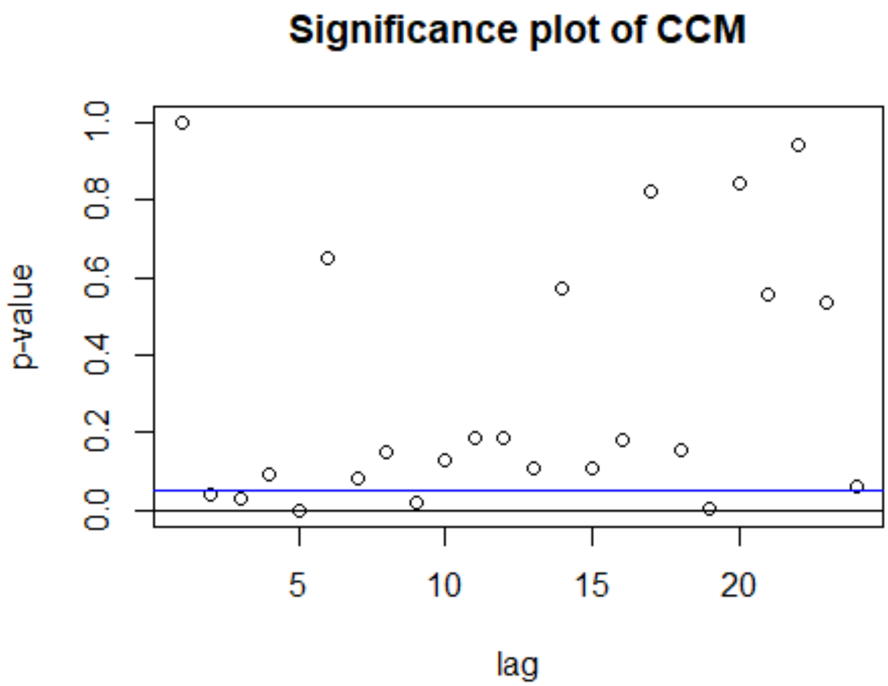
```
## [1] "Covariance matrix:"
##       gMI   gIL   gIN
## gMI 3.863 0.308 0.716
## gIL 0.308 1.467 0.403
## gIN 0.716 0.403 3.390
## CCM at lag:  0
##       [,1]  [,2]  [,3]
## [1,] 1.000 0.129 0.198
## [2,] 0.129 1.000 0.181
## [3,] 0.198 0.181 1.000
## Simplified matrix:
## CCM at lag:  1
## . . .
## . . .
## . . .
## 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
## . . .
## . . .
## . . .
```

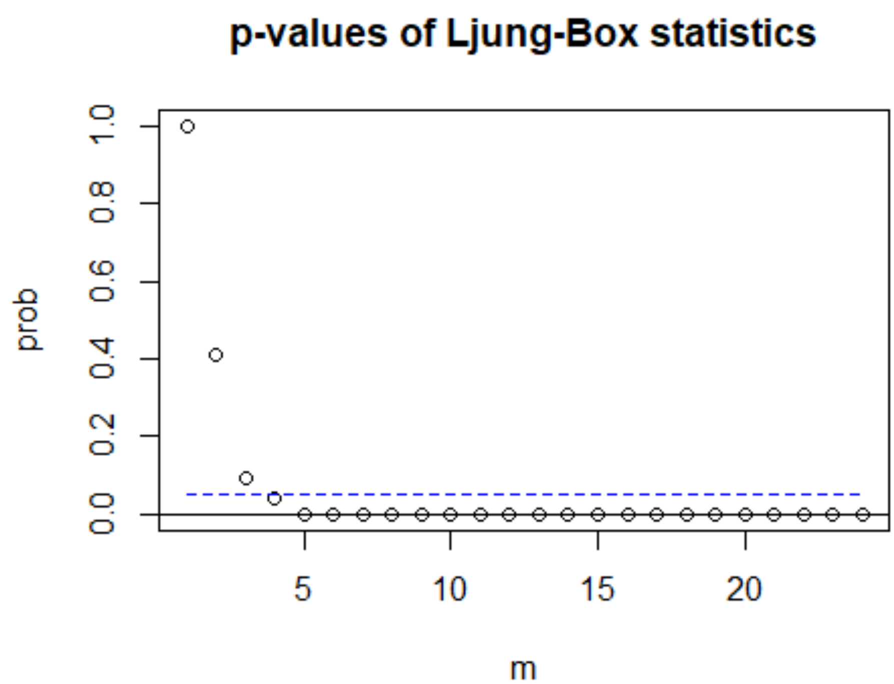



```
## Hit Enter for p-value plot of individual ccm:
```

