阅读作业

阅读《金融时间序列分析》第 8 章的附录 A 和附录 B

书面作业

《金融时间序列分析》第 8 章课后作业

P391-391:8.1；8.2；8.3

8.1 考虑 Merck & Company, Johnson & Johnson, General Electric, General Motors, Ford Motor Company 以及价值加权指数从 1960 年 1 月至 2008 年 12 月以百分比表示的月对数股票收益率，包括了红利支付。见文件 m-mrk2vw.txt。它共有 6 列且次序同前面罗列的次序一致。

（a）计算数据的样本均值、样本协方差矩阵以及样本相关矩阵。

由于老师给的文件找不到数据集，所以我从书上写的

http://faculty.chicagobooth.edu/ruey.tsay/teaching/fts/m-mrk2vw.dat 下载了数据

Code:

```
da <- read.table("E:/DATA/data mining/fts03/data/m-mrk2vw.txt", header=F, quote="\"")
head(da)
dim(da)
MRK=da$V1
JNJ=da$V2
GE=da$V3
GM=da$V4
F=da$V5
VW=da$V6
data=cbind(MRK,JNJ,GE,GM,F,VW)
apply(data,2,mean);#样本均值
cov(data)#样本协方差
cor(data)#样本相关
```

运行结果：

```
> da <- read.table("E:/DATA/data mining/fts03/data/m-mrk2vw.txt", header=F, quote="\"")
> head(da)
      V1     V2      V3      V4      V5     V6
1  -7.745 -4.869 -14.786 -12.961 -13.392 -6.964
2   7.590  3.202   4.572  -2.914  -1.299  1.239
3   0.651 -5.641   0.973  -3.315 -11.037 -1.220
4   5.439 -0.447  -1.401  -0.564  -5.536 -1.558
5  11.648 17.256   0.842  -0.567   0.718  3.274
6 -11.472 -0.189   3.706   1.142   0.000  2.286
> dim(da)
[1] 480   6
> MRK=da$V1
> JNJ=da$V2
> GE=da$V3
> GM=da$V4
> F=da$V5
> VW=da$V6
> data=cbind(MRK,JNJ,GE,GM,F,VW)
```

```
> apply(data,2,mean);#样本均值
      MRK       JNJ        GE        GM         F        VW
1.2756583 1.3448375 1.0738687 0.7231104 1.0294687 0.9406417
> cov(data)#样本协方差
         MRK       JNJ       GE        GM        F       VW
MRK 43.63852 25.241730 20.07163 11.313983 12.28988 15.49844
JNJ 25.24173 42.107141 18.47133  9.718801 11.65204 16.23558
GE  20.07163 18.471330 39.60404 20.553714 22.40821 20.20492
GM  11.31398  9.718801 20.55371 43.675362 34.69194 16.81969
F   12.28988 11.652038 22.40821 34.691944 55.29522 18.36573
VW  15.49844 16.235581 20.20492 16.819685 18.36573 19.04396
> cor(data)#样本相关
          MRK       JNJ        GE        GM         F        VW
MRK 1.0000000 0.5888521 0.4828117 0.2591566 0.2501894 0.5376187
JNJ 0.5888521 1.0000000 0.4523250 0.2266296 0.2414795 0.5733387
GE  0.4828117 0.4523250 1.0000000 0.4941995 0.4788436 0.7357135
GM  0.2591566 0.2266296 0.4941995 1.0000000 0.7059381 0.5832046
F   0.2501894 0.2414795 0.4788436 0.7059381 1.0000000 0.5659601
VW  0.5376187 0.5733387 0.7357135 0.5832046 0.5659601 1.0000000
```

