

# VEC

gpetrini

19/05/2020

## Pacotes

```
library(dplyr)
```

## Dados

```
df <- read.csv(  
  "../data/raw_data.csv",  
  encoding="UTF-8",  
  row.names=1,  
  stringsAsFactors=FALSE  
)  
df <- df[,c( # Subset das colunas com ordenação de Choleski  
  "Exportações.FOB",  
  "Taxa.de.câmbio",  
  "Importações.FOB",  
  "Índice.da.Produção.Física.Industrial.com.ajuste.sazonal..Média.2012...100.",  
  "ICMS.Nominal.milhões.de.reais"  
)]  
colnames(df) <- c( # Encurtando nomes  
  "Exportacoes",  
  "Cambio",  
  "Importacoes",  
  "Industrial",  
  "ICMS"  
)  
df <- xts::as.xts(df)  
df %>% head() %>% knitr::kable()
```

Exportacoes	Cambio	Importacoes	Industrial	ICMS
1262216472	2.3771	1588583185	75.7	2956.254
1345978624	2.4188	1507819585	78.6	2612.978
1443341004	2.3458	1654236906	78.1	2603.101
1614508483	2.3196	1752896831	78.2	2964.823
1491268802	2.4796	1666945463	78.0	2848.264
1670856204	2.7132	1537291228	77.4	2934.246

# Estimação

## Ordem do modelo

```
vars::VARselect(  
  df %>% log() %>% diff() %>% na.omit(),  
  lag.max = 15,  
  type = 'const'  
)$selection -> ordem  
ordem %>% knitr::kable(col.names = "Ordem do modelo VAR")
```

Ordem do modelo VAR	
AIC(n)	14
HQ(n)	3
SC(n)	1
FPE(n)	4

```
urca::ca.jo(  
  df %>% log(), # fix sistema é computacionalmente singular  
  type = "trace",  
  ecdet = "const",  
  K = 4, # Following FPE(n) criteria  
  season = 12,  
  spec = "transitory"  
) -> z  
z %>% urca::cajools() -> modelo  
  
modelo %>% summary()
```

```
## Response Exportacoes.d :  
##  
## Call:  
## lm(formula = Exportacoes.d ~ sd1 + sd2 + sd3 + sd4 + sd5 + sd6 +  
##      sd7 + sd8 + sd9 + sd10 + sd11 + Exportacoes.dl1 + Cambio.dl1 +  
##      Importacoes.dl1 + Industrial.dl1 + ICMS.dl1 + Exportacoes.dl2 +  
##      Cambio.dl2 + Importacoes.dl2 + Industrial.dl2 + ICMS.dl2 +  
##      Exportacoes.dl3 + Cambio.dl3 + Importacoes.dl3 + Industrial.dl3 +  
##      ICMS.dl3 + Exportacoes.l1 + Cambio.l1 + Importacoes.l1 +  
##      Industrial.l1 + ICMS.l1 + constant - 1, data = data.mat)  
##  
## Residuals:  
##      Min      1Q   Median      3Q      Max  
## -0.171625 -0.043792 -0.003818  0.044629  0.243880  
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)  
## sd1             -0.315868   0.032903  -9.600 < 2e-16 ***  
## sd2             -0.189248   0.036323  -5.210 5.05e-07 ***  
## sd3              0.067811   0.038737   1.751 0.08169 .  
## sd4             -0.013592   0.044062  -0.308 0.75807
```

```

## sd5          0.063636  0.036352  1.751  0.08170 .
## sd6          0.028947  0.033153  0.873  0.38374
## sd7          0.003522  0.030986  0.114  0.90963
## sd8          0.033954  0.032208  1.054  0.29317
## sd9          0.003829  0.030712  0.125  0.90093
## sd10         -0.030583  0.030147 -1.014  0.31170
## sd11         -0.124682  0.029204 -4.269 3.14e-05 ***
## Exportacoes.dl1 -0.600999  0.084543 -7.109 2.54e-11 ***
## Cambio.dl1    -0.139325  0.175316 -0.795  0.42781
## Importacoes.dl1 0.075166  0.101018  0.744  0.45778
## Industrial.dl1  0.105934  0.309794  0.342  0.73278
## ICMS.dl1      -0.169194  0.146794 -1.153  0.25058
## Exportacoes.dl2 -0.281317  0.091995 -3.058  0.00256 **
## Cambio.dl2     0.175308  0.182899  0.958  0.33908
## Importacoes.dl2 -0.109146  0.096038 -1.136  0.25724
## Industrial.dl2  0.351208  0.300501  1.169  0.24403
## ICMS.dl2       0.005652  0.160393  0.035  0.97193
## Exportacoes.dl3 -0.080338  0.078922 -1.018  0.31005
## Cambio.dl3     -0.175730  0.176430 -0.996  0.32055
## Importacoes.dl3 0.073274  0.078424  0.934  0.35137
## Industrial.dl3  0.212234  0.261141  0.813  0.41744
## ICMS.dl3       0.126845  0.130794  0.970  0.33342
## Exportacoes.l1 -0.114830  0.049762 -2.308  0.02214 *
## Cambio.l1      -0.117104  0.065667 -1.783  0.07620 .
## Importacoes.l1 -0.184048  0.101204 -1.819  0.07061 .
## Industrial.l1   0.297810  0.244393  1.219  0.22458
## ICMS.l1        0.181635  0.083174  2.184  0.03025 *
## constant       3.774516  1.214749  3.107  0.00219 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.07902 on 183 degrees of freedom
## Multiple R-squared:  0.7561, Adjusted R-squared:  0.7135
## F-statistic: 17.73 on 32 and 183 DF, p-value: < 2.2e-16
##
##
## Response Cambio.d :
##
## Call:
## lm(formula = Cambio.d ~ sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 +
##     sd8 + sd9 + sd10 + sd11 + Exportacoes.dl1 + Cambio.dl1 +
##     Importacoes.dl1 + Industrial.dl1 + ICMS.dl1 + Exportacoes.dl2 +
##     Cambio.dl2 + Importacoes.dl2 + Industrial.dl2 + ICMS.dl2 +
##     Exportacoes.dl3 + Cambio.dl3 + Importacoes.dl3 + Industrial.dl3 +
##     ICMS.dl3 + Exportacoes.l1 + Cambio.l1 + Importacoes.l1 +
##     Industrial.l1 + ICMS.l1 + constant - 1, data = data.mat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.10148 -0.02044 -0.00266  0.01970  0.14246
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## sd1          -0.016410   0.014708  -1.116   0.2660

```

```

## sd2          -0.011526   0.016237  -0.710   0.4787
## sd3           0.011857   0.017316   0.685   0.4944
## sd4          -0.026360   0.019697  -1.338   0.1825
## sd5          -0.006596   0.016250  -0.406   0.6853
## sd6          -0.031960   0.014820  -2.156   0.0324 *
## sd7          -0.019485   0.013852  -1.407   0.1612
## sd8          -0.006394   0.014398  -0.444   0.6575
## sd9          -0.009957   0.013729  -0.725   0.4692
## sd10         -0.021303   0.013476  -1.581   0.1157
## sd11         -0.011902   0.013055  -0.912   0.3631
## Exportacoes.dl1 0.009509   0.037792   0.252   0.8016
## Cambio.dl1     0.402432   0.078370   5.135 7.18e-07 ***
## Importacoes.dl1 0.017127   0.045157   0.379   0.7049
## Industrial.dl1  0.004573   0.138484   0.033   0.9737
## ICMS.dl1       -0.002041   0.065620  -0.031   0.9752
## Exportacoes.dl2 0.044720   0.041124   1.087   0.2783
## Cambio.dl2     -0.049893   0.081760  -0.610   0.5425
## Importacoes.dl2 0.023911   0.042931   0.557   0.5782
## Industrial.dl2 -0.141681   0.134330  -1.055   0.2929
## ICMS.dl2       0.018115   0.071699   0.253   0.8008
## Exportacoes.dl3 0.057110   0.035280   1.619   0.1072
## Cambio.dl3     -0.004673   0.078868  -0.059   0.9528
## Importacoes.dl3 0.053466   0.035057   1.525   0.1290
## Industrial.dl3 -0.067411   0.116736  -0.577   0.5643
## ICMS.dl3       -0.018700   0.058468  -0.320   0.7495
## Exportacoes.l1 -0.041393   0.022245  -1.861   0.0644 .
## Cambio.l1      -0.026546   0.029355  -0.904   0.3670
## Importacoes.l1  0.069069   0.045240   1.527   0.1286
## Industrial.l1  -0.188721   0.109249  -1.727   0.0858 .
## ICMS.l1        -0.013701   0.037181  -0.369   0.7129
## constant       0.378985   0.543018   0.698   0.4861
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03532 on 183 degrees of freedom
## Multiple R-squared:  0.3213, Adjusted R-squared:  0.2026
## F-statistic: 2.707 on 32 and 183 DF, p-value: 1.666e-05
##
##
## Response Importacoes.d :
##
## Call:
## lm(formula = Importacoes.d ~ sd1 + sd2 + sd3 + sd4 + sd5 + sd6 +
##     sd7 + sd8 + sd9 + sd10 + sd11 + Exportacoes.dl1 + Cambio.dl1 +
##     Importacoes.dl1 + Industrial.dl1 + ICMS.dl1 + Exportacoes.dl2 +
##     Cambio.dl2 + Importacoes.dl2 + Industrial.dl2 + ICMS.dl2 +
##     Exportacoes.dl3 + Cambio.dl3 + Importacoes.dl3 + Industrial.dl3 +
##     ICMS.dl3 + Exportacoes.l1 + Cambio.l1 + Importacoes.l1 +
##     Industrial.l1 + ICMS.l1 + constant - 1, data = data.mat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.159999 -0.050296 -0.003047  0.049735  0.264739
##