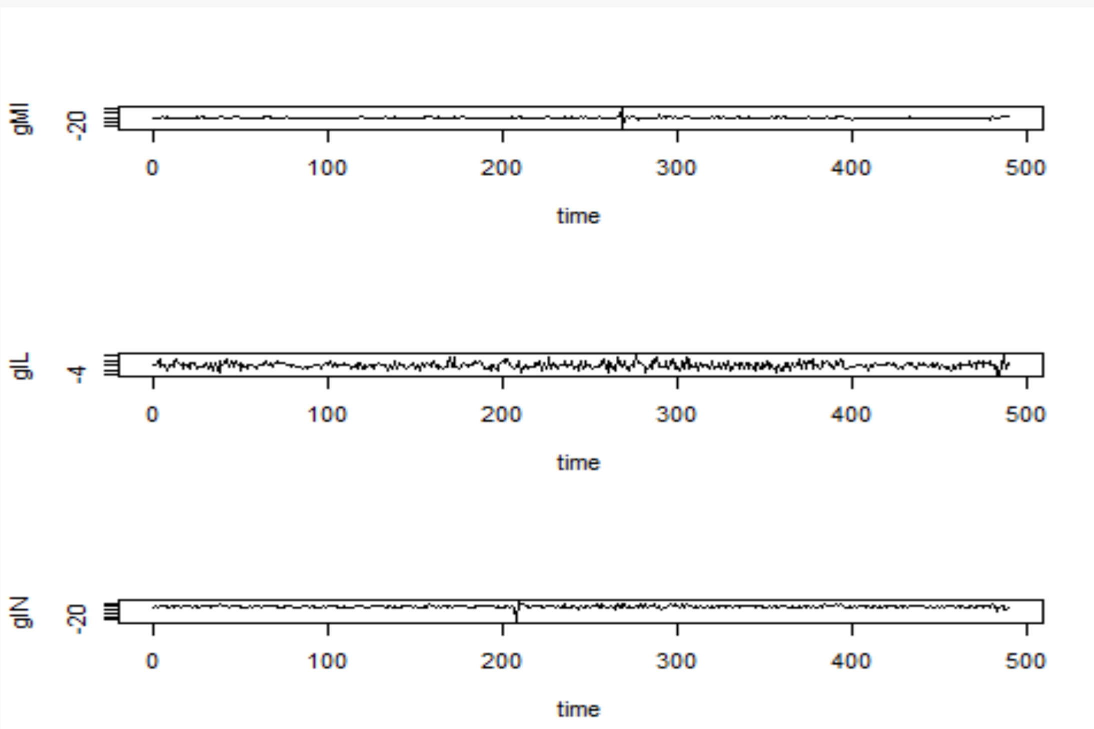



```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##          m       Q(m)     df    p-value
##  [1,]   1.00      1.05    9.00     1.00
##  [2,]   2.00     18.67   18.00     0.41
##  [3,]   3.00     37.04   27.00     0.09
##  [4,]   4.00     52.00   36.00     0.04
##  [5,]   5.00     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:
```



```
m2=refVAR(m1, 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
```

Ljung-Box test of $\hat{e}_t$: not rejecting H_0 : no correlation for first 3 lag → adequate model

ANS. Final fitted model (using t=1.645 as cut-off value)

gMI_t : growth of unemploy. in Michigan at t

gIL_t : growth of unemploy. in Illinois at t

gIN_t : growth of unemploy. in Indiana at t

$$\left.\begin{aligned}
g\hat{MI}_t &= 0.192\, gMI_{t-1} + 0.206\, gIL_{t-1} + 0.13\, gIN_{t-1} + 0.3035\, gMI_{t-2} \\
g\hat{IL}_t &= 0.105\, gMI_{t-1} + 0.528\, gIL_{t-1} + 0.101\, gIN_{t-1} + 0.0491\, gMI_{t-2} + 0.183\, gIL_{t-2} - 0.0849\, gIN_{t-2} \\
g\hat{IN}_t &= 0.152\, gMI_{t-1} + 0.273\, gIL_{t-1} + 0.574\, gIN_{t-1} - 0.168\, gIL_{t-2}
\end{aligned}\right\} \text{find fitted model}$$

Question 1.2)

```
detach("package:MTS", unload = TRUE)
require(vars)

varfit=VAR(zt, p=2)
summary(varfit)

##
## VAR Estimation Results:
## =========================
## Endogenous variables: gMI, gIL, gIN
## 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 = zt, p = 2)
##
##
## Estimation results for equation gMI:
## ====================================
## gMI = gMI.l1 + gIL.l1 + gIN.l1 + gMI.l2 + gIL.l2 + gIN.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## gMI.l1  0.198967   0.044522   4.469 9.81e-06 ***
## gIL.l1  0.275604   0.073512   3.749 0.000199 ***
## gIN.l1  0.130995   0.049704   2.635 0.008673 **
```

```
## gMI.l2  0.309097   0.045360   6.814 2.84e-11 ***
## gIL.l2 -0.106027   0.072016  -1.472 0.141604
## gIN.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 gIL:
## ====================================
## gIL = gMI.l1 + gIL.l1 + gIN.l1 + gMI.l2 + gIL.l2 + gIN.l2 + const
##
##        Estimate Std. Error t value Pr(>|t|)
## gMI.l1  0.10580    0.02743   3.856 0.000131 ***
## gIL.l1  0.52800    0.04530  11.656  < 2e-16 ***
## gIN.l1  0.10090    0.03063   3.294 0.001059 **
## gMI.l2  0.04956    0.02795   1.773 0.076841 .
## gIL.l2  0.18303    0.04438   4.125 4.37e-05 ***
## gIN.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 gIN:
## ====================================
## gIN = gMI.l1 + gIL.l1 + gIN.l1 + gMI.l2 + gIL.l2 + gIN.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## gMI.l1  0.151449   0.041706   3.631 0.000312 ***
## gIL.l1  0.273801   0.068861   3.976 8.08e-05 ***
## gIN.l1  0.568094   0.046560  12.201  < 2e-16 ***
## gMI.l2 -0.006117   0.042490  -0.144 0.885584
## gIL.l2 -0.169976   0.067460  -2.520 0.012069 *
## gIN.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
##
##
```

