SVAR Model

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VAR

Avant d'analyser un modèle SVAR, nous reprenons l'analyse VAR

```
library(readxl)
library(urca)
library(MASS)
library(vars)
library(lmtest)
```

Les données pour l'économie canadienne :

```
data("Canada")
```

Estimation du modèle VAR

```
modelo = VAR(diff(Canada), type = "const", p = 2)
summary(modelo)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: e, prod, rw, U
## Deterministic variables: const
## Sample size: 81
## Log Likelihood: -186.088
## Roots of the characteristic polynomial:
## 0.6801 0.6801 0.5621 0.5621 0.4314 0.4314  0.33 0.3171
## Call:
## VAR(y = diff(Canada), p = 2, type = "const")
##
##
## Estimation results for equation e:
## ==================================
## e = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1     0.92480    0.15232   6.071  5.4e-08 ***
## prod.l1  0.17822    0.06342   2.810  0.00637 **
## rw.l1   -0.03217    0.04782  -0.673  0.50325
## U.l1     0.08640    0.19356   0.446  0.65666
## e.l2    -0.37185    0.16360  -2.273  0.02602 *
## prod.l2  0.02248    0.06497   0.346  0.73034
## rw.l2   -0.04652    0.04678  -0.995  0.32330
## U.l2    -0.06662    0.20198  -0.330  0.74248
## const    0.22248    0.09380   2.372  0.02038 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
##
## Residual standard error: 0.3698 on 72 degrees of freedom
## Multiple R-Squared: 0.6476,  Adjusted R-squared: 0.6084
## F-statistic: 16.54 on 8 and 72 DF,  p-value: 1.282e-13
##
##
## Estimation results for equation prod:
## ====================================
## prod = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.16719    0.26882  -0.622  0.53593
## prod.l1  0.21697    0.11193   1.938  0.05648 .
## rw.l1    0.04031    0.08438   0.478  0.63432
## U.l1    -0.91606    0.34160  -2.682  0.00908 **
## e.l2    -0.51296    0.28872  -1.777  0.07985 .
## prod.l2 -0.04934    0.11466  -0.430  0.66824
## rw.l2   -0.15237    0.08255  -1.846  0.06906 .
## U.l2    -0.09982    0.35645  -0.280  0.78024
## const    0.50563    0.16555   3.054  0.00316 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.6526 on 72 degrees of freedom
## Multiple R-Squared: 0.2568,  Adjusted R-squared: 0.1743
## F-statistic:  3.11 on 8 and 72 DF,  p-value: 0.004506
##
##
## Estimation results for equation rw:
## ===================================
## rw = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.07297    0.36022  -0.203   0.8400
## prod.l1 -0.19804    0.14998  -1.320   0.1909
## rw.l1    0.23967    0.11308   2.120   0.0375 *
## U.l1     0.51435    0.45775   1.124   0.2649
## e.l2     0.55859    0.38690   1.444   0.1531
## prod.l2 -0.39211    0.15365  -2.552   0.0128 *
## rw.l2    0.11061    0.11062   1.000   0.3207
## U.l2    -0.03004    0.47764  -0.063   0.9500
## const    0.53044    0.22183   2.391   0.0194 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.8745 on 72 degrees of freedom
## Multiple R-Squared: 0.3624,  Adjusted R-squared: 0.2916
## F-statistic: 5.115 on 8 and 72 DF,  p-value: 4.628e-05
##
##
## Estimation results for equation U:
## ==================================
```

```
## U = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.58955    0.12091  -4.876 6.26e-06 ***
## prod.l1 -0.15153    0.05034  -3.010  0.00360 **
## rw.l1    0.04297    0.03795   1.132  0.26135
## U.l1    -0.14505    0.15364  -0.944  0.34827
## e.l2     0.02900    0.12986   0.223  0.82391
## prod.l2 -0.01722    0.05157  -0.334  0.73941
## rw.l2    0.10772    0.03713   2.901  0.00493 **
## U.l2    -0.24227    0.16032  -1.511  0.13513
## const    0.07837    0.07446   1.052  0.29610
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2935 on 72 degrees of freedom
## Multiple R-Squared: 0.5975,  Adjusted R-squared: 0.5528
## F-statistic: 13.36 on 8 and 72 DF,  p-value: 1.219e-11
##
##
##
## Covariance matrix of residuals:
##              e       prod        rw          U
## e     0.136736 -0.0178671 -0.009849 -0.0738072
## prod -0.017867  0.4258636  0.059273  0.0003443
## rw   -0.009849  0.0592729  0.764699  0.0559236
## U    -0.073807  0.0003443  0.055924  0.0861512
##
## Correlation matrix of residuals:
##             e      prod       rw         U
## e     1.00000 -0.074042 -0.03046 -0.680027
## prod -0.07404  1.000000  0.10387  0.001798
## rw   -0.03046  0.103866  1.00000  0.217881
## U    -0.68003  0.001798  0.21788  1.000000
```