```

```

## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## sd1              0.068252   0.030196   2.260 0.024978 *
## sd2             -0.003697   0.033335  -0.111 0.911803
## sd3              0.157634   0.035550   4.434 1.59e-05 ***
## sd4              0.135535   0.040437   3.352 0.000975 ***
## sd5              0.210687   0.033361   6.315 1.99e-09 ***
## sd6              0.123464   0.030426   4.058 7.33e-05 ***
## sd7              0.206575   0.028437   7.264 1.04e-11 ***
## sd8              0.204235   0.029558   6.910 7.79e-11 ***
## sd9              0.171378   0.028186   6.080 6.83e-09 ***
## sd10             0.194211   0.027667   7.020 4.20e-11 ***
## sd11             0.103808   0.026801   3.873 0.000149 ***
## Exportacoes.dl1 -0.103619   0.077587  -1.336 0.183365
## Cambio.dl1       -0.019154   0.160891  -0.119 0.905368
## Importacoes.dl1 -0.311350   0.092706  -3.358 0.000954 ***
## Industrial.dl1   -0.344726   0.284305  -1.213 0.226876
## ICMS.dl1         -0.246014   0.134716  -1.826 0.069455 .
## Exportacoes.dl2 -0.195374   0.084426  -2.314 0.021771 *
## Cambio.dl2        0.086999   0.167851   0.518 0.604866
## Importacoes.dl2 -0.151453   0.088136  -1.718 0.087417 .
## Industrial.dl2   -0.364285   0.275777  -1.321 0.188171
## ICMS.dl2         -0.192144   0.147197  -1.305 0.193411
## Exportacoes.dl3 -0.024493   0.072429  -0.338 0.735621
## Cambio.dl3       -0.213078   0.161914  -1.316 0.189822
## Importacoes.dl3  0.185141   0.071971   2.572 0.010892 *
## Industrial.dl3   -0.135560   0.239656  -0.566 0.572328
## ICMS.dl3         -0.154638   0.120033  -1.288 0.199267
## Exportacoes.l1   -0.005239   0.045668  -0.115 0.908792
## Cambio.l1        -0.195837   0.060264  -3.250 0.001375 **
## Importacoes.l1   -0.593069   0.092877  -6.386 1.37e-09 ***
## Industrial.l1     1.037606   0.224285   4.626 7.03e-06 ***
## ICMS.l1           0.442156   0.076331   5.793 2.97e-08 ***
## constant          4.860967   1.114804   4.360 2.16e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.07251 on 183 degrees of freedom
## Multiple R-squared:  0.7434, Adjusted R-squared:  0.6986
## F-statistic: 16.57 on 32 and 183 DF, p-value: < 2.2e-16
##
##
## Response Industrial.d :
##
## Call:
## lm(formula = Industrial.d ~ sd1 + sd2 + sd3 + sd4 + sd5 + sd6 +
##     sd7 + sd8 + sd9 + sd10 + sd11 + Exportacoes.dl1 + Cambio.dl1 +
##     Importacoes.dl1 + Industrial.dl1 + ICMS.dl1 + Exportacoes.dl2 +
##     Cambio.dl2 + Importacoes.dl2 + Industrial.dl2 + ICMS.dl2 +
##     Exportacoes.dl3 + Cambio.dl3 + Importacoes.dl3 + Industrial.dl3 +
##     ICMS.dl3 + Exportacoes.l1 + Cambio.l1 + Importacoes.l1 +
##     Industrial.l1 + ICMS.l1 + constant - 1, data = data.mat)
##
## Residuals:

```

```

##           Min           1Q       Median           3Q           Max
## -0.116606 -0.012013  0.001979  0.013854  0.083181
##
## Coefficients:
##           Estimate Std. Error t value Pr(>|t|)
## sd1           0.008003  0.010523   0.761  0.44792
## sd2           0.009963  0.011617   0.858  0.39224
## sd3           0.013376  0.012389   1.080  0.28171
## sd4           0.022101  0.014092   1.568  0.11854
## sd5           0.002189  0.011627   0.188  0.85084
## sd6           0.010558  0.010604   0.996  0.32071
## sd7           0.009112  0.009910   0.919  0.35906
## sd8           0.007867  0.010301   0.764  0.44603
## sd9           0.014987  0.009823   1.526  0.12881
## sd10          0.013755  0.009642   1.427  0.15541
## sd11          0.005333  0.009340   0.571  0.56871
## Exportacoes.dl1 -0.023072  0.027039  -0.853  0.39463
## Cambio.dl1     -0.088360  0.056072  -1.576  0.11679
## Importacoes.dl1  0.034129  0.032309   1.056  0.29220
## Industrial.dl1  -0.306011  0.099082  -3.088  0.00233 **
## ICMS.dl1       0.070005  0.046949   1.491  0.13767
## Exportacoes.dl2 -0.030760  0.029423  -1.045  0.29720
## Cambio.dl2     -0.025992  0.058497  -0.444  0.65732
## Importacoes.dl2  0.033359  0.030716   1.086  0.27889
## Industrial.dl2  -0.219419  0.096110  -2.283  0.02358 *
## ICMS.dl2       0.076039  0.051299   1.482  0.13999
## Exportacoes.dl3  0.001689  0.025242   0.067  0.94672
## Cambio.dl3      0.003063  0.056428   0.054  0.95676
## Importacoes.dl3  0.002982  0.025082   0.119  0.90549
## Industrial.dl3  -0.029406  0.083522  -0.352  0.72518
## ICMS.dl3       0.046679  0.041832   1.116  0.26594
## Exportacoes.l1  0.017225  0.015916   1.082  0.28056
## Cambio.l1      -0.063455  0.021003  -3.021  0.00288 **
## Importacoes.l1  -0.032310  0.032368  -0.998  0.31950
## Industrial.l1   -0.150796  0.078165  -1.929  0.05525 .
## ICMS.l1        0.029883  0.026602   1.123  0.26276
## constant       0.809270  0.388517   2.083  0.03864 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02527 on 183 degrees of freedom
## Multiple R-squared:  0.2588, Adjusted R-squared:  0.1292
## F-statistic: 1.997 on 32 and 183 DF, p-value: 0.002452
##
##
## Response ICMS.d :
##
## Call:
## lm(formula = ICMS.d ~ sd1 + sd2 + sd3 + sd4 + sd5 + sd6 + sd7 +
##     sd8 + sd9 + sd10 + sd11 + Exportacoes.dl1 + Cambio.dl1 +
##     Importacoes.dl1 + Industrial.dl1 + ICMS.dl1 + Exportacoes.dl2 +
##     Cambio.dl2 + Importacoes.dl2 + Industrial.dl2 + ICMS.dl2 +
##     Exportacoes.dl3 + Cambio.dl3 + Importacoes.dl3 + Industrial.dl3 +
##     ICMS.dl3 + Exportacoes.l1 + Cambio.l1 + Importacoes.l1 +

```

```

##      Industrial.l1 + ICMS.l1 + constant - 1, data = data.mat)
##
## Residuals:
##      Min        1Q      Median        3Q      Max
## -0.133787 -0.026243 -0.002359  0.022744  0.179162
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## sd1            -0.096169   0.018597  -5.171 6.06e-07 ***
## sd2            -0.141663   0.020530  -6.900 8.21e-11 ***
## sd3            -0.099437   0.021894  -4.542 1.01e-05 ***
## sd4            -0.066175   0.024904  -2.657 0.008575 **
## sd5            -0.052299   0.020546  -2.545 0.011738 *
## sd6            -0.059730   0.018738  -3.188 0.001687 **
## sd7            -0.066996   0.017514  -3.825 0.000179 ***
## sd8            -0.062934   0.018204  -3.457 0.000679 ***
## sd9            -0.031454   0.017359  -1.812 0.071621 .
## sd10           -0.018878   0.017039  -1.108 0.269348
## sd11           -0.043798   0.016506  -2.653 0.008668 **
## Exportacoes.dl1  0.027343   0.047783   0.572 0.567874
## Cambio.dl1       0.131232   0.099088   1.324 0.187023
## Importacoes.dl1  0.036060   0.057095   0.632 0.528453
## Industrial.dl1   0.502793   0.175095   2.872 0.004567 **
## ICMS.dl1        -0.770254   0.082968  -9.284 < 2e-16 ***
## Exportacoes.dl2 -0.003210   0.051996  -0.062 0.950845
## Cambio.dl2      -0.078211   0.103374  -0.757 0.450273
## Importacoes.dl2  0.058225   0.054281   1.073 0.284837
## Industrial.dl2   0.021685   0.169843   0.128 0.898545
## ICMS.dl2        -0.478307   0.090654  -5.276 3.70e-07 ***
## Exportacoes.dl3  0.023829   0.044607   0.534 0.593855
## Cambio.dl3      -0.129546   0.099718  -1.299 0.195537
## Importacoes.dl3  0.081962   0.044325   1.849 0.066056 .
## Industrial.dl3  -0.081866   0.147597  -0.555 0.579804
## ICMS.dl3        -0.240913   0.073925  -3.259 0.001333 **
## Exportacoes.l1  -0.018060   0.028125  -0.642 0.521596
## Cambio.l1       -0.024346   0.037115  -0.656 0.512674
## Importacoes.l1   0.009025   0.057200   0.158 0.874812
## Industrial.l1    -0.041676   0.138131  -0.302 0.763211
## ICMS.l1         -0.002840   0.047010  -0.060 0.951894
## constant         0.449705   0.686575   0.655 0.513292
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04466 on 183 degrees of freedom
## Multiple R-squared:  0.6142, Adjusted R-squared:  0.5468
## F-statistic: 9.106 on 32 and 183 DF, p-value: < 2.2e-16