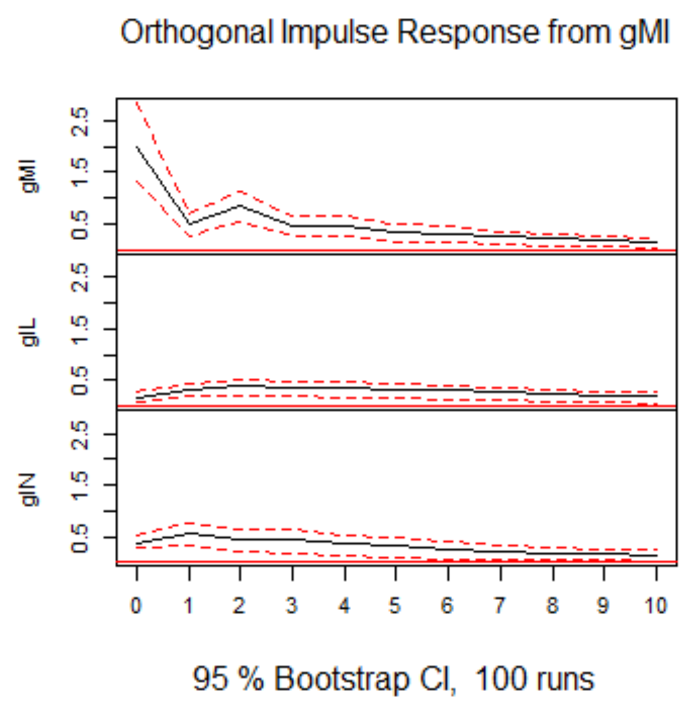
6104640542 Jak A.

```
## 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:
##        gMI    gIL    gIN
## gMI 3.9112 0.3116 0.7248
## gIL 0.3116 1.4851 0.4078
## gIN 0.7248 0.4078 3.4319
##
## Correlation matrix of residuals:
##        gMI    gIL    gIN
## gMI 1.0000 0.1293 0.1978
## gIL 0.1293 1.0000 0.1807
## gIN 0.1978 0.1807 1.0000
```

```
impresp=irf(varfit)
plot(impresp)
```

$$\begin{array}{cc} \begin{bmatrix} 1 & 0 & 0 \\ b_{21} & 1 & 0 \\ b_{31} & b_{32} & 1 \end{bmatrix} & \begin{array}{l} gML \\ gIL \\ gIN \end{array} \end{array}$$

Ans



from unemployment in Michigan

- IL :

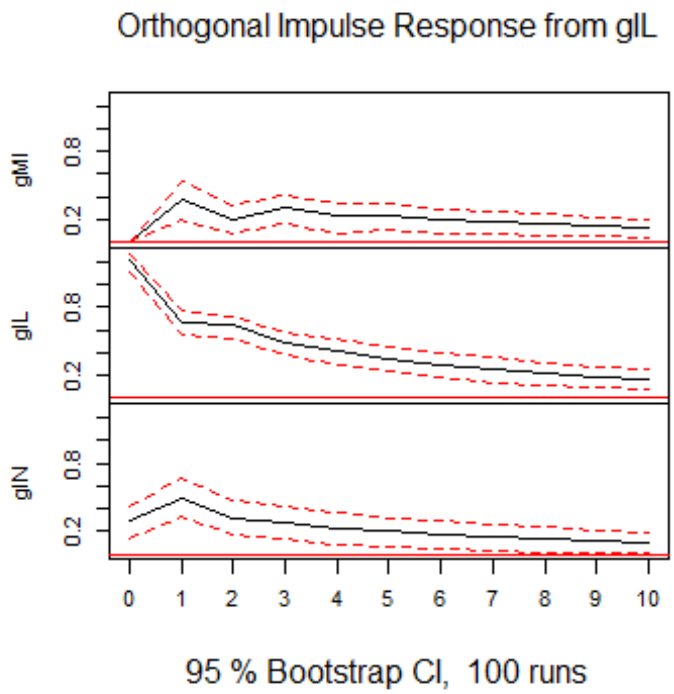
there is concurrent effect / impact from shock in gMI to gIL. The impact is weakly positive significantly for all current and lag periods. The magnitude of impact die down as lag increase

- IN :

there is concurrent effect / impact from shock in gMI to gIN. The impact is weakly positive significantly for all current and lag periods. The magnitude of impact die down as lag increase