VAR com restrição

```
modelo.res = restrict(modelo, method = "ser", thresh = 2)
summary(modelo.res)
```

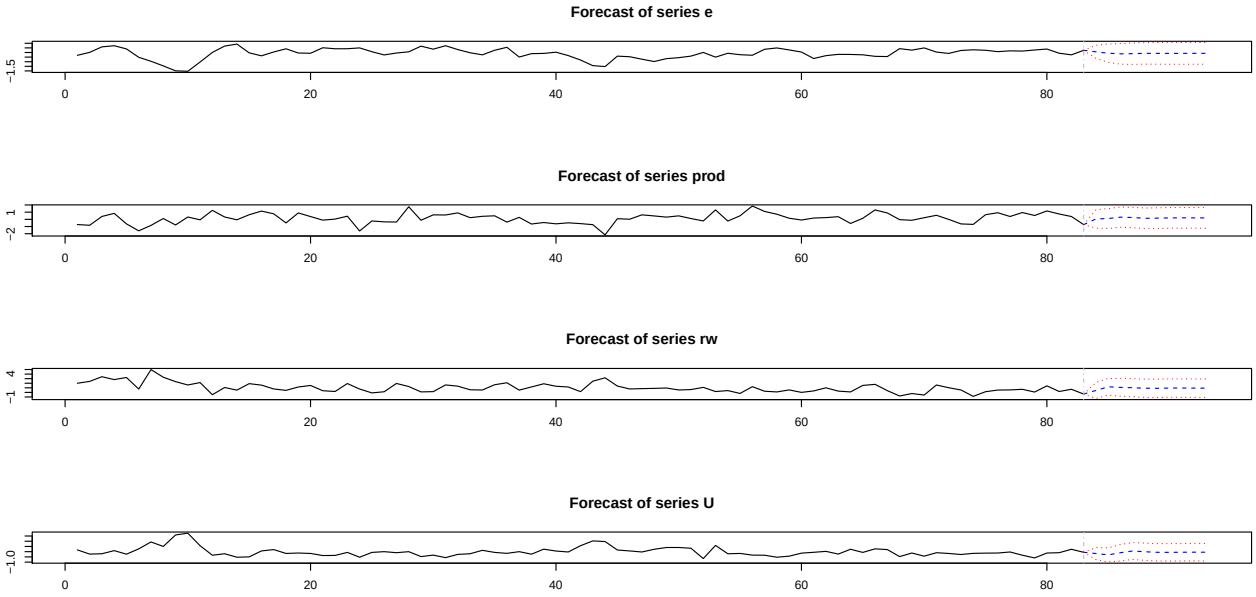
```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: e, prod, rw, U
## Deterministic variables: const
## Sample size: 81
## Log Likelihood: -203.033
## Roots of the characteristic polynomial:
## 0.6499 0.6499 0.5892 0.5845 0.5845 0.4771 0.4771 3.365e-16
## Call:
## VAR(y = diff(Canada), p = 2, type = "const")
##
```

```
##
## Estimation results for equation e:
## ==================================
## e = e.l1 + prod.l1 + e.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1     0.91491    0.10171   8.995 1.22e-13 ***
## prod.l1  0.20232    0.05782   3.499  0.00078 ***
## e.l2    -0.32401    0.10089  -3.212  0.00193 **
## const    0.12686    0.04980   2.548  0.01284 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.3648 on 77 degrees of freedom
## Multiple R-Squared: 0.7447,  Adjusted R-squared: 0.7315
## F-statistic: 56.16 on 4 and 77 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation prod:
## =====================================
## prod = prod.l1 + U.l1 + e.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## prod.l1  0.23346    0.10368   2.252 0.027190 *
## U.l1    -0.78168    0.22331  -3.500 0.000776 ***
## e.l2    -0.45150    0.16425  -2.749 0.007449 **
## const    0.29389    0.09649   3.046 0.003178 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.6509 on 77 degrees of freedom
## Multiple R-Squared:  0.25,   Adjusted R-squared: 0.211
## F-statistic: 6.416 on 4 and 77 DF,  p-value: 0.0001648
##
##
## Estimation results for equation rw:
## ===================================
## rw = rw.l1 + prod.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## rw.l1     0.3160     0.1005   3.143  0.00236 **
## prod.l2  -0.4901     0.1440  -3.403  0.00105 **
## const     0.7313     0.1481   4.936 4.42e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.8909 on 78 degrees of freedom
## Multiple R-Squared: 0.6216,  Adjusted R-squared: 0.6071
## F-statistic: 42.72 on 3 and 78 DF,  p-value: < 2.2e-16
##
##
```

```
## Estimation results for equation U:
## ==================================
## U = e.l1 + prod.l1 + rw.l2 + U.l2
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.45294    0.06108  -7.416 1.34e-10 ***
## prod.l1 -0.14656    0.04690  -3.125  0.00251 **
## rw.l2    0.15596    0.02564   6.082 4.28e-08 ***
## U.l2    -0.25154    0.10087  -2.494  0.01478 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2928 on 77 degrees of freedom
## Multiple R-Squared: 0.5716,  Adjusted R-squared: 0.5494
## F-statistic: 25.69 on 4 and 77 DF,  p-value: 1.541e-13
##
##
##
## Covariance matrix of residuals:
##             e      prod       rw         U
## e     0.14233 -0.010406 -0.01064 -0.073451
## prod -0.01041  0.453071  0.04289  0.009356
## rw   -0.01064  0.042892  0.85979  0.050687
## U    -0.07345  0.009356  0.05069  0.090796
##
## Correlation matrix of residuals:
##             e     prod       rw        U
## e     1.00000 -0.04098 -0.03042 -0.64614
## prod -0.04098  1.00000  0.06872  0.04613
## rw   -0.03042  0.06872  1.00000  0.18141
## U    -0.64614  0.04613  0.18141  1.00000
```