```

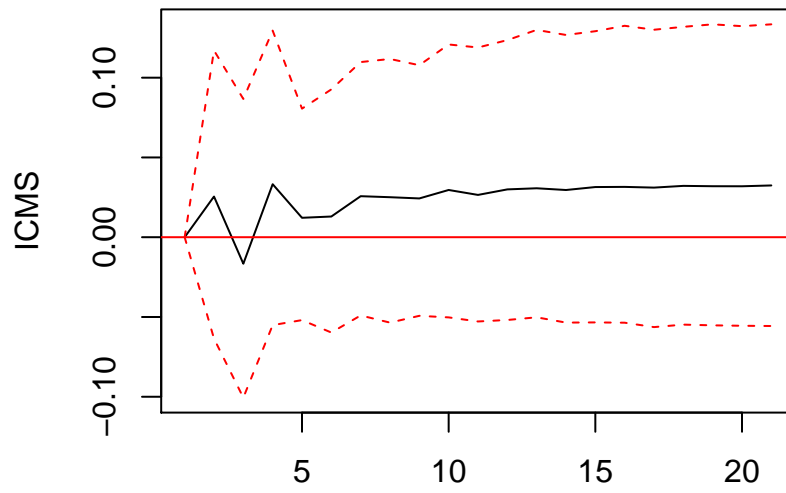
## Resposta ao Impulso

```

z %>% vars::vec2var() %>% vars::irf(n.ahead = 20, response = "ICMS",
  ortho = FALSE, runs = 500) %>% plot()

```

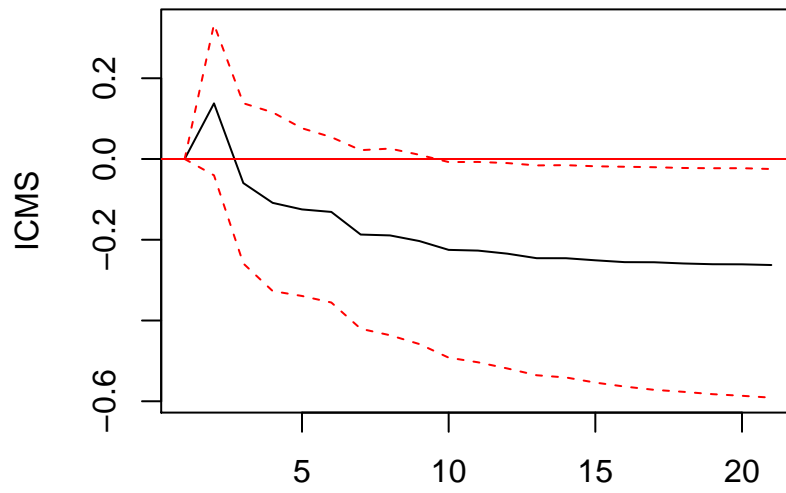
### Impulse Response from Exportacoes



95 % Bootstrap CI, 500 runs

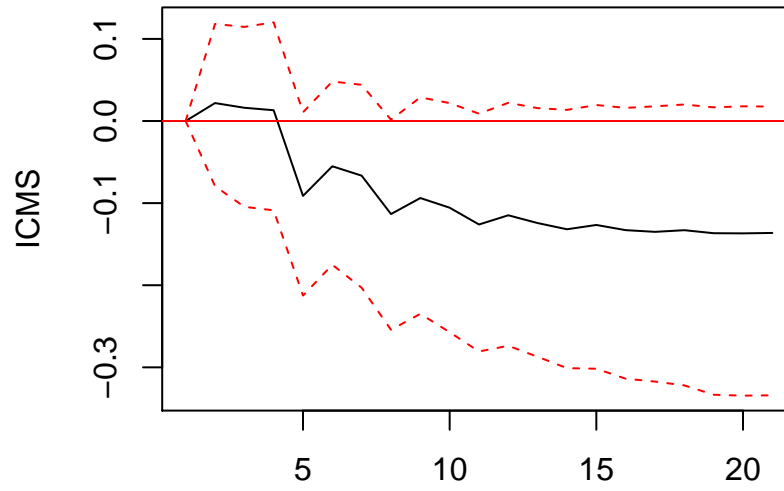


### Impulse Response from Cambio



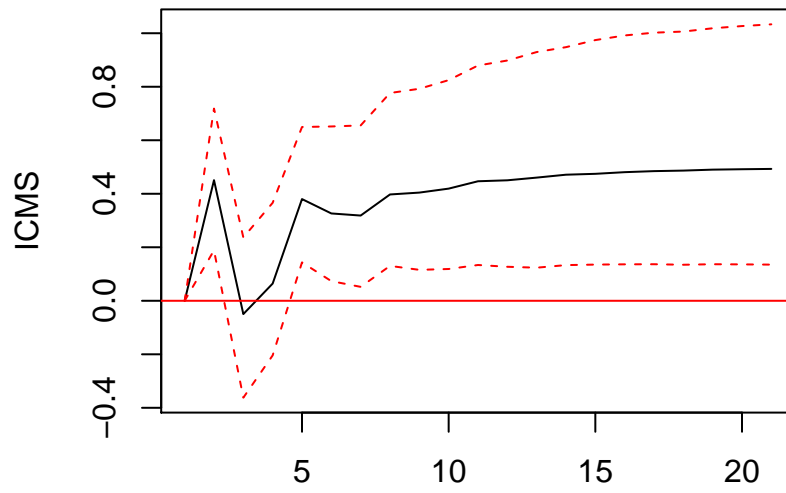
95 % Bootstrap CI, 500 runs

### Impulse Response from Importacoes



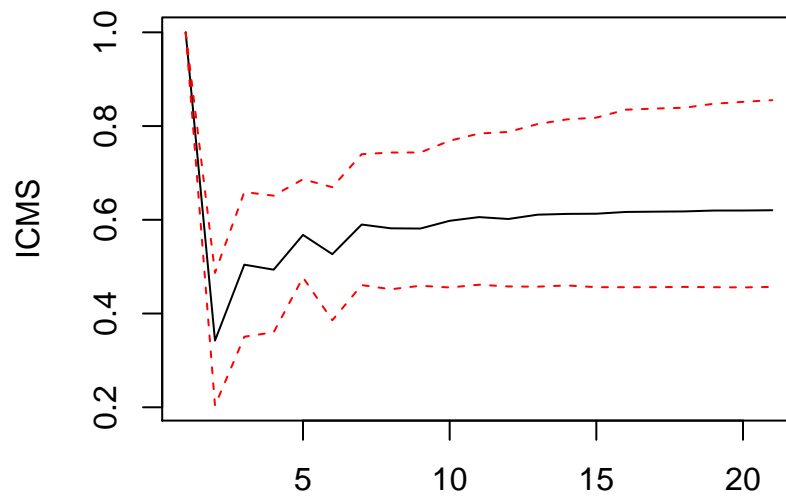
95 % Bootstrap CI, 500 runs

### Impulse Response from Industrial



95 % Bootstrap CI, 500 runs

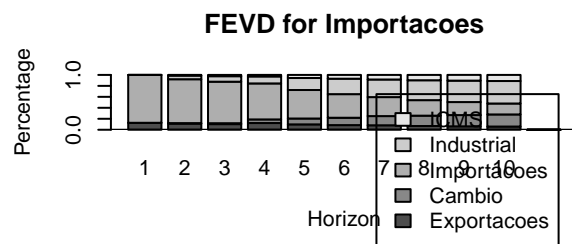
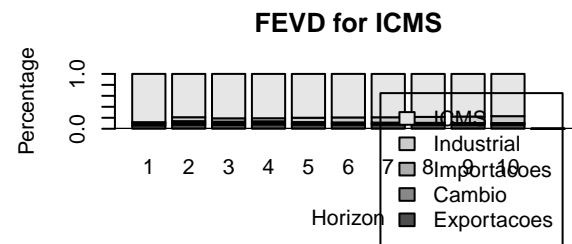
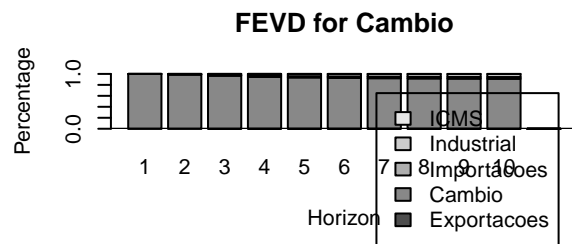
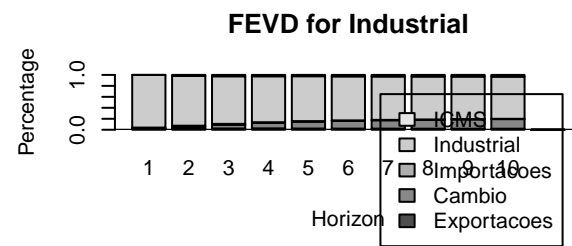
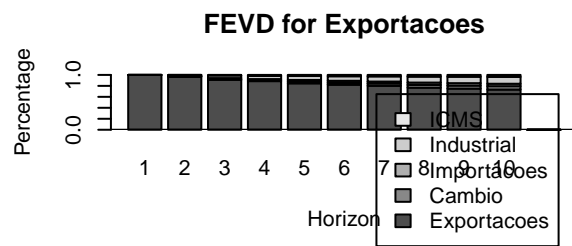
### Impulse Response from ICMS