（b）检验零假设 H_0：$\rho_1=\cdots=\rho_6=0$，其中ρ_i为数据的延迟 i 的交叉相关矩阵。基于 5%显

著水平推出结论。

Code:

```
library(MTS)
ccm(data,lags=5,level=T)
```

运行结果：

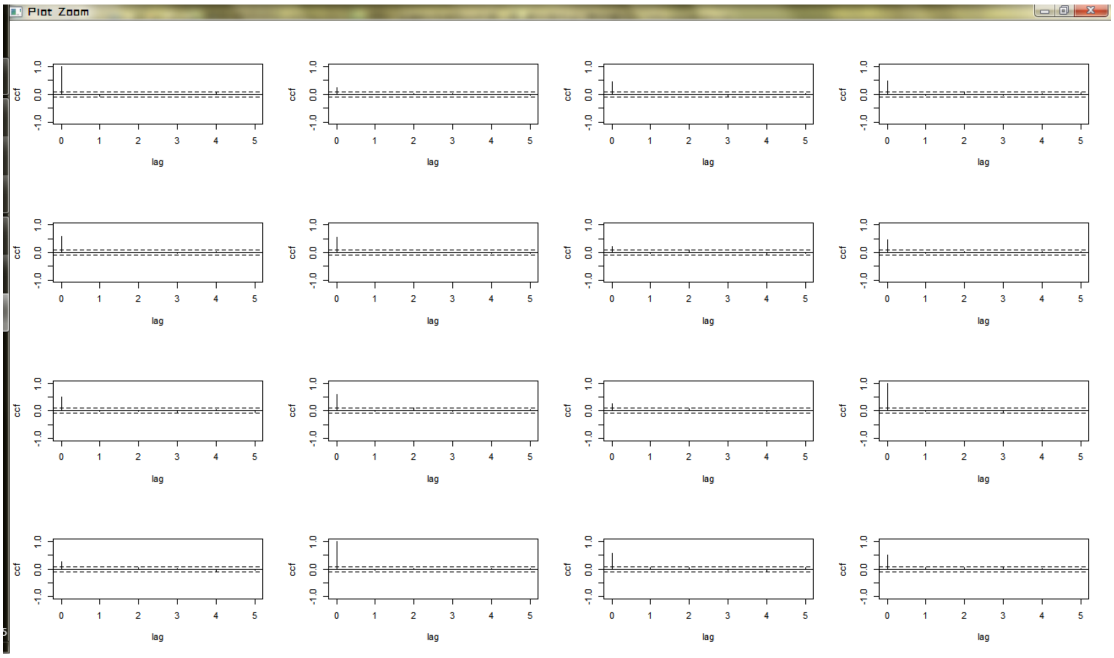
```
> library(MTS)
Warning message:
程辑包‘MTS’是用R版本3.1.3 来建造的
> ccm(data,lags=5,level=T)
[1] "Covariance matrix:"
     MRK   JNJ   GE    GM    F    VW
MRK 43.6 25.24 20.1 11.31 12.3 15.5
JNJ 25.2 42.11 18.5  9.72 11.7 16.2
GE  20.1 18.47 39.6 20.55 22.4 20.2
GM  11.3  9.72 20.6 43.68 34.7 16.8
F   12.3 11.65 22.4 34.69 55.3 18.4
VW  15.5 16.24 20.2 16.82 18.4 19.0
CCM at lag:  0
      [,1]  [,2]  [,3]  [,4]  [,5]  [,6]
[1,] 1.000 0.589 0.483 0.259 0.250 0.538
[2,] 0.589 1.000 0.452 0.227 0.241 0.573
[3,] 0.483 0.452 1.000 0.494 0.479 0.736
[4,] 0.259 0.227 0.494 1.000 0.706 0.583
[5,] 0.250 0.241 0.479 0.706 1.000 0.566
[6,] 0.538 0.573 0.736 0.583 0.566 1.000
```

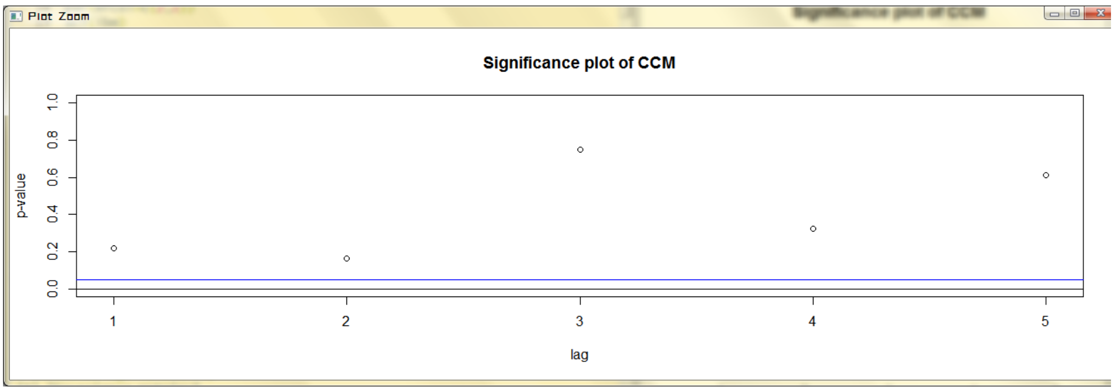
```
Simplified matrix:
CCM at lag:  1
. . . . . .
. . . . . .
. . . . . .
. . . . + .
. . . . . .
. . . . . .
Correlations:
         [,1]      [,2]    [,3]     [,4]     [,5]    [,6]
[1,] -0.07765 -0.012542 -0.0425 -0.05133 -0.04415 -0.0158
[2,] -0.00856 -0.034286 -0.0324 -0.06761 -0.06442 -0.0485
[3,] -0.00876  0.000257 -0.0220 -0.00154  0.00376  0.0271
[4,] -0.02206 -0.029188  0.0532  0.04436  0.12743  0.0871
[5,] -0.01203  0.008394  0.0120  0.04770  0.07376  0.0639
[6,]  0.01611  0.031779  0.0312  0.02853  0.05817  0.0650
CCM at lag:  2
. + . . . .
. . . . . .
. . . . . .
. + . . . .
. . . . . .
. . . . . .
```

```
Correlations:
         [,1]    [,2]     [,3]      [,4]     [,5]    [,6]
[1,]  0.00168 0.09237  0.076335  0.054139  0.05854  0.0600
[2,]  0.01069 0.01130  0.031990  0.047712  0.04034  0.0198
[3,] -0.03193 0.00245  0.000566  0.018962  0.00848 -0.0479
[4,]  0.05374 0.09544  0.049748 -0.032351  0.01751  0.0128
[5,]  0.02155 0.05776  0.090515  0.025923  0.06254  0.0335
[6,] -0.01129 0.03454 -0.013394  0.000278 -0.03053 -0.0428
CCM at lag:  3
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
Correlations:
        [,1]    [,2]      [,3]     [,4]    [,5]     [,6]
[1,] -0.0113 -0.0301 -3.40e-02 -0.04919 -0.0166 -0.03324
[2,] -0.0309 -0.0174 -3.39e-03 -0.02374 -0.0304  0.01483
[3,] -0.0533 -0.0793 -3.80e-02 -0.06186 -0.0281 -0.04252
[4,]  0.0177  0.0097  3.61e-02  0.01405 -0.0146  0.00120
[5,]  0.0192  0.0104 -2.56e-03 -0.00764  0.0302 -0.00630
[6,]  0.0163 -0.0337  4.47e-06 -0.04352 -0.0461 -0.00992
CCM at lag:  4
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
```

```
Correlations:
          [,1]     [,2]   [,3]     [,4]    [,5]    [,6]
[1,]  0.06720  0.00271 0.0107  0.01239 -0.0087  0.0447
[2,]  0.02148  0.00546 0.0454  0.00399 -0.0115  0.0271
[3,]  0.03056 -0.00630 0.0473 -0.01993 -0.0255  0.0478
[4,] -0.07331 -0.08217 0.0169 -0.09106 -0.0460 -0.0503
[5,] -0.00957 -0.01172 0.0232 -0.07511 -0.0346 -0.0164
[6,] -0.02791 -0.08674 0.0187 -0.02254 -0.0300 -0.0236
CCM at lag:  5
. . . . . .
. . . . . .
. . . + . .
. . . . . .
. . . . . .
. . . . . .
Correlations:
          [,1]     [,2]    [,3]    [,4]     [,5]    [,6]
[1,]  0.00356  0.04672 0.05200 0.02821  0.03688 0.04388
[2,]  0.00462  0.02492 0.04328 0.05889  0.00751 0.02970
[3,] -0.06311  0.02153 0.01855 0.09348  0.05426 0.06413
[4,] -0.05969 -0.03129 0.00351 0.00243 -0.07870 0.00226
[5,] -0.03524 -0.00552 0.01477 0.00346 -0.04306 0.01695
[6,] -0.02722  0.03375 0.03283 0.08565  0.02849 0.06436
```