Prévision

```
modelo.prev = predict(modelo.res, n.ahead = 10, ci = 0.95)
plot(modelo.prev)
```



Matriz de restrição

```
modelo.res$restrictions
```

```
##      e.l1 prod.l1 rw.l1 U.l1 e.l2 prod.l2 rw.l2 U.l2 const
## e       1       1     0    0    1       0     0    0     1
## prod    0       1     0    1    1       0     0    0     1
## rw      0       0     1    0    0       1     0    0     1
## U       1       1     0    0    0       0     1    1     0
```

Coeficientes estimados da matriz

```
Acoef(modelo.res)
```

```
## [[1]]
##             e.l1    prod.l1     rw.l1       U.l1
## e     0.9149131  0.2023237 0.0000000  0.0000000
## prod  0.0000000  0.2334553 0.0000000 -0.7816823
## rw    0.0000000  0.0000000 0.3160282  0.0000000
## U    -0.4529394 -0.1465641 0.0000000  0.0000000
##
## [[2]]
##             e.l2   prod.l2     rw.l2      U.l2
## e    -0.3240077  0.000000 0.0000000  0.000000
## prod -0.4515019  0.000000 0.0000000  0.000000
## rw    0.0000000 -0.490105 0.0000000  0.000000
## U     0.0000000  0.000000 0.1559625 -0.251545
```

Construção de matriz manualmente

```
matriz = matrix(rep(1, (4*9)), nrow = 4, ncol = 9)
# 4 = número de variaveis, 9 = numero de parametros

matriz
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
## [1,]    1    1    1    1    1    1    1    1    1
## [2,]    1    1    1    1    1    1    1    1    1
## [3,]    1    1    1    1    1    1    1    1    1
## [4,]    1    1    1    1    1    1    1    1    1
```

```
matriz[1, 3] = 0
matriz[1, 7] = 0
matriz
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
## [1,]    1    1    0    1    1    1    0    1    1
## [2,]    1    1    1    1    1    1    1    1    1
## [3,]    1    1    1    1    1    1    1    1    1
## [4,]    1    1    1    1    1    1    1    1    1
```