95 % Bootstrap CI, 500 runs

### FEVD

```
z %>% vars::vec2var() %>% vars::fevd() %>% plot()
```

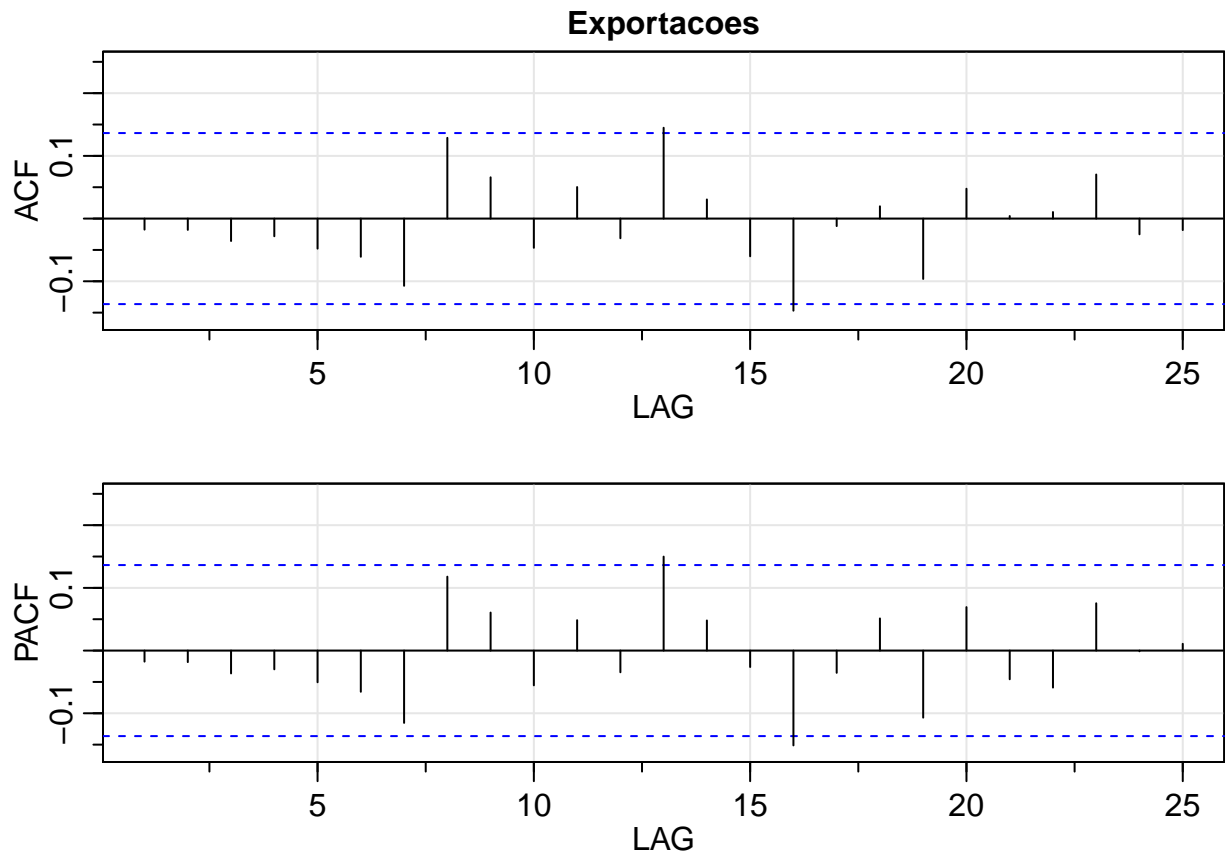


## Pós-Estimação

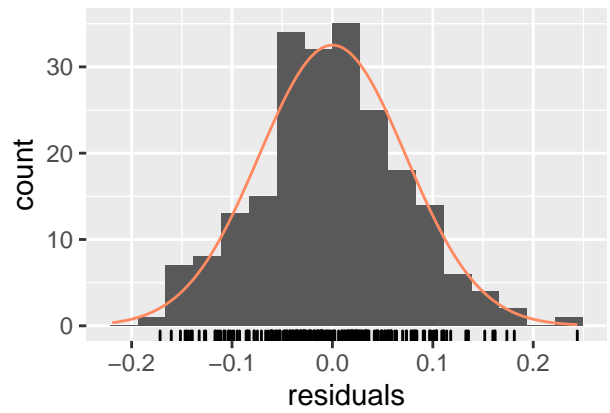
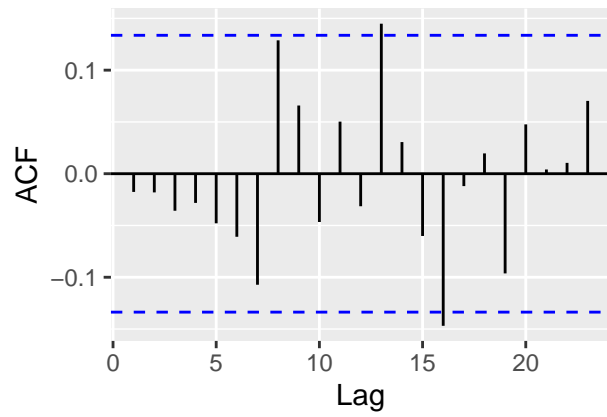
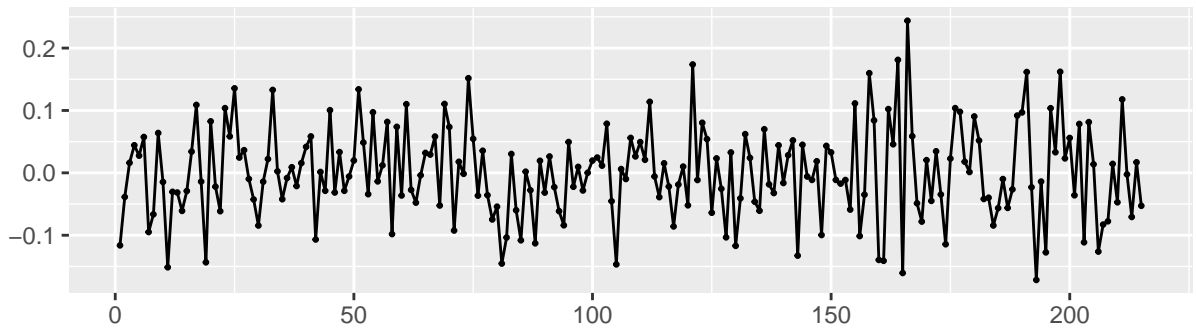
### Resíduos

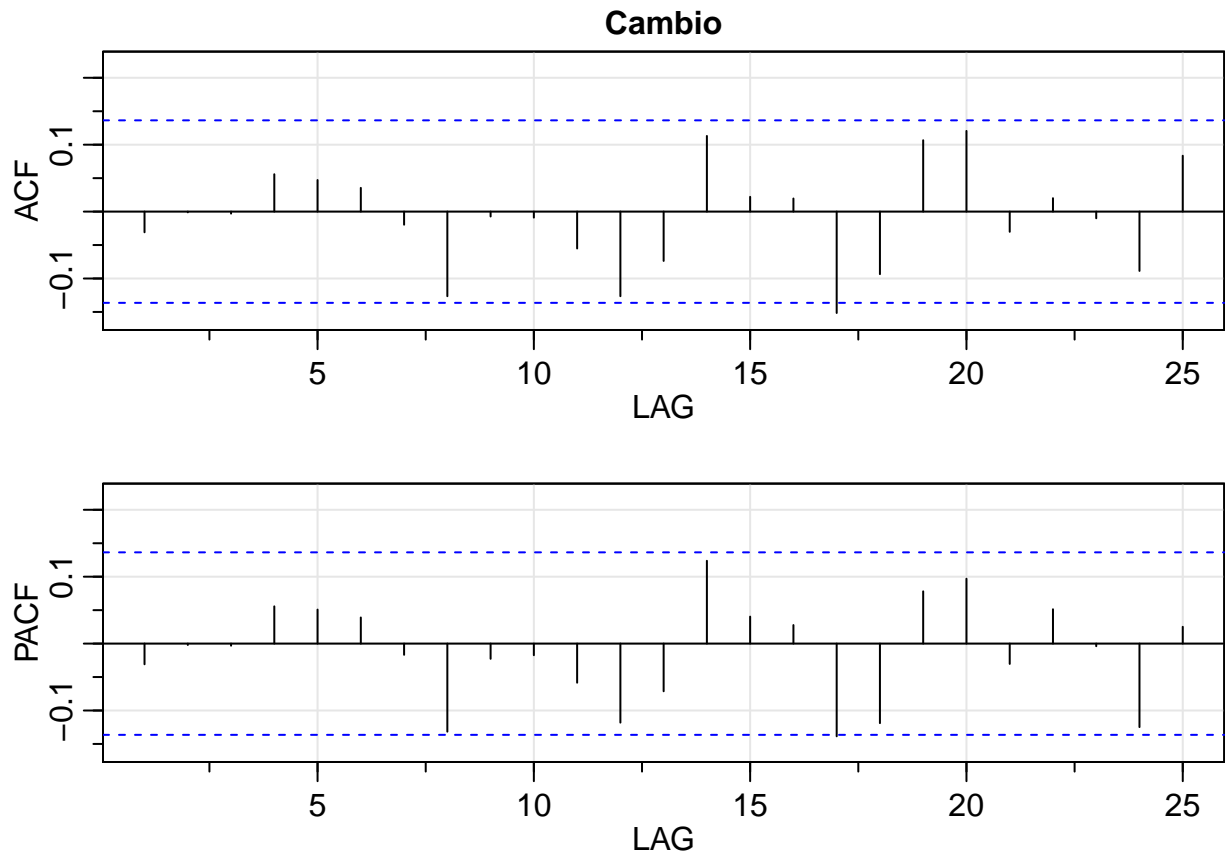
### Correlograma

```
for (serie in colnames(df)) {
  astsa::acf2(
    residuals(modelo)[,paste0(serie,".d")],
    main = serie
  )
  forecast::checkresiduals(
    residuals(modelo)[,paste0(serie,".d")],
    main = serie
  )
}
```