其中“• ”表示不显著，“+”表示显著正相关，“-”表示显著负相关





相关性不显著

拒绝 5%显著水平下的原假设

（c）这 6 个收益率序列间有引导-延迟关系吗？

根据（b）的结果是有“+”的，所以是有延迟关系的。

8.2 圣·路易斯联邦储备银行在它网页上出版所选择的利率及美国的金融数据，网址是：

http://research.stlouisfed.org/fred2/.

考虑固定期限为 1 年和 10 年的国库券的月利率，时间从 1953 年 4 月至 2009 年 10 月共 679 个观测值；见文件 m-gsln10.txt.利率是用百分比表示的。

数据来源同 8.1，http://faculty.chicagobooth.edu/ruey.tsay/teaching/fts/m-gs1n10.dat

（a）令 $c_t=r_t-r_{t-1}$ 为月利率 r_t 的变化量序列。对两个变化量序列构造一个二元自回归模型。讨论模型所蕴含的意义，并将模型转换为结构形式。

Code:

```r
library(MTS)
da <- read.table("E:/DATA/data mining/fts03/data/m-gs1n10.txt", header=F, quote="\"")
head(da)
dim(da)
dgs1=diff(da$V1)
dgs10=diff(da$V2)
data=data.frame(cbind(dgs1,dgs10))
head(data)
ord.choice=VARorder(data,maxp=10)
var6.fit=VAR(data,p=6)
MTSdiag(var6.fit)

var6.pred=VARpred(var6.fit,h=6)
```