Prévision avec nouvelles restrictions

```
modelo.manual = restrict(modelo, method = 'manual', resmat = matriz) #resmat refere-se a matriz de rest
summary(modelo.manual)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: e, prod, rw, U
## Deterministic variables: const
## Sample size: 81
## Log Likelihood: -188.176
## Roots of the characteristic polynomial:
## 0.6378 0.6378 0.5842 0.5842 0.4587 0.4587 0.4172 0.3322
## Call:
## VAR(y = diff(Canada), p = 2, type = "const")
##
##
## Estimation results for equation e:
## ==================================
## e = e.l1 + prod.l1 + U.l1 + e.l2 + prod.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1     0.91107    0.15154   6.012 6.39e-08 ***
## prod.l1  0.17974    0.06339   2.835   0.0059 **
## U.l1     0.01812    0.18493   0.098   0.9222
## e.l2    -0.41586    0.16032  -2.594   0.0114 *
## prod.l2  0.03349    0.06406   0.523   0.6026
## U.l2    -0.15598    0.19160  -0.814   0.4182
## const    0.16093    0.08284   1.943   0.0559 .
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.3697 on 74 degrees of freedom
## Multiple R-Squared: 0.7481,  Adjusted R-squared: 0.7242
## F-statistic: 31.39 on 7 and 74 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation prod:
## =====================================
## prod = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.16719    0.26882  -0.622  0.53593
## prod.l1  0.21697    0.11193   1.938  0.05648 .
## rw.l1    0.04031    0.08438   0.478  0.63432
## U.l1    -0.91606    0.34160  -2.682  0.00908 **
## e.l2    -0.51296    0.28872  -1.777  0.07985 .
## prod.l2 -0.04934    0.11466  -0.430  0.66824
## rw.l2   -0.15237    0.08255  -1.846  0.06906 .
## U.l2    -0.09982    0.35645  -0.280  0.78024
## const    0.50563    0.16555   3.054  0.00316 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.6526 on 72 degrees of freedom
## Multiple R-Squared: 0.295,   Adjusted R-squared: 0.2069
## F-statistic: 3.348 on 9 and 72 DF,  p-value: 0.001796
##
##
## Estimation results for equation rw:
## ===================================
## rw = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.07297    0.36022  -0.203   0.8400
## prod.l1 -0.19804    0.14998  -1.320   0.1909
## rw.l1    0.23967    0.11308   2.120   0.0375 *
## U.l1     0.51435    0.45775   1.124   0.2649
## e.l2     0.55859    0.38690   1.444   0.1531
## prod.l2 -0.39211    0.15365  -2.552   0.0128 *
## rw.l2    0.11061    0.11062   1.000   0.3207
## U.l2    -0.03004    0.47764  -0.063   0.9500
## const    0.53044    0.22183   2.391   0.0194 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.8745 on 72 degrees of freedom
## Multiple R-Squared: 0.6635,  Adjusted R-squared: 0.6214
## F-statistic: 15.77 on 9 and 72 DF,  p-value: 6.965e-14
##
##
```

```
## Estimation results for equation U:
## ==================================
## U = e.l1 + prod.l1 + rw.l1 + U.l1 + e.l2 + prod.l2 + rw.l2 + U.l2 + const
##
##         Estimate Std. Error t value Pr(>|t|)
## e.l1    -0.58955    0.12091  -4.876 6.26e-06 ***
## prod.l1 -0.15153    0.05034  -3.010  0.00360 **
## rw.l1    0.04297    0.03795   1.132  0.26135
## U.l1    -0.14505    0.15364  -0.944  0.34827
## e.l2     0.02900    0.12986   0.223  0.82391
## prod.l2 -0.01722    0.05157  -0.334  0.73941
## rw.l2    0.10772    0.03713   2.901  0.00493 **
## U.l2    -0.24227    0.16032  -1.511  0.13513
## const    0.07837    0.07446   1.052  0.29610
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2935 on 72 degrees of freedom
## Multiple R-Squared: 0.5976,  Adjusted R-squared: 0.5473
## F-statistic: 11.88 on 9 and 72 DF,  p-value: 3.063e-11
##
##
##
## Covariance matrix of residuals:
##              e       prod        rw          U
## e     0.140468 -0.0178671 -0.009849 -0.0738072
## prod -0.017867  0.4258636  0.059273  0.0003443
## rw   -0.009849  0.0592729  0.764699  0.0559236
## U    -0.073807  0.0003443  0.055924  0.0861512
##
## Correlation matrix of residuals:
##              e      prod       rw         U
## e     1.00000 -0.073052 -0.03005 -0.670934
## prod -0.07305  1.000000  0.10387  0.001798
## rw   -0.03005  0.103866  1.00000  0.217881
## U    -0.67093  0.001798  0.21788  1.000000
```

Plot de prévision

```
modelo.prev1 = predict(modelo.manual, n.ahead = 10, ci = 0.95)
plot(modelo.manual)
```