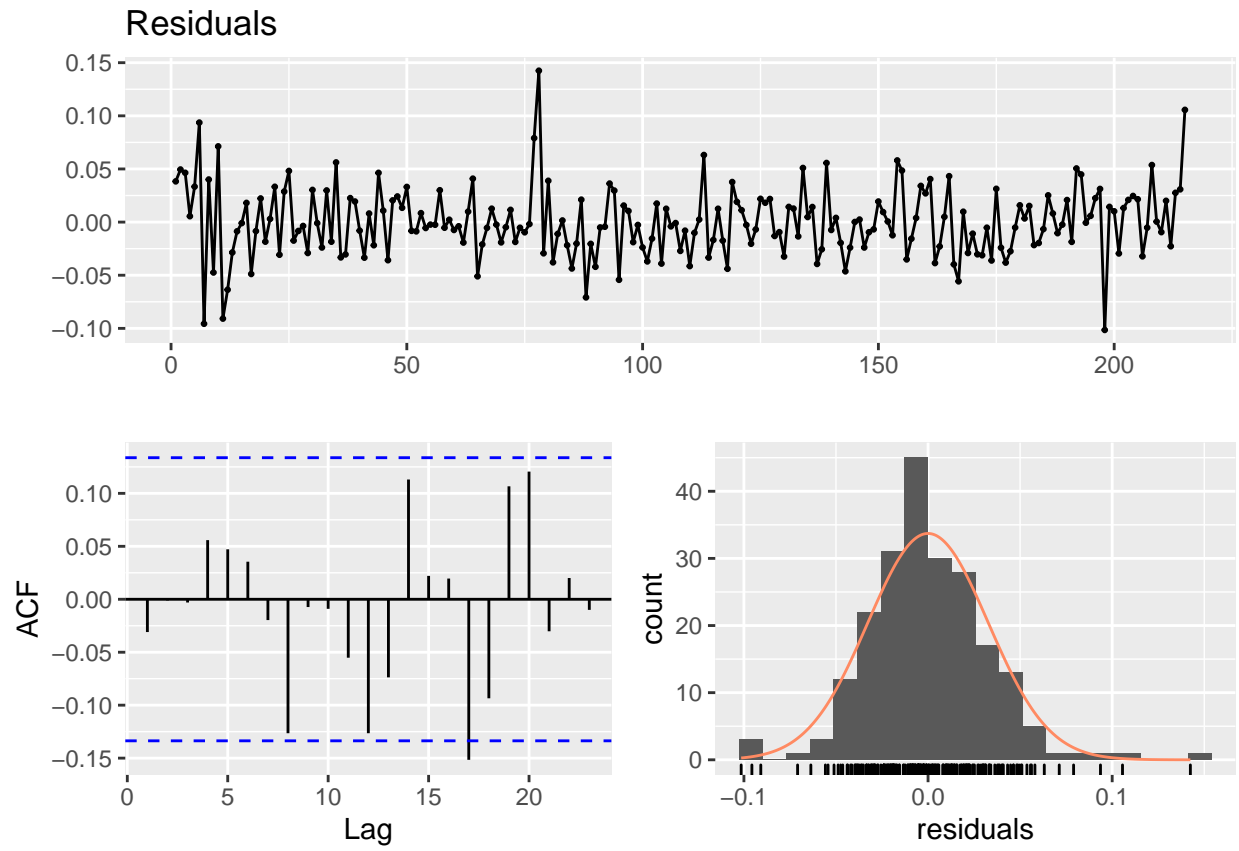


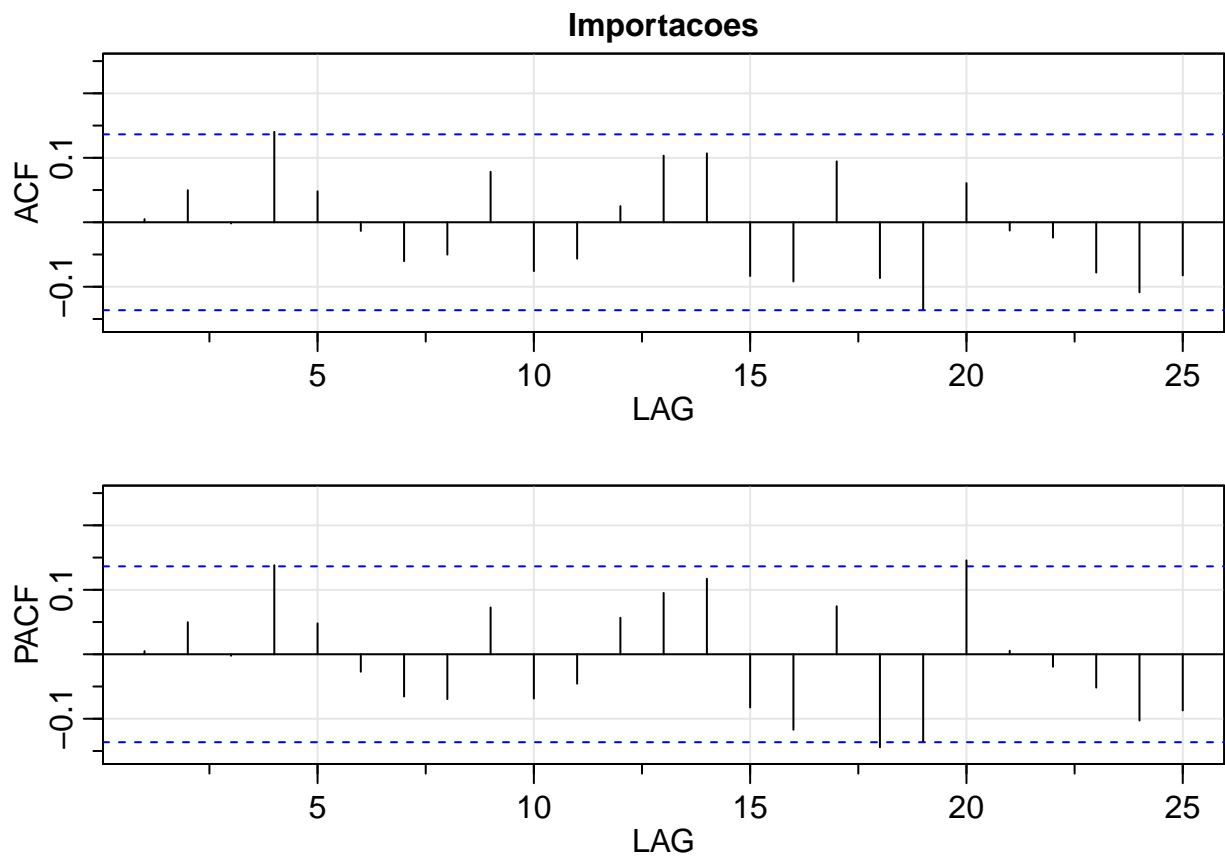
Residuals



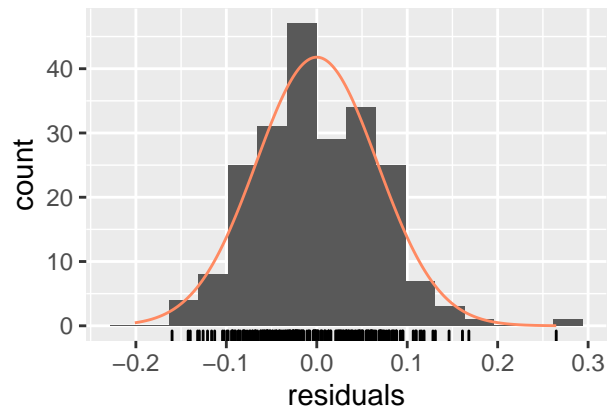
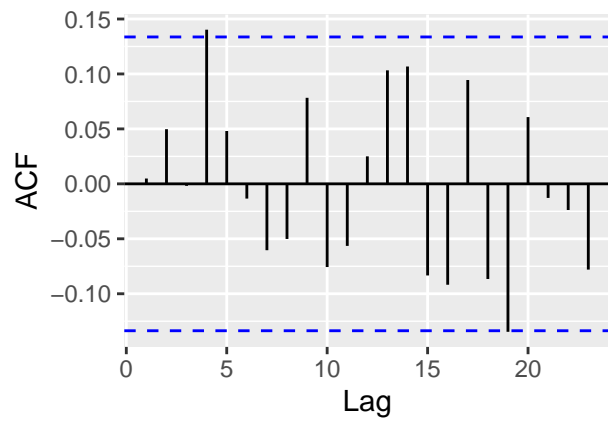
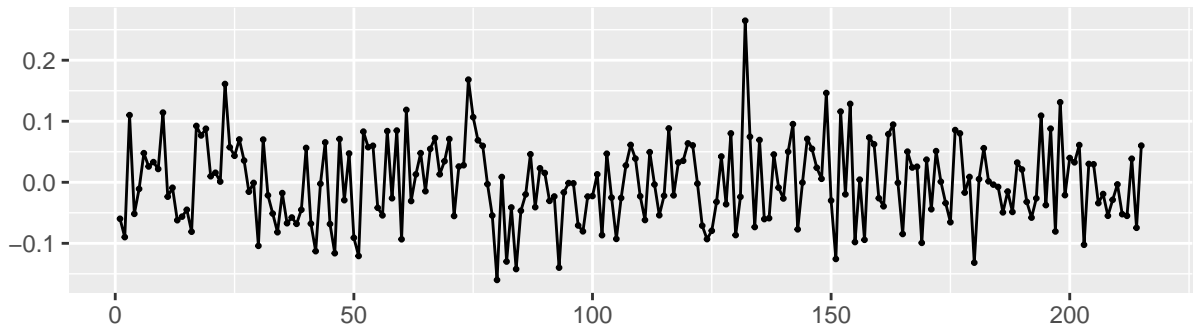