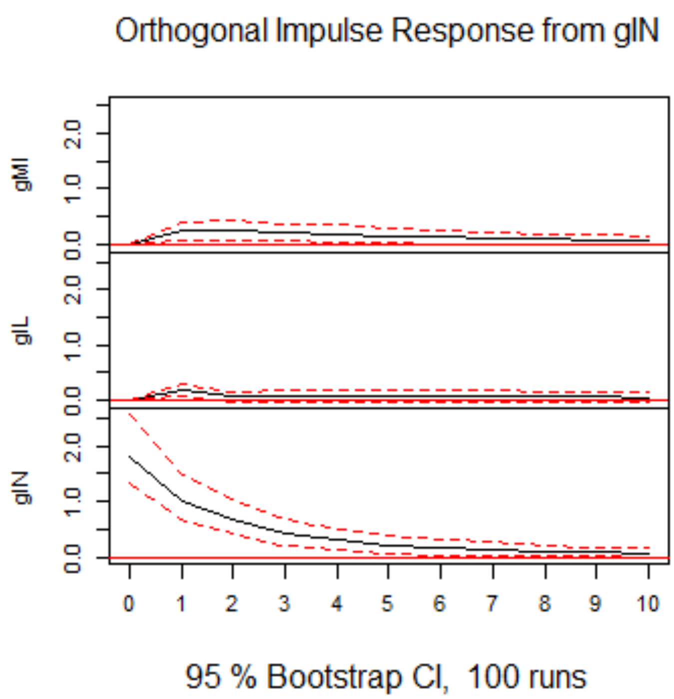
- MI : strong significant positive impact from shock itself to gMI, especially from concurrent period and the magnitude start to die down as lag increase

6104640542 Jak A.



From unemployment in Illinois

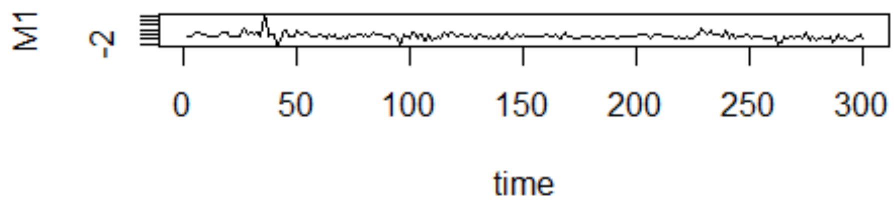
- ML : no concurrent effect from shock of gIL to gMI from choleski decomposition
  For lag period, the shock of gIL has strong significantly positive impact on gMI where the magnitude die down as lag increase
- IN : there is concurrent effect / impact from shock in gIL to gIN. The impact is positive (strong) significantly for all current and lag periods. The magnitude of impact die down as lag increase
- IL : strong significant positive impact from shock itself to gIL, especially from concurrent period and the magnitude start to die down as lag increase

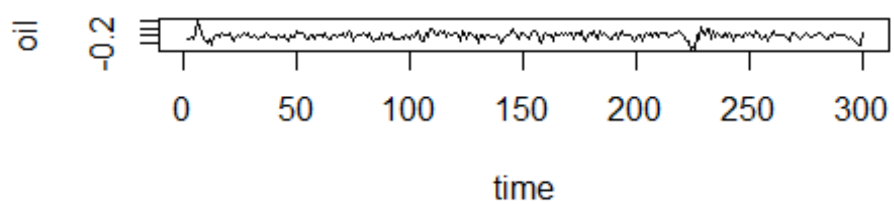


From unemployment in Indiana

- ML : no concurrent effect from shock of gIN to gMI from choleski decomposition
  For lag period, the shock of gIN has weak significantly positive impact on gMI where the magnitude die down as lag increase
- IL : no concurrent effect from shock of gIN to gIL from choleski decomposition
  For lag period, the shock of gIN has weak significantly positive impact on gIL only for first few lag till t-2 ; after that the impact is insignificant for gIL.
- IN : strong significant positive impact from shock itself to gIN, especially from concurrent period and the magnitude start to die down as lag increase

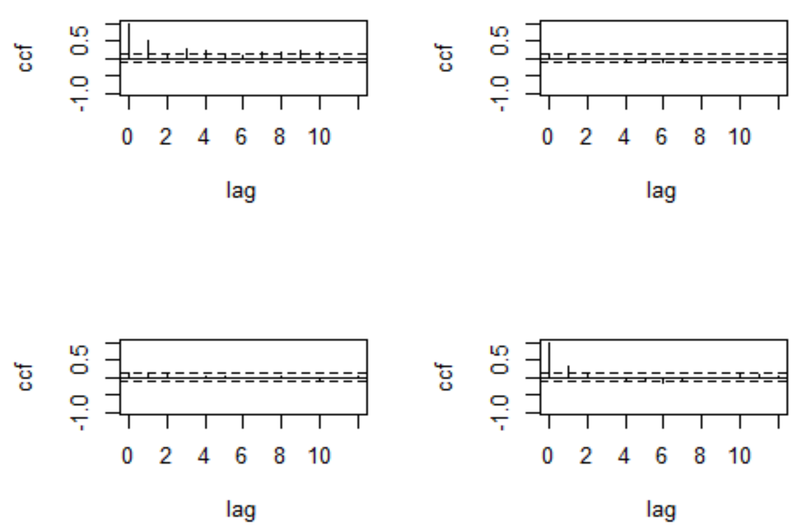
```
library(MTS)

m.m1cnwti <- read.table("C:/Users/ASUS/Downloads/m-m1cnwti.txt", quote="\"",
comment.char="")
Question 2.1

zt <- cbind(m.m1cnwti[,1],m.m1cnwti[,2])
colnames(zt) <- c("M1","oil")
MTSplot(zt)
```