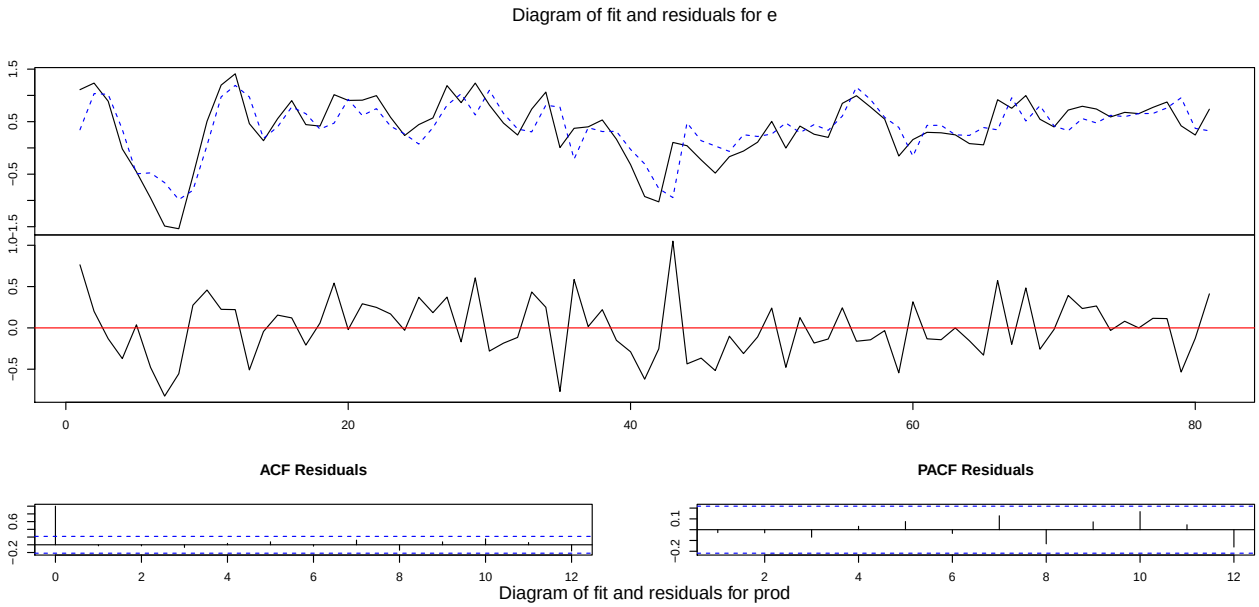


Diagram of fit and residuals for e
ACF Residuals
PACF Residuals