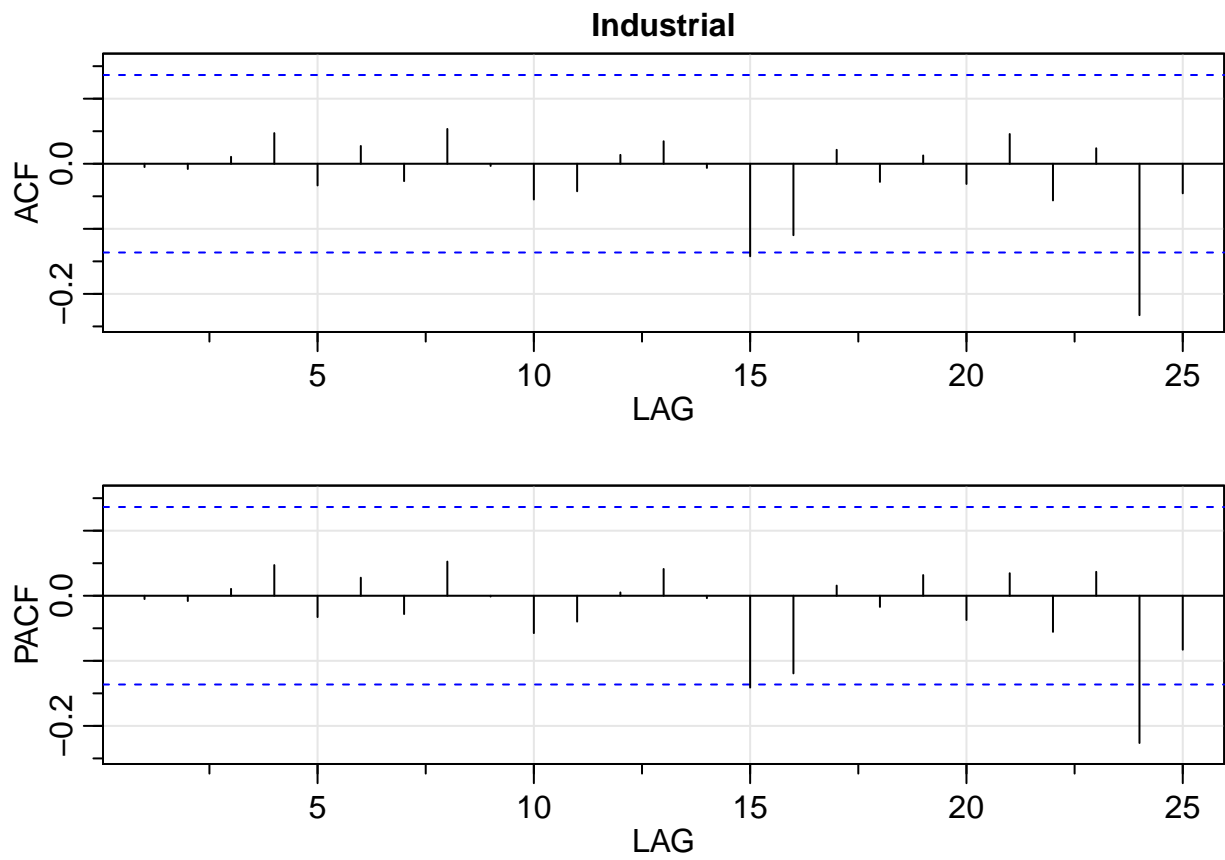




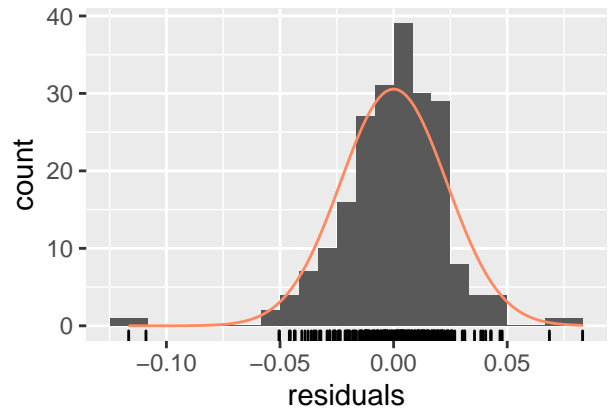
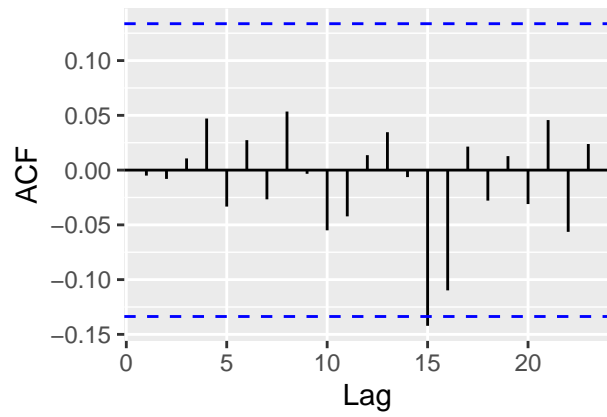
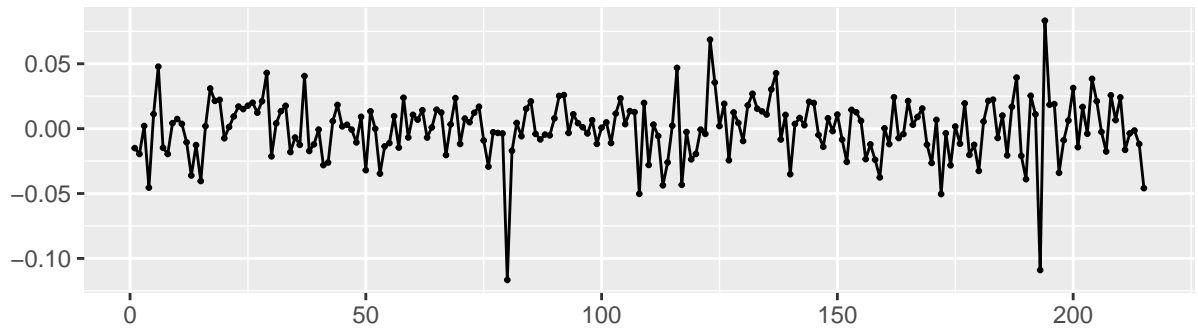


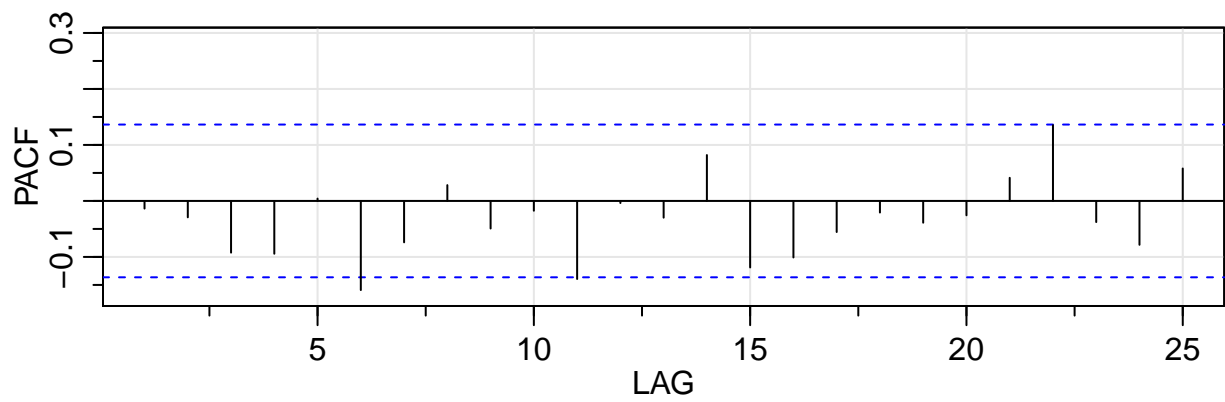
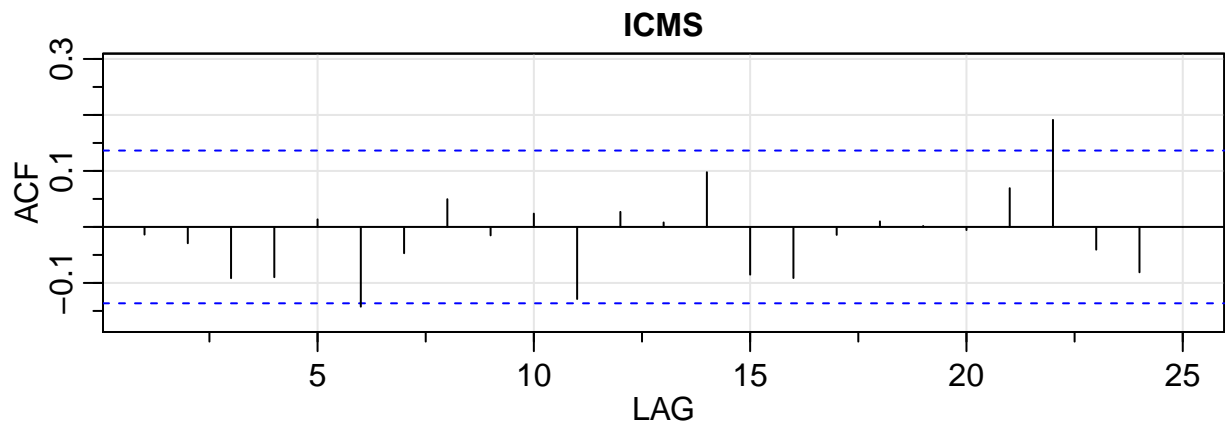
Residuals