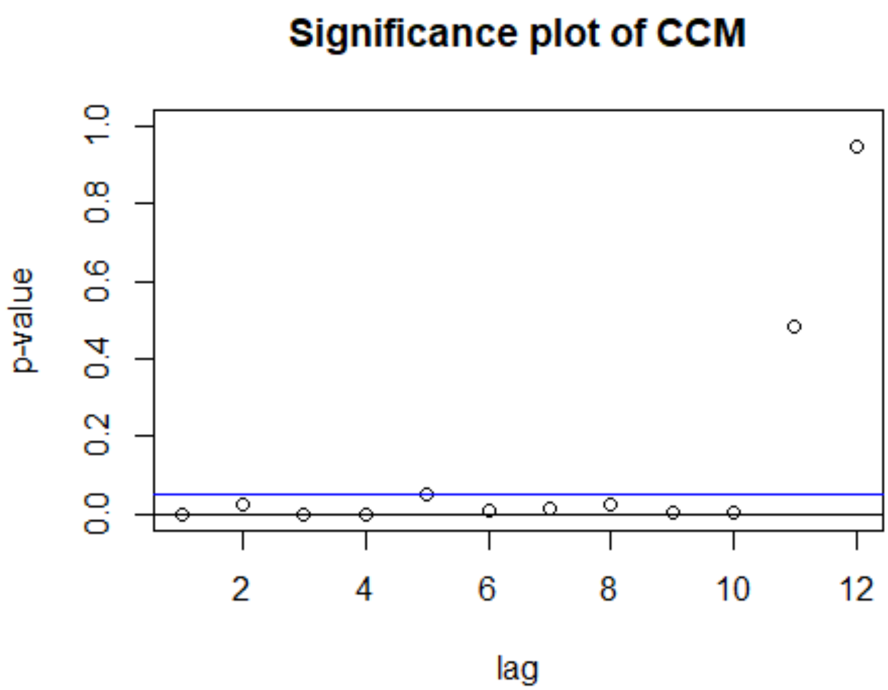



```
ccm(zt)

## [1] "Covariance matrix:"
##         M1     oil
## M1  1.4767 0.01254
## oil 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
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

m1 <-VAR(zt, p=3)
```

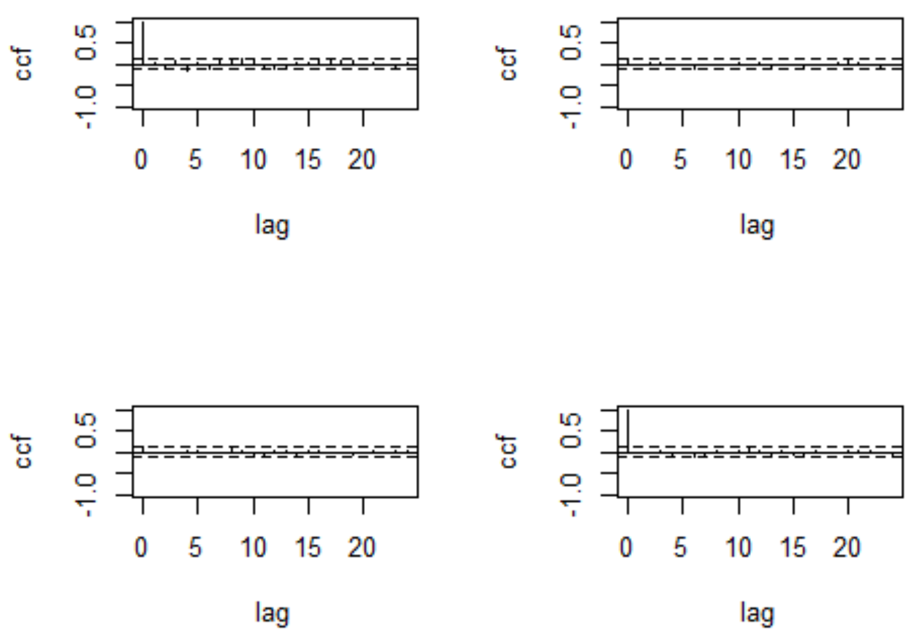
```
## Constant term:
## Estimates:  0.4973633 -0.002715112
## Std.Error:  0.1030757 0.008624222
## AR coefficient matrix
## AR( 1 )-matrix
##         [,1]  [,2]
## [1,] 0.66841 0.701
## [2,] 0.00347 0.297
## standard error
##         [,1]   [,2]
## [1,] 0.05465 0.7026
## [2,] 0.00457 0.0588
## AR( 2 )-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(m1)
```