运行结果：

```
> library(MTS)
> da <- read.table("E:/DATA/data mining/fts03/data/m-gs1n10.txt", header=F, quote="\"")
> head(da)
    V1   V2
1 2.36 2.83
2 2.48 3.05
3 2.45 3.11
4 2.38 2.93
5 2.28 2.95
6 2.20 2.87
> dim(da)
[1] 571   2
> dgs1=diff(da$V1)
> dgs10=diff(da$V2)
> data=data.frame(cbind(dgs1,dgs10))
> head(data)
   dgs1 dgs10
1  0.12  0.22
2 -0.03  0.06
3 -0.07 -0.18
4 -0.10  0.02
5 -0.08 -0.08
6 -0.41 -0.21
```

```
> ord.choice=VARorder(data,maxp=10)
selected order: aic =  6
selected order: bic =  2
selected order: hq =  6
Summary table:
       p     AIC     BIC      HQ     M(p)
 [1,]  0 -5.1562 -5.1562 -5.1562   0.0000
 [2,]  1 -5.3515 -5.3210 -5.3396 116.4942
 [3,]  2 -5.4298 -5.3688 -5.4060  51.2057
 [4,]  3 -5.4424 -5.3509 -5.4067  14.6951
 [5,]  4 -5.4515 -5.3296 -5.4039  12.7813
 [6,]  5 -5.4510 -5.2985 -5.3915   7.4017
 [7,]  6 -5.5223 -5.3393 -5.4509  46.6277
 [8,]  7 -5.5178 -5.3043 -5.4345   5.1874
 [9,]  8 -5.5157 -5.2717 -5.4205   6.4733
[10,]  9 -5.5128 -5.2383 -5.4057   6.0377
[11,] 10 -5.5136 -5.2087 -5.3946   7.9996
      p-value
 [1,]  0.0000
 [2,]  0.0000
 [3,]  0.0000
 [4,]  0.0054
 [5,]  0.0124
 [6,]  0.1161
 [7,]  0.0000
 [8,]  0.2686
 [9,]  0.1665
[10,]  0.1963
[11,]  0.0916
```

```
> var6.fit=VAR(data,p=6)
Constant term:
Estimates:  0.006004299 0.00413986
Std.Error:  0.01682637 0.01067487
AR coefficient matrix
AR( 1 )-matrix
        [,1]  [,2]
[1,]  0.2601 0.446
[2,] -0.0348 0.491
standard error
       [,1]   [,2]
[1,] 0.0688 0.1098
[2,] 0.0437 0.0697
AR( 2 )-matrix
        [,1]   [,2]
[1,] -0.1441 -0.275
[2,]  0.0438 -0.318
standard error
       [,1]   [,2]
[1,] 0.0718 0.1147
[2,] 0.0456 0.0727
AR( 3 )-matrix
        [,1]  [,2]
[1,] -0.0706 0.227
[2,] -0.1308 0.257
standard error
       [,1]   [,2]
[1,] 0.0728 0.1172
[2,] 0.0462 0.0743
```

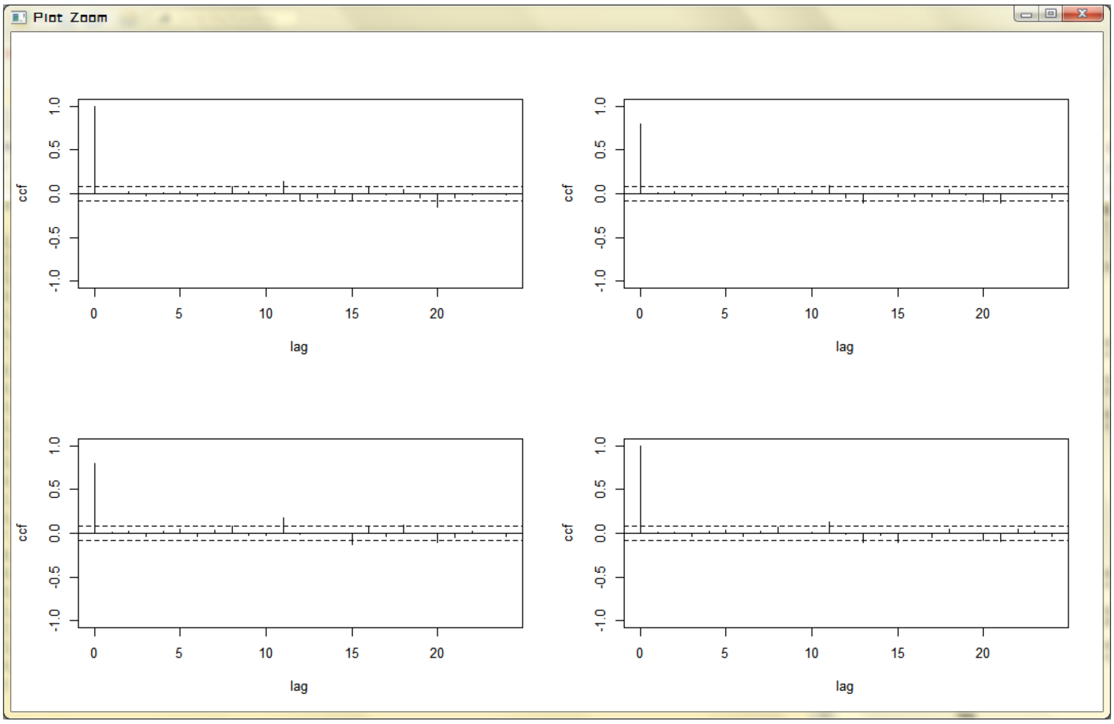
```
AR( 4 )-matrix
         [,1]    [,2]
[1,] -0.12648 -0.0151
[2,]  0.00127 -0.0508
standard error
       [,1]   [,2]
[1,] 0.0735 0.1175
[2,] 0.0466 0.0745
AR( 5 )-matrix
      [,1]    [,2]
[1,] 0.188  0.0217
[2,] 0.136 -0.0433
standard error
       [,1]   [,2]
[1,] 0.0725 0.1159
[2,] 0.0460 0.0736
AR( 6 )-matrix
       [,1]  [,2]
[1,] -0.335 0.127
[2,] -0.204 0.131
standard error
       [,1]   [,2]
[1,] 0.0684 0.1118
[2,] 0.0434 0.0709

Residuals cov-mtx:
           [,1]       [,2]
[1,] 0.15574638 0.07828542
[2,] 0.07828542 0.06268480
```