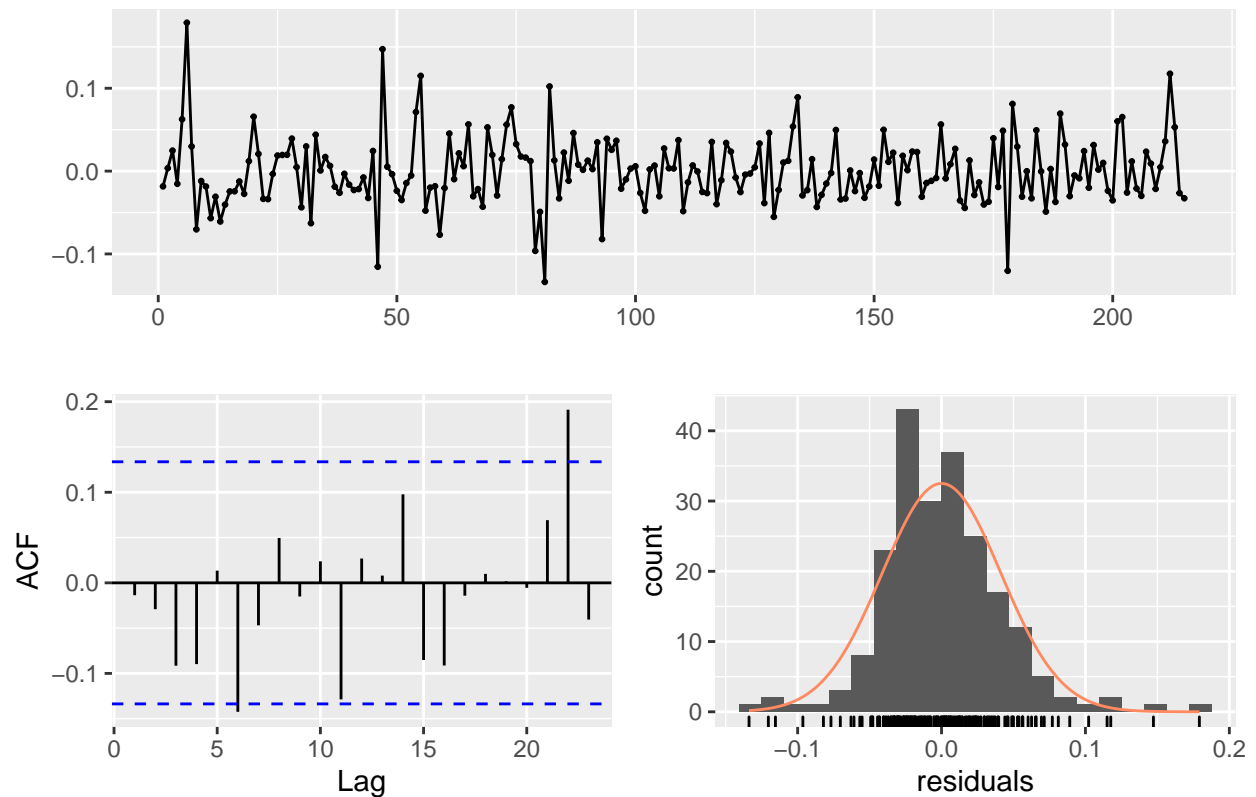


Residuals





## Residuals



## Autocorrelação

```
vars::serial.test(
  z %>% vars::vec2var(),
  lags.pt = 15,
  type = 'PT.asymptotic'
)

##
## Portmanteau Test (asymptotic)
##
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 306.4, df = 280, p-value = 0.1334
```

```
vars::serial.test(
  z %>% vars::vec2var(),
  lags.pt = 15,
  type = 'PT.adjusted'
)
```

```
##
## Portmanteau Test (adjusted)
##
```

```
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 320.97, df = 280, p-value = 0.04635
```

```
vars::serial.test(
  z %>% vars::vec2var(),
  lags.pt = 15,
  type = 'BG'
)
```

```
##
## Breusch-Godfrey LM test
##
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 152.18, df = 125, p-value = 0.0495
```

## Normalidade

```
vars::normality.test(
  z %>% vars::vec2var(),
  multivariate.only = FALSE)
```

```
## $`resids of Exportacoes`
##
## JB-Test (univariate)
##
## data: Residual of resids of Exportacoes equation
## Chi-squared = 0.72732, df = 2, p-value = 0.6951
##
##
## $`resids of Cambio`
##
## JB-Test (univariate)
##
## data: Residual of resids of Cambio equation
## Chi-squared = 28.746, df = 2, p-value = 5.726e-07
##
##
## $`resids of Importacoes`
##
## JB-Test (univariate)
##
## data: Residual of resids of Importacoes equation
## Chi-squared = 3.6024, df = 2, p-value = 0.1651
##
##
## $`resids of Industrial`
##
## JB-Test (univariate)
##
## data: Residual of resids of Industrial equation
## Chi-squared = 182.75, df = 2, p-value < 2.2e-16
```

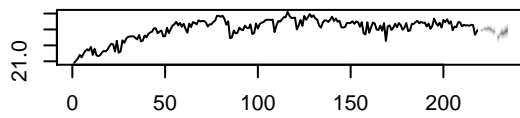


```
##
##
## $`resids of ICMS`
##
## JB-Test (univariate)
##
## data: Residual of resids of ICMS equation
## Chi-squared = 62.208, df = 2, p-value = 3.098e-14
##
##
## $JB
##
## JB-Test (multivariate)
##
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 195.33, df = 10, p-value < 2.2e-16
##
##
## $Skewness
##
## Skewness only (multivariate)
##
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 27.089, df = 5, p-value = 5.48e-05
##
##
## $Kurtosis
##
## Kurtosis only (multivariate)
##
## data: Residuals of VAR object z %>% vars::vec2var()
## Chi-squared = 168.24, df = 5, p-value < 2.2e-16
```

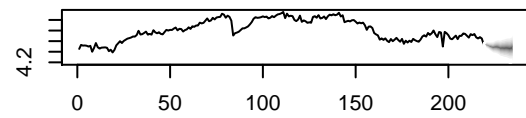
## Previsão

```
vars::fanchart(predict(
  z %>% vars::vec2var(),
  n.ahead = 15,
  ci=0.95
))
```

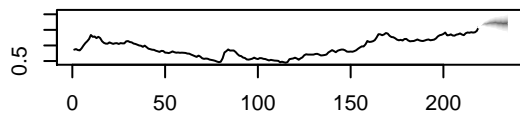
**Fanchart for variable Exportacoes**



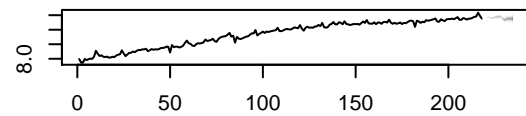
**Fanchart for variable Industrial**



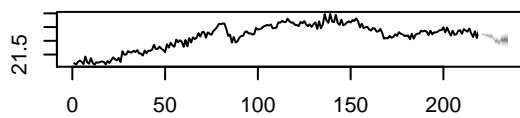
**Fanchart for variable Cambio**



**Fanchart for variable ICMS**

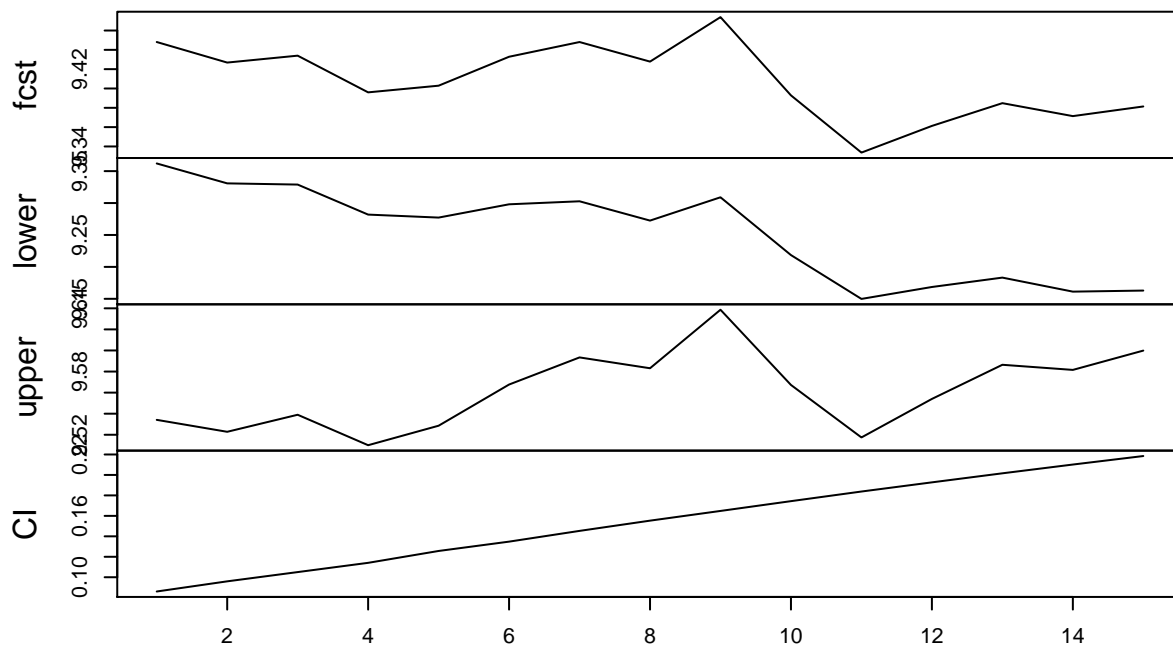


**Fanchart for variable Importacoes**



```
predict(  
  z %>% vars::vec2var(),  
  n.ahead = 15,  
  ci=0.95  
)$fcst$ICMS %>% plot.ts(  
  main = "Previsão ICMS",  
  xlab = "",  
  ylab = "R$ Milhões"  
)
```