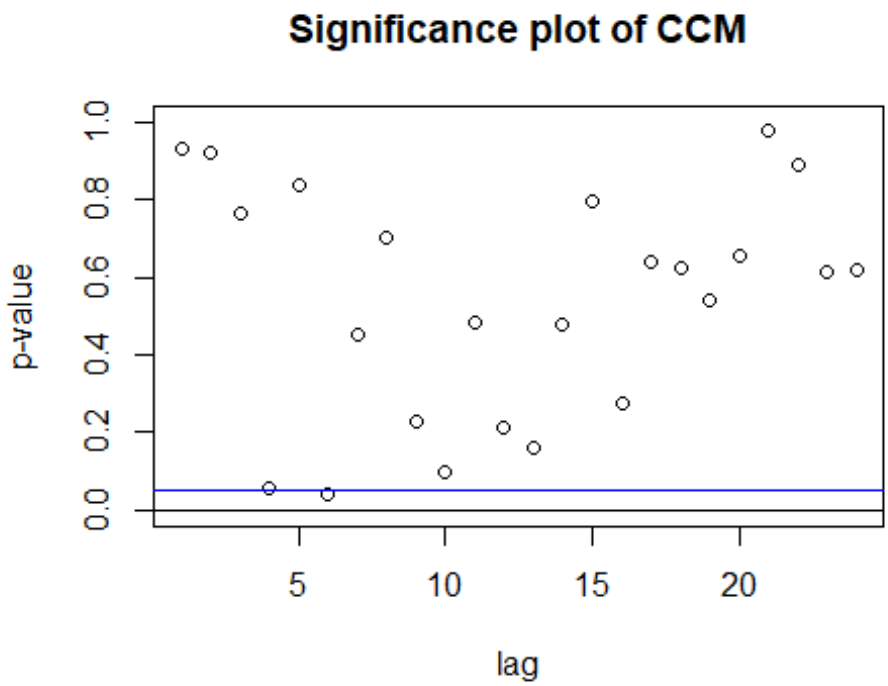
```
## [1] "Covariance matrix:"
##          M1     oil
## M1  0.90913 0.00794
## oil 0.00794 0.00636
## CCM at lag:  0
##       [,1]  [,2]
## [1,] 1.000 0.104
## [2,] 0.104 1.000
## Simplified matrix:
```

```
## 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
## . .
## . .
```

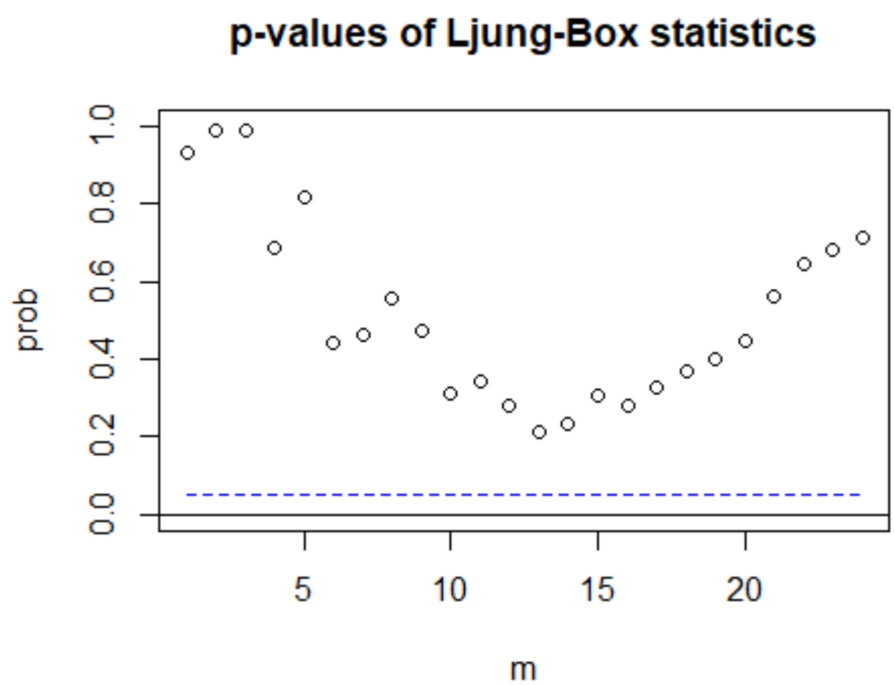



```
## Hit Enter for p-value plot of individual ccm:
```

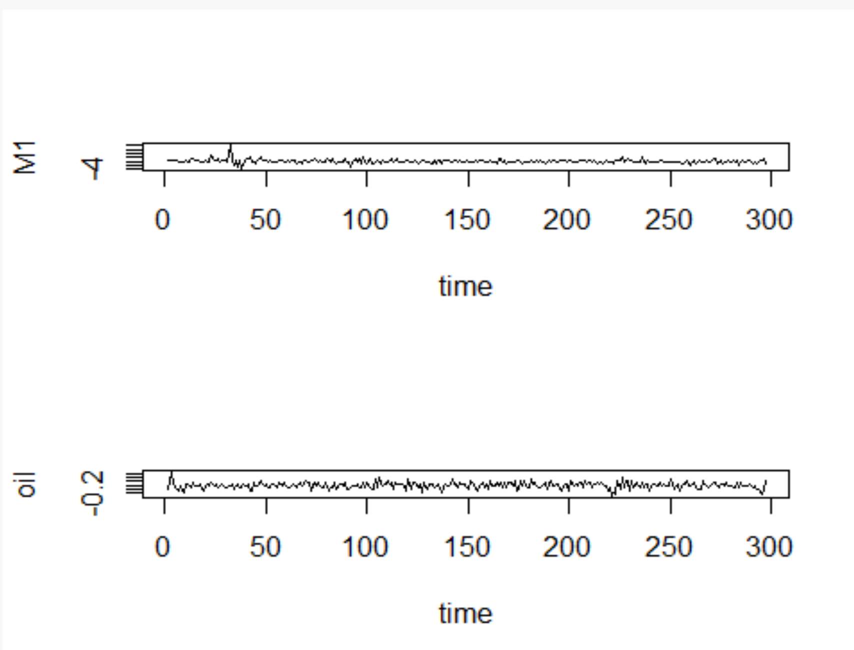



```
## Hit Enter to compute MQ-statistics:
##
## Ljung-Box Statistics:
##           m       Q(m)     df    p-value
##  [1,]  1.000      0.838   4.000     0.93
##  [2,]  2.000      1.780   8.000     0.99
##  [3,]  3.000      3.646  12.000     0.99
##  [4,]  4.000     12.783  16.000     0.69
##  [5,]  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:
```




```
m2=refVAR(m1)
```

```
## 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
## 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
```