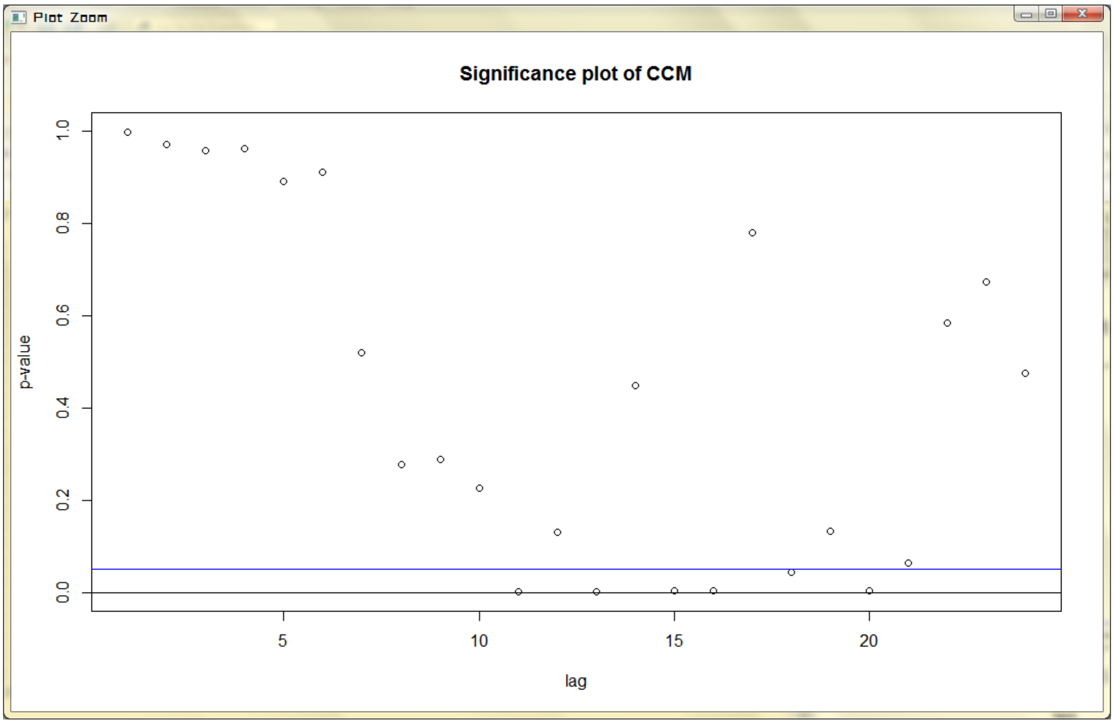
```
det(SSE) =  0.003634323
AIC =  -5.533122
BIC =  -5.350148
HQ  =  -5.461731
> MTSdiag(var6.fit)
[1] "Covariance matrix:"
        dgs1  dgs10
dgs1  0.1560 0.0784
dgs10 0.0784 0.0628
CCM at lag:  0
      [,1]  [,2]
[1,] 1.000 0.792
[2,] 0.792 1.000
Simplified matrix:
CCM at lag:  1
. .
. .
CCM at lag:  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
- .
- -
```