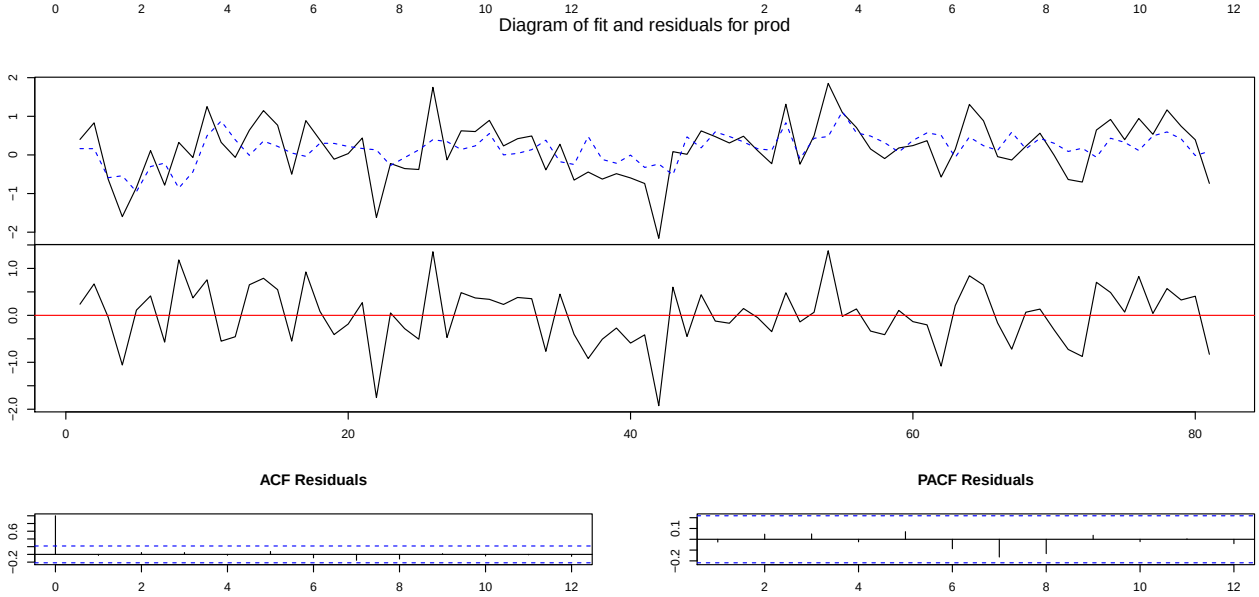
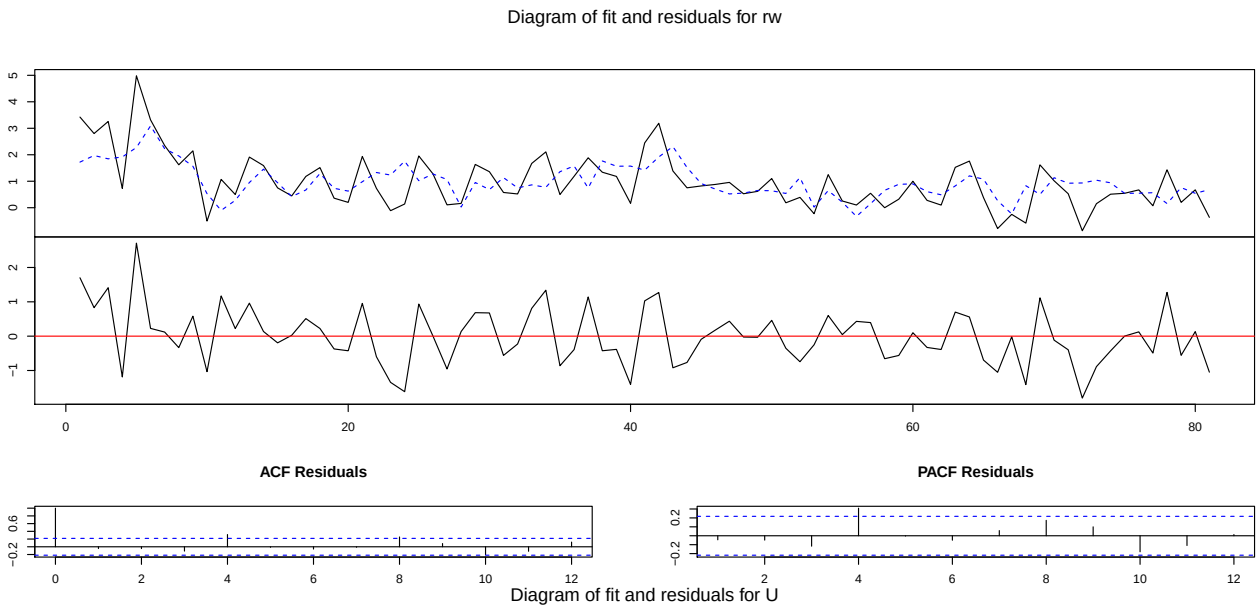
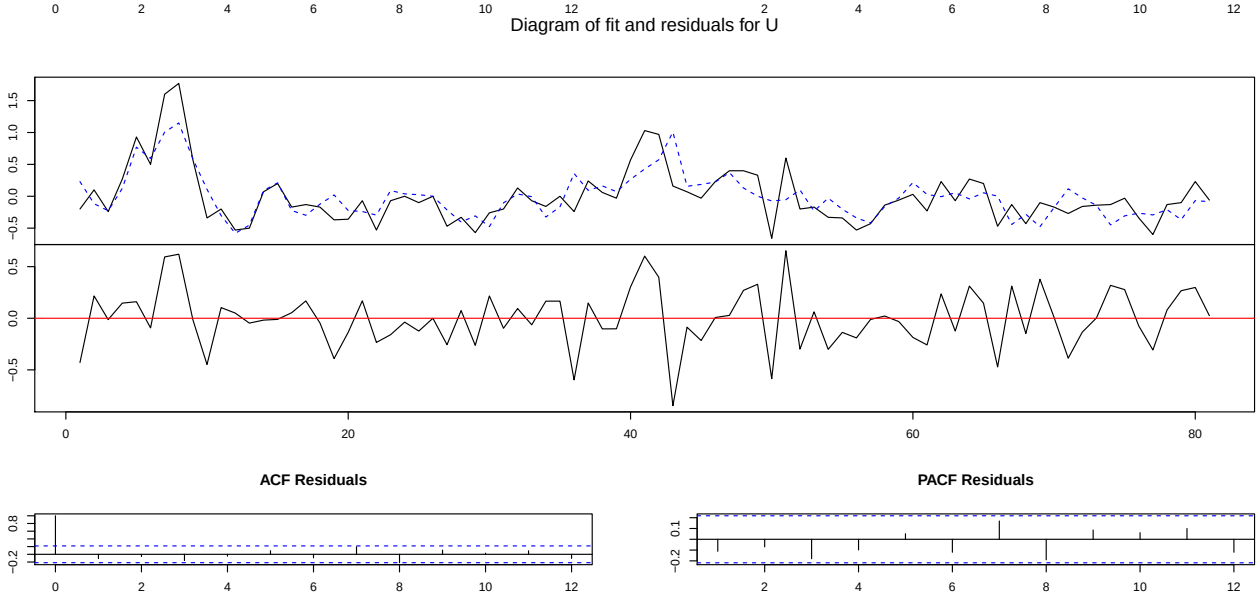