<u>Ans</u> refinement with $t=2$; Ljung-Box : not rejecting H_0: No correlation among $\hat{e}_t$ of e_t for all lags → model adequate with 95% CI

M_1 = growth rate of M1 supply

oil = growth rate of oil price

$$\hat{M_1}_t = 0.489 + 0.675\, M_{t-1} - 0.406\, M_{t-2} - 0.932\, oil_{t-2}$$

$$\hat{oil}_t = 0.303\, oil_{t-1} + 0.0096\, M_{t-2}$$

```
Question 3
detach("package:MTS", unload = TRUE)
require(vars)

varfit=VAR(zt, p=3)
summary(varfit)

##
## VAR Estimation Results:
## =========================
## Endogenous variables: M1, oil
## 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 M1:
## ===================================
## M1 = M1.l1 + oil.l1 + M1.l2 + oil.l2 + M1.l3 + oil.l3 + const
##
##        Estimate Std. Error t value Pr(>|t|)
## M1.l1   0.66841    0.05465  12.230  < 2e-16 ***
## oil.l1  0.70145    0.70262   0.998    0.319
## M1.l2  -0.40451    0.06295  -6.426 5.37e-10 ***
## oil.l2 -1.01842    0.73654  -1.383    0.168
## M1.l3   0.37999    0.05474   6.942 2.53e-11 ***
## oil.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 oil:
## ====================================
## oil = M1.l1 + oil.l1 + M1.l2 + oil.l2 + M1.l3 + oil.l3 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## M1.l1   0.003467   0.004573   0.758    0.449
## oil.l1  0.296716   0.058787   5.047 7.93e-07 ***
## M1.l2   0.007504   0.005267   1.425    0.155
## oil.l2  0.029814   0.061626   0.484    0.629
```

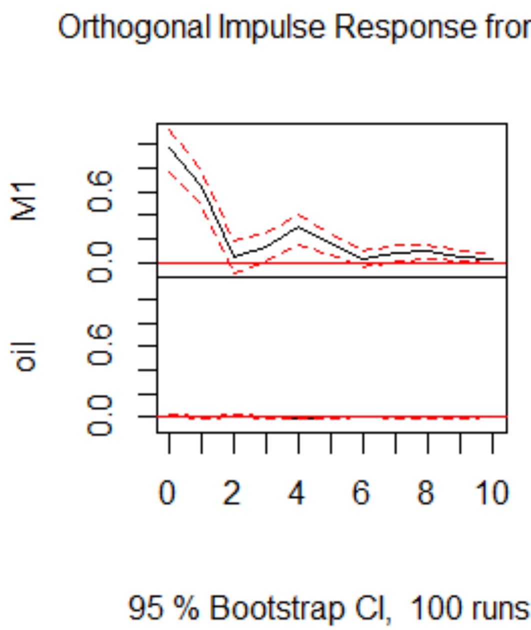
```
## M1.l3  -0.007121   0.004580  -1.555    0.121
## oil.l3 -0.057191   0.059854  -0.956    0.340
## const  -0.002715   0.008624  -0.315    0.753
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.0806 on 290 degrees of freedom
## Multiple R-Squared: 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:
##           M1      oil
## M1  0.927944 0.008104
## oil 0.008104 0.006496
##
## Correlation matrix of residuals:
##         M1    oil
## M1  1.0000 0.1044
## oil 0.1044 1.0000
```

```
impresp=irf(varfit)
plot(impresp)
```

6104640542 Jak A.

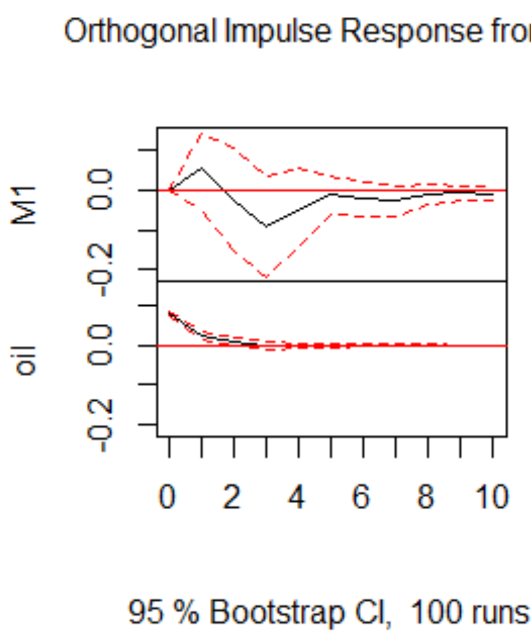
Ans

$$\begin{bmatrix} 1 & 0 \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} M_1 \\ oil \end{bmatrix}$$



from M1 growth

- M1 : strong significant positive impact from shock of M_1 to M_1 itself for concurrent period and first lag (t-1). After that, the impact starts to die down with lag in some period being insignificantly different from zero in second and sixth lag
- oil : No significant impact from M1 shock to oil for all periods