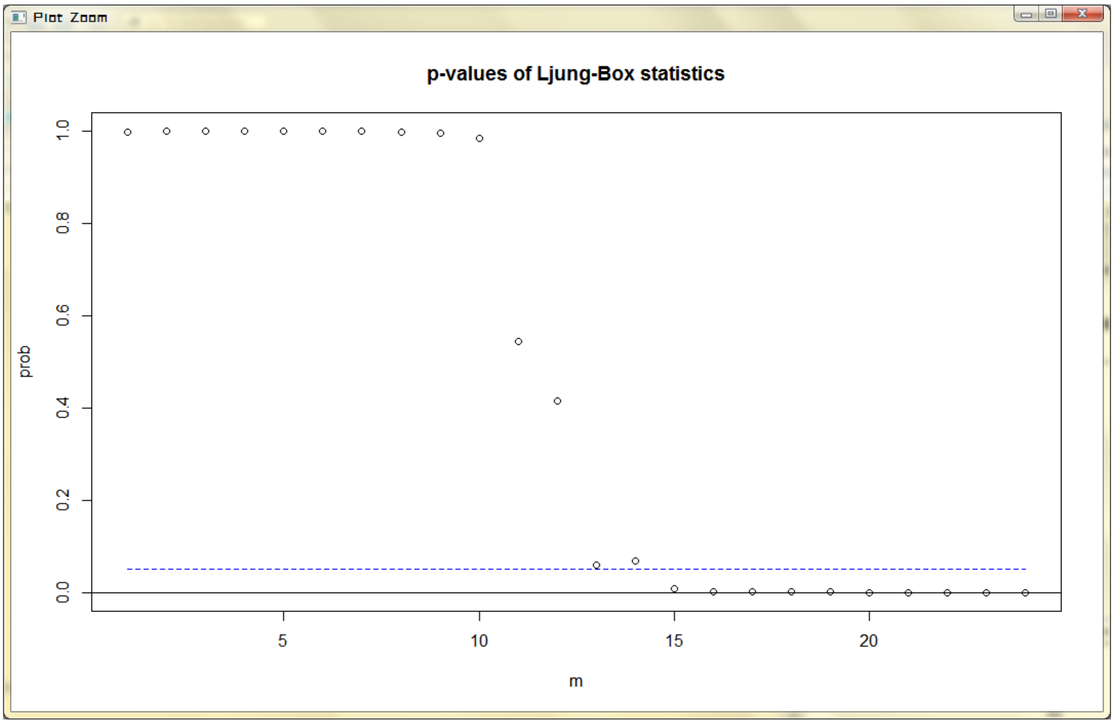
```
CCM at lag:  16
. .
. .
CCM at lag:  17
. .
. .
CCM at lag:  18
. .
+ .
CCM at lag:  19
. .
. .
CCM at lag:  20
- -
- -
CCM at lag:  21
. -
. -
CCM at lag:  22
. .
. .
CCM at lag:  23
. .
. .
CCM at lag:  24
. .
. .
Hit Enter for p-value plot of individual ccm:
```

```
Hit Enter to compute MQ-statistics:
var6.pred=VARpred(var6.fit,h=6)
Ljung-Box Statistics:
          m       Q(m)      df    p-value
 [1,]   1.000     0.107   4.000      1.00
 [2,]   2.000     0.631   8.000      1.00
 [3,]   3.000     1.273  12.000      1.00
 [4,]   4.000     1.870  16.000      1.00
 [5,]   5.000     2.990  20.000      1.00
 [6,]   6.000     3.986  24.000      1.00
 [7,]   7.000     7.225  28.000      1.00
 [8,]   8.000    12.336  32.000      1.00
 [9,]   9.000    17.338  36.000      1.00
[10,]  10.000    23.027  40.000      0.99
[11,]  11.000    42.334  44.000      0.54
[12,]  12.000    49.450  48.000      0.42
[13,]  13.000    68.858  52.000      0.06
[14,]  14.000    72.570  56.000      0.07
[15,]  15.000    88.901  60.000      0.01
[16,]  16.000   104.262  64.000      0.00
[17,]  17.000   106.031  68.000      0.00
[18,]  18.000   115.916  72.000      0.00
[19,]  19.000   122.996  76.000      0.00
[20,]  20.000   138.850  80.000      0.00
[21,]  21.000   147.752  84.000      0.00
[22,]  22.000   150.601  88.000      0.00
[23,]  23.000   152.957  92.000      0.00
[24,]  24.000   156.491  96.000      0.00
Hit Enter to obtain residual plots:
```

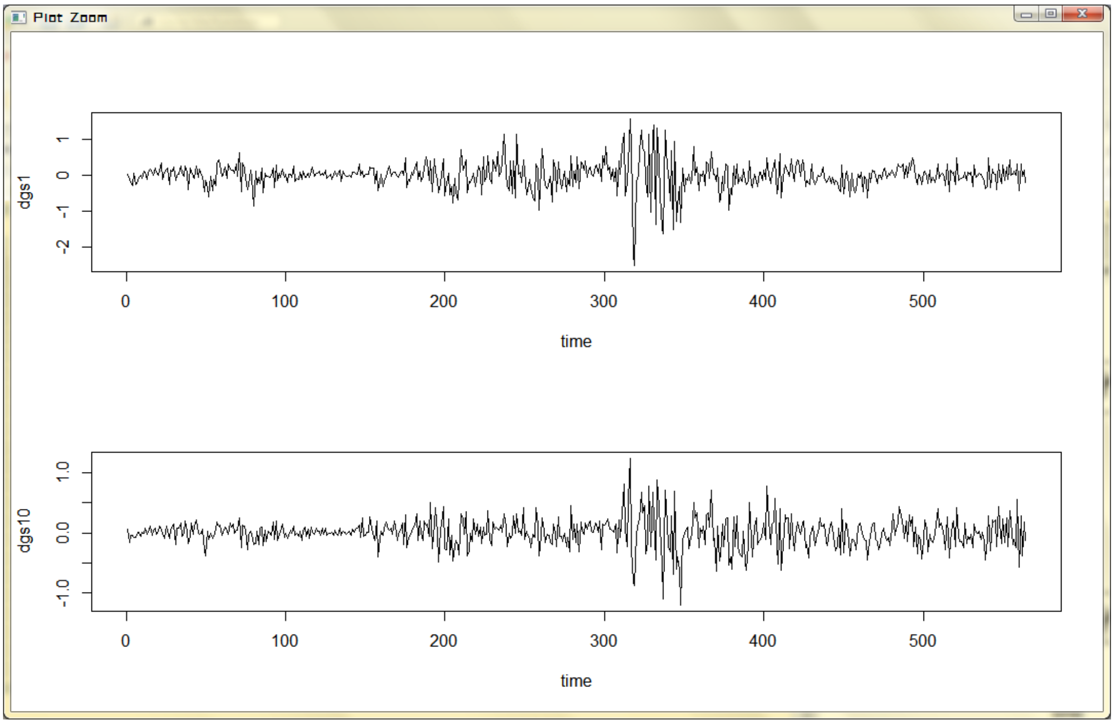




Plot Zoom
Significance plot of CCM
p-value
1.0
0.8
0.6
0.4
0.2
0.0
5
10
15
20
lag