## Previsão ICMS



## Comparação

```
comparacao <- data.frame(
  matrix(ncol = 5, nrow = 4)
)
colnames(comparacao) <- c(
  "Critérios",
  "Portmanteau_pvalue",
  "LjungBox_pvalue",
  "BG_pvalue",
  "JB_pvalue"
)

comparacao$Critérios <- c(
  "AIC(n)",
  "HQ(n)",
  "SC(n)",
  "FPE(n)"
)

ordem <- ordem[ordem >= 2] # K must be at least K=2.
for (i in 1:length(ordem)) {
  print(paste0("Estimando para VECN(K = ", ordem[i]-1, ")"), quote = FALSE)
  urca::ca.jo(
```

```

    df %>% log(), # fix sistema é computacionalmente singular
    type = "trace",
    ecdet = "const",
    K = ordem[i] %>% as.numeric(),
    season = 12,
    spec = "transitory"
  ) -> z
  z %>% urca::cajools() -> modelo
  astsa::acf2(
    residuals(modelo)[,"ICMS.d"],
    main = "ICMS"
  )
  forecast::checkresiduals(
    residuals(modelo)[,"ICMS.d"],
    main = "ICMS"
  )

  vars::serial.test(
    z %>% vars::vec2var(),
    lags.pt = 15,
    type = 'PT.asymptotic'
  ) -> teste
  comparacao$Portmanteau_pvalue[i] <- teste$serial$p.value %>% as.numeric()

  vars::serial.test(
    z %>% vars::vec2var(),
    lags.pt = 15,
    type = 'PT.adjusted'
  ) -> teste
  comparacao$LjungBox_pvalue[i] <- teste$serial$p.value %>% as.numeric()

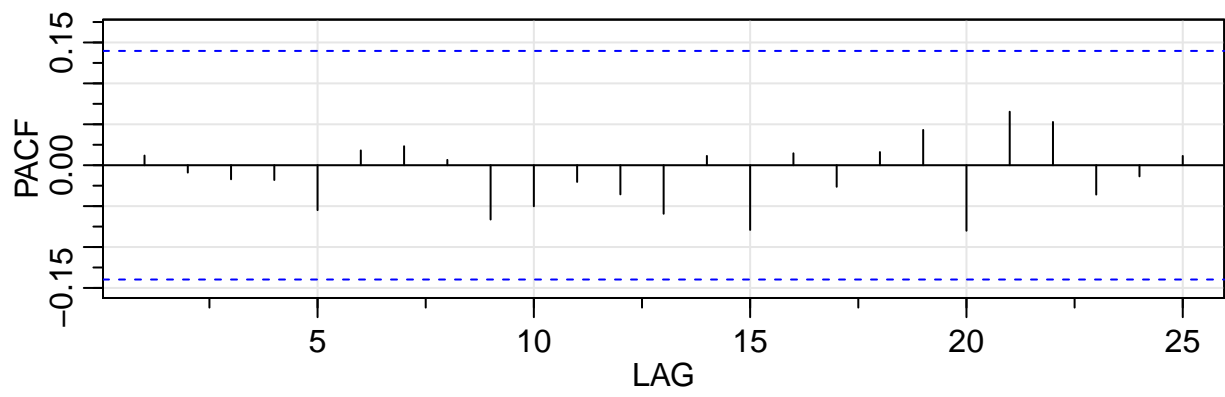
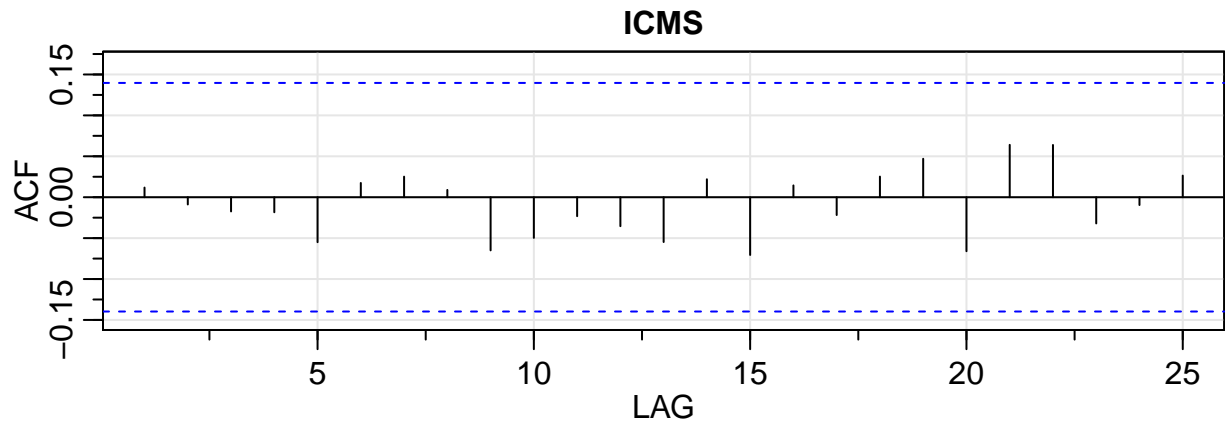
  vars::serial.test(
    z %>% vars::vec2var(),
    lags.pt = 15,
    type = 'BG'
  ) -> teste
  comparacao$BG_pvalue[i] <- teste$serial$p.value %>% as.numeric()

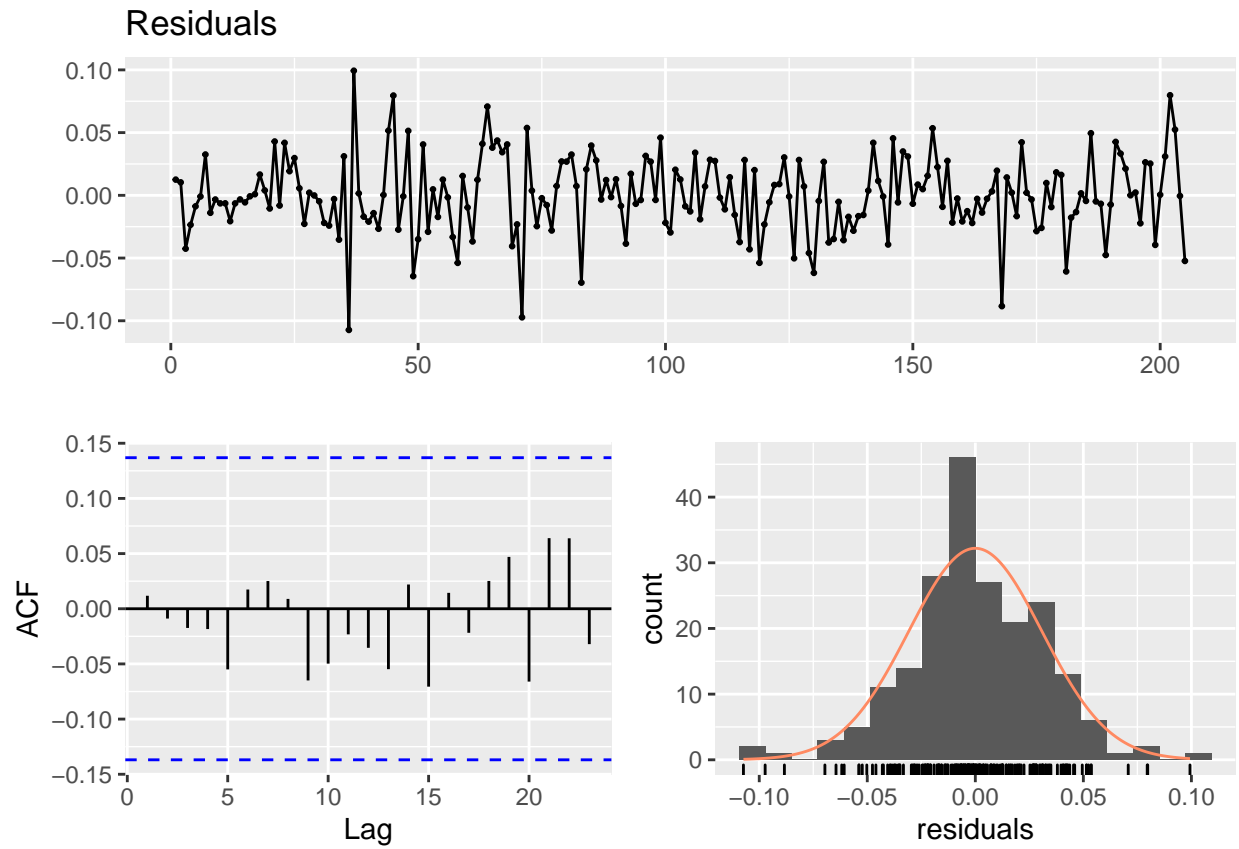
  vars::normality.test(z %>% vars::vec2var(),)$jb.mul$JB$p.value -> teste
  comparacao$JB_pvalue[i] <- teste %>% as.numeric()

  rownames(comparacao)[i] <- c(paste0("VECM(K = ", ordem[i]-1 %>% as.numeric(), ")"))
}

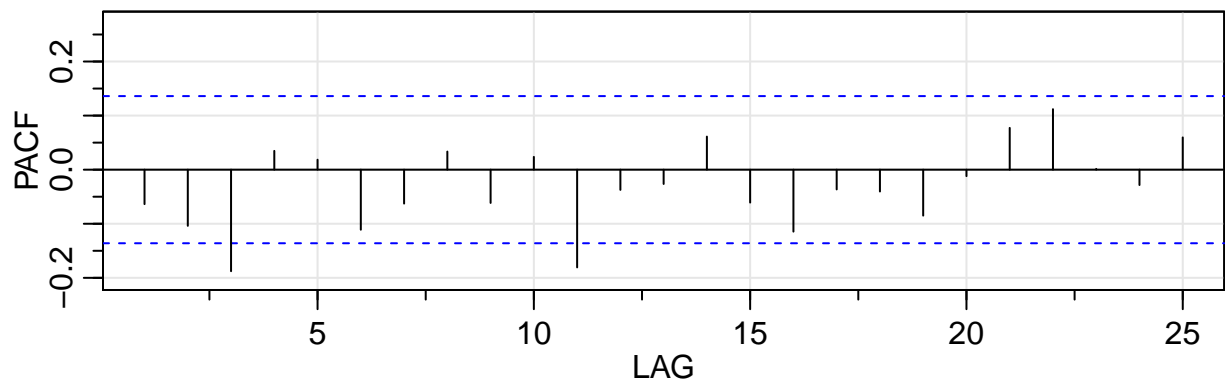
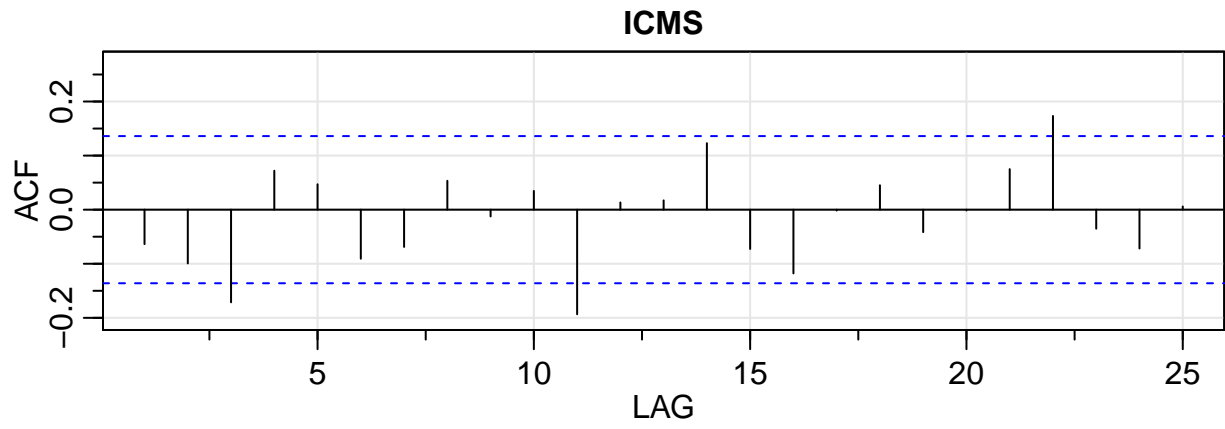
```