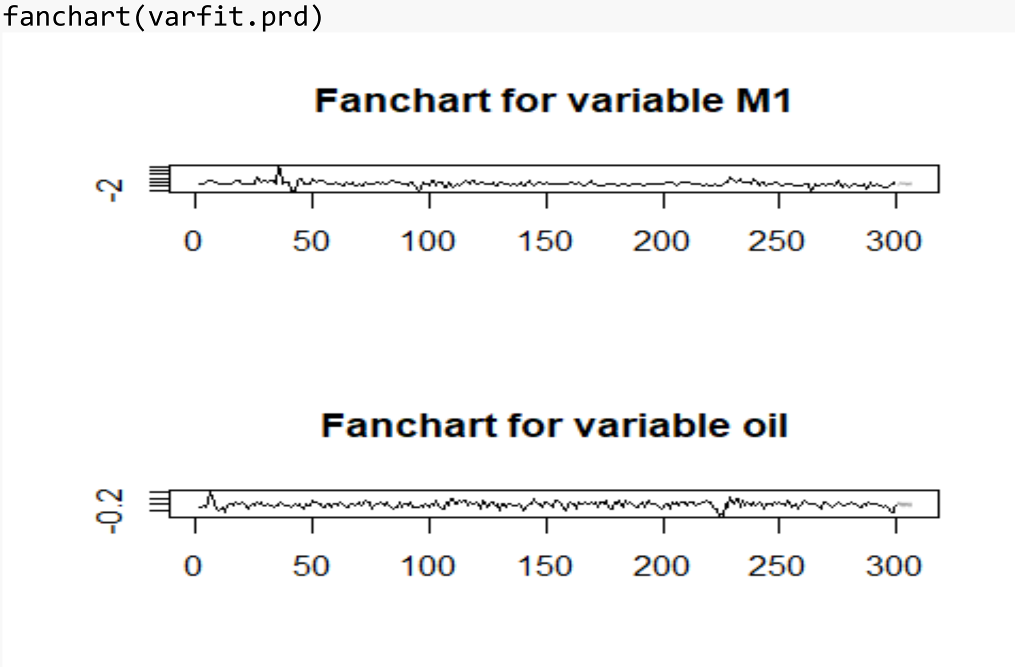
from oil

- oil : strong significant positive impact from shock itself to oil, especially from concurrent period and the magnitude start to die down as lag increase since (t-2) second lag
- M1 : no concurrent effect from shock of oil to M1 from choleski decomposition. For lag period, the shock of oil has insignificant impact on M1

```
Question 4

VARpred(m2,6)

## orig  300
## Forecasts at origin:  300
##           M1        oil
## [1,] 0.6274  0.0343342
## [2,] 1.4320 -0.0009906
## [3,] 1.4213  0.0004798
## [4,] 1.1070  0.0089677
## [5,] 1.2044  0.0050435
## [6,] 1.3856  0.0009089
## Standard Errors of predictions:
##         [,1]    [,2]
## [1,] 0.9541 0.07987
## [2,] 1.1509 0.08345
## [3,] 1.1539 0.08436
## [4,] 1.1631 0.08441
## [5,] 1.2028 0.08451
## [6,] 1.2146 0.08452
## Root mean square errors of predictions:
##         [,1]    [,2]
## [1,] 0.9651 0.08080
## [2,] 3.9947 0.16623
## [3,] 1.2569 0.11182
## [4,] 1.4501 0.08598
## [5,] 2.1821 0.08818
## [6,] 1.5763 0.08455
```

Or

```
varfit.prd <- predict(varfit, n.ahead=6, ci=0.95)
fanchart(varfit.prd)
```



Question #5

```
fevd(varfit, n.ahead=6)

## $M1
##                M1          oil
## [1,] 1.0000000 0.000000000
## [2,] 0.9976640 0.002336045
## [3,] 0.9971155 0.002884469
## [4,] 0.9908030 0.009196979
## [5,] 0.9896296 0.010370432
## [6,] 0.9897108 0.010289214
##
## $oil
##                 M1       oil
## [1,] 0.01089392 0.9891061
## [2,] 0.01477258 0.9852274
## [3,] 0.03227375 0.9677262
## [4,] 0.03247842 0.9675216
## [5,] 0.03407249 0.9659275
## [6,] 0.03405620 0.9659438

detach("package:vars", unload = TRUE)
```

source of deviation from Actual future value of predicted future M_1
for 1-step ahead : all deviation come only from shock of M_1 itself
for 2-step ahead : deviation come from M_1 shock ~ 99.7 %
and oil shock ~ 1.3 %

For further predict, the source of deviation come from oil shock increasingly
and from M1 shock decreasingly

source of deviation from Actual future value of predicted future oil
for 1-step ahead : deviation come from shock of oil itself ~ 98.9 %
and M_1 shock ~ 1 %
for 2-step ahead : deviation come from M_1 shock ~ 98.5 %
and oil shock ~ 1.4 %

For further predict, the source of deviation come from oil shock increasingly
and from M1 shock decreasingly