Plot Zoom
p-values of Ljung-Box statistics
prob
1.0
0.8
0.6
0.4
0.2
0.0
5
10
15
20
m



（b）对两个变化量序列建立一个二元滑动平均模型。讨论这个模型所蕴含的意义，并与前面的二元 AR 模型的结果比较。

Code:

```
######构建VMA模型######
vma6.fit=VMAs(data,malags=c(1,2,3,4,5,6))

```

运行结果：

```
> ######构建VMA模型######
> vma6.fit=VMAs(data,malags=c(1,2,3,4,5,6))
Initial estimates:  0.0082 0.0057 -0.3275 -0.3914 0.0466 -0.068 0.0837 0.1224 0.1775 -0.02
22 -0.1247 0.0146 0.0845 -0.085 -0.0119 -0.4539 -0.0226 0.0882 0.1046 -0.0211 0.0803 -0.07
54 -0.1614 0.0782 0.049 -0.0563
Par. lower-bounds:  -0.027 -0.0164 -0.4776 -0.6291 -0.1035 -0.3058 -0.0669 -0.1167 0.027 -
0.2613 -0.2754 -0.2254 -0.0665 -0.3267 -0.1062 -0.6032 -0.1169 -0.0612 0.0099 -0.1713 -0.0
143 -0.2256 -0.2561 -0.0725 -0.0459 -0.2082
Par. upper-bounds:  0.0435 0.0279 -0.1775 -0.1537 0.1967 0.1698 0.2343 0.3615 0.3281 0.217
0.0259 0.2546 0.2355 0.1568 0.0824 -0.3045 0.0717 0.2376 0.1992 0.1291 0.1748 0.0749 -0.06
67 0.229 0.1438 0.0956
Final    Estimates:  0.006781772 0.00531601 -0.2800748 -0.4399404 0.001414681 -0.03313935
0.1676741 0.07436943 0.2418681 -0.02637421 -0.2020514 0.0655895 0.1054269 -0.2265761 0.011
13978 -0.4868893 -0.05654501 0.09896809 0.1304723 -0.03044819 0.095806 -0.02988462 -0.1833
715 0.08487844 0.0420553 -0.1146305
```

通过比较 AIC,BIC 值，两个模型效果差不多。二元滑动模型稍微好点。

```
Coefficient(s):
       Estimate  Std. Error  t value Pr(>|t|)
dgs1   0.006782    0.021255    0.319 0.749671
dgs10  0.005316    0.014943    0.356 0.722028
      -0.280075    0.073711   -3.800 0.000145 ***
      -0.439940    0.110306   -3.988 6.65e-05 ***
       0.001415    0.077417    0.018 0.985421
      -0.033139    0.123192   -0.269 0.787925
       0.167674    0.078517    2.136 0.032720 *
       0.074369    0.120871    0.615 0.538372
       0.241868    0.074285    3.256 0.001130 **
      -0.026374    0.118649   -0.222 0.824091
      -0.202051    0.076545   -2.640 0.008299 **
       0.065589    0.121716    0.539 0.589973
       0.105427    0.076807    1.373 0.169872
      -0.226576    0.114205   -1.984 0.047262 *
       0.011140    0.044958    0.248 0.804303
      -0.486889    0.069218   -7.034 2.01e-12 ***
      -0.056545    0.048518   -1.165 0.243839
       0.098968    0.076724    1.290 0.197077
       0.130472    0.047952    2.721 0.006510 **
      -0.030448    0.075941   -0.401 0.688459
       0.095806    0.047540    2.015 0.043878 *
      -0.029885    0.074334   -0.402 0.687662
      -0.183371    0.047225   -3.883 0.000103 ***
       0.084878    0.073154    1.160 0.245941
       0.042055    0.049082    0.857 0.391533
      -0.114631    0.072910   -1.572 0.115898
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
---
```

```
Estimates in matrix form:
Constant term:
Estimates:  0.006781772 0.00531601
MA coefficient matrix
MA( 1 )-matrix
        [,1]   [,2]
[1,] -0.2801 -0.440
[2,]  0.0111 -0.487
MA( 2 )-matrix
         [,1]    [,2]
[1,]  0.00141 -0.0331
[2,] -0.05655  0.0990
MA( 3 )-matrix
      [,1]    [,2]
[1,] 0.168  0.0744
[2,] 0.130 -0.0304
MA( 4 )-matrix
       [,1]    [,2]
[1,] 0.2419 -0.0264
[2,] 0.0958 -0.0299
MA( 5 )-matrix
       [,1]   [,2]
[1,] -0.202 0.0656
[2,] -0.183 0.0849
MA( 6 )-matrix
       [,1]   [,2]
[1,] 0.1054 -0.227
[2,] 0.0421 -0.115

Residuals cov-matrix:
           [,1]       [,2]
[1,] 0.15773834 0.07875143
[2,] 0.07875143 0.06252270
```

```
---
aic =  -5.518944
bic =  -5.320722
```