Diagram of fit and residuals for prod
ACF Residuals
PACF Residuals





SVAR

Modelo A : relações contemporâneas

```
amat = diag(4)
amat
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    0    0    0
## [2,]    0    1    0    0
## [3,]    0    0    1    0
## [4,]    0    0    0    1
```

```
diag(amat) = NA
amat
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   NA    0    0    0
```

```
## [2,]    0   NA    0    0
## [3,]    0    0   NA    0
## [4,]    0    0    0   NA
```

A partir de cette matrice, on mets des restrictions sur les relations de variables. Ses restrictions sont formulées à partir des théories économiques et des objectifs poursuivis. Pour décider sur les restrictions à donner sur la matrice A, on utilise la formule $\frac{(n^2-n)}{2}$, pour ce cas, comme nous avons quatre variables alors notre $n = 4$, ainsi $\frac{4^2-4}{2} = 6$. Nous devons avoir six restrictions à donner à la matrice A. Mais ici nous avaons réalisé que quatre restrictions. Sur VAR ses restrictions sont effectuées en utilisant la decomposition de Cholesky ou bien à partir de la théorie économique afin de récuperer les innovations structurelles à partir des séquences ε_{1t} et ε_{2t}.

```
amat[1, 2] = NA
amat[1, 3] = NA
amat[3, 2] = NA
amat[4, 1] = NA
amat
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   NA   NA   NA    0
## [2,]    0   NA    0    0
## [3,]    0   NA   NA    0
## [4,]   NA    0    0   NA
```

```
modelo.svarA = SVAR(modelo, estmethod = "direct", Amat = amat, Bmat = NULL,
                    hessian = TRUE)
modelo.svarA
```

```
##
## SVAR Estimation Results:
## ========================
##
##
## Estimated A matrix:
##          e    prod      rw    U
## e    1.511 -1.0321 -0.2049 0.00
## prod 0.000  1.5959  0.0000 0.00
## rw   0.000 -0.4951  1.0002 0.00
## U    3.701  0.0000  0.0000 5.62
```

```
modelo.svarA$A
```

```
##             e       prod         rw        U
## e    1.510533 -1.0320891 -0.2049311 0.000000
## prod 0.000000  1.5958582  0.0000000 0.000000
## rw   0.000000 -0.4950794  1.0002059 0.000000
## U    3.701285  0.0000000  0.0000000 5.620344
```

```
modelo.svarA$Ase
```

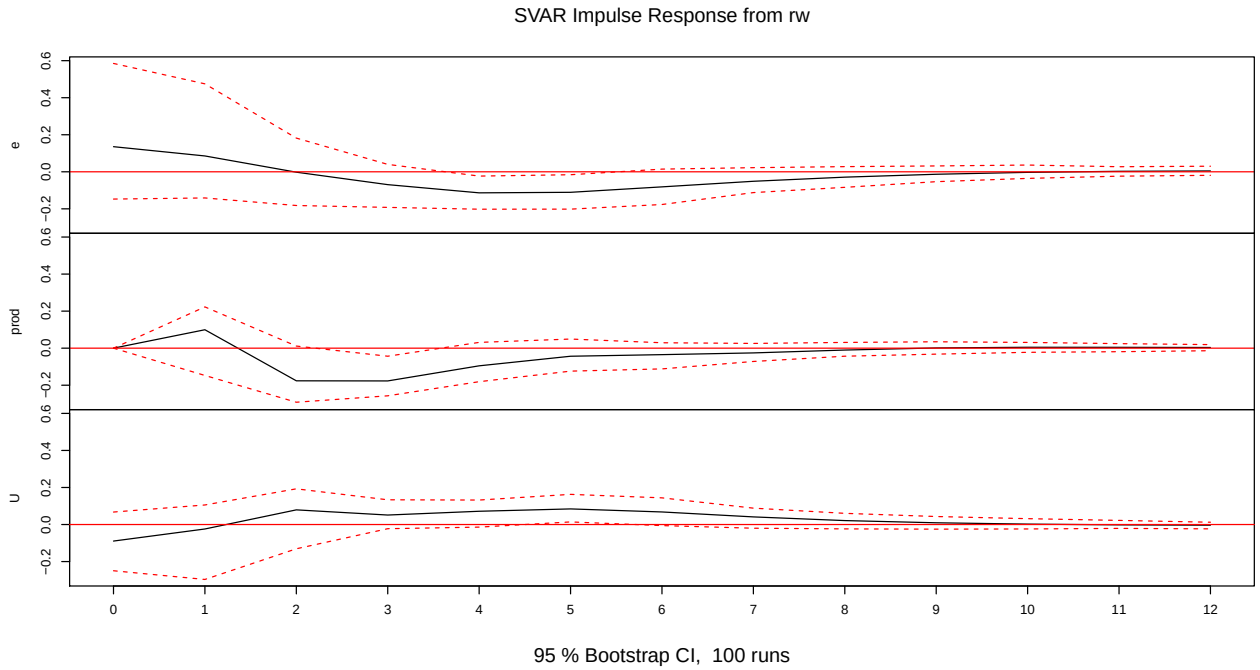
```
##              e      prod         rw         U
## e    0.1466332 0.1712932 0.12775993 0.0000000
## prod 0.0000000 0.1228126 0.00000000 0.0000000
## rw   0.0000000 0.1706632 0.08384754 0.0000000
## U    0.3693540 0.0000000 0.00000000 0.3979205
```

```
modelo.svarA$B
```

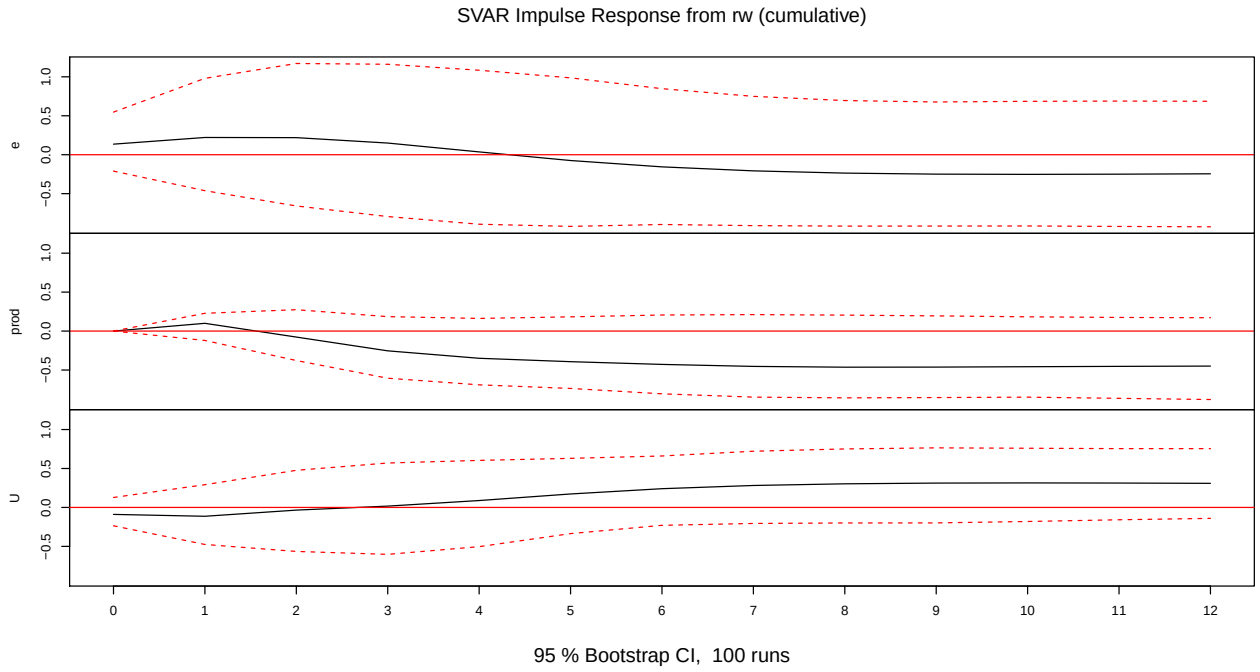
```
##       e prod rw U
## e     1    0  0 0
## prod  0    1  0 0
## rw    0    0  1 0
## U     0    0  0 1
```

Função Resposta ao impulso

```
svar.irf = irf(modelo.svarA, impulse = "rw", response = c("e", "prod", "U"),
               boot = TRUE, cumulative = FALSE, n.ahead = 12)
plot(svar.irf)
```




```
svar.irf1 = irf(modelo.svarA, impulse = "rw", response = c("e", "prod", "U"),
               boot = TRUE, cumulative = TRUE, n.ahead = 12)
plot(svar.irf1)
```



Decomposição da variança