通过比较 AIC,BIC 值，两个模型效果差不多。二元滑动模型稍微好点。

8.3 再次考虑固定期限为 1 年和 10 年的国库券的月利率，时间从 1953 年 4 月至 2009 年 10 月共 571 个观测值。考虑数据的对数序列，并对序列建立一个 VARMA 模型。讨论所得模型

蕴含的意义。

Code:

```
log10=log(da$V2+1)
log1=log(da$V1+1)
y=data.frame(cbind(log1,log10))
ord.choice=VARorder(y,maxp=10)
VARMA(y,p=2,q=1)
```

运行结果：

```
> log10=log(da$V2+1)
> log1=log(da$V1+1)
> y=data.frame(cbind(log1,log10))
> ord.choice=VARorder(y,maxp=10)
selected order: aic =  4
selected order: bic =  4
selected order: hq =  4
Summary table:
       p      AIC      BIC       HQ      M(p) p-value
 [1,]  0  -5.9900  -5.9900  -5.9900    0.0000  0.0000
 [2,]  1 -13.7216 -13.6911 -13.7097 4318.1874  0.0000
 [3,]  2 -13.9635 -13.9026 -13.9397  142.1584  0.0000
 [4,]  3 -13.9973 -13.9059 -13.9617   26.4758  0.0000
 [5,]  4 -14.0313 -13.9095 -13.9837   26.4610  0.0000
 [6,]  5 -14.0184 -13.8661 -13.9590    0.6126  0.9617
 [7,]  6 -14.0076 -13.8249 -13.9363    1.7802  0.7761
 [8,]  7 -14.0134 -13.8003 -13.9303   10.8211  0.0286
 [9,]  8 -14.0022 -13.7586 -13.9071    1.4981  0.8270
[10,]  9 -13.9935 -13.7194 -13.8866    2.8858  0.5771
[11,] 10 -13.9918 -13.6872 -13.8730    6.6245  0.1571
> VARMA(y,p=2,q=1)
Number of parameters:  14
initial estimates:  0.0156 0.0223 1.1641 -0.0219 -0.2044 0.0525 0.0302 0.8251 -0.0257 0.16
0.1057 0.4747 0.0111 0.5325
Par. lower-bounds:  -0.0103 0.007 0.8335 -0.6931 -0.5251 -0.6059 -0.165 0.4289 -0.215 -0.2
287 -0.2487 -0.2312 -0.1981 0.1157
Par. upper-bounds:  0.0416 0.0376 1.4948 0.6492 0.1163 0.7109 0.2254 1.2213 0.1637 0.5487
0.4601 1.1807 0.2203 0.9492
Final   Estimates:  0.006926773 0.0182367 1.009882 0.633082 -0.05771106 -0.5912106 0.14936
43 0.9465354 -0.1435082 0.03918446 0.2445663 -0.2312376 -0.1329401 0.3649957
```

```
Coefficient(s):
       Estimate  Std. Error  t value Pr(>|t|)
log1   0.006927    0.014923    0.464 0.642520
log10  0.018237    0.009371    1.946 0.051650 .
log1   1.009882    0.226222    4.464 8.04e-06 ***
log10  0.633082    0.464404    1.363 0.172815
log1  -0.057711    0.219112   -0.263 0.792253
log10 -0.591211    0.455442   -1.298 0.194252
log1   0.149364    0.127792    1.169 0.242480
log10  0.946535    0.260779    3.630 0.000284 ***
log1  -0.143508    0.123905   -1.158 0.246776
log10  0.039184    0.255773    0.153 0.878241
       0.244566    0.230422    1.061 0.288516
      -0.231238    0.459856   -0.503 0.615071
      -0.132940    0.125998   -1.055 0.291382
       0.364996    0.250247    1.459 0.144691
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
---
```

```
Estimates in matrix form:
Constant term:
Estimates:  0.006926773 0.0182367
AR coefficient matrix
AR( 1 )-matrix
      [,1]  [,2]
[1,] 1.010 0.633
[2,] 0.149 0.947
AR( 2 )-matrix
        [,1]    [,2]
[1,] -0.0577 -0.5912
[2,] -0.1435  0.0392
MA coefficient matrix
MA( 1 )-matrix
       [,1]   [,2]
[1,] -0.245  0.231
[2,]  0.133 -0.365

Residuals cov-matrix:
            [,1]         [,2]
[1,] 0.002300168 0.0010317369
[2,] 0.001031737 0.0008264881
----
aic=  -13.94491
bic=  -13.83832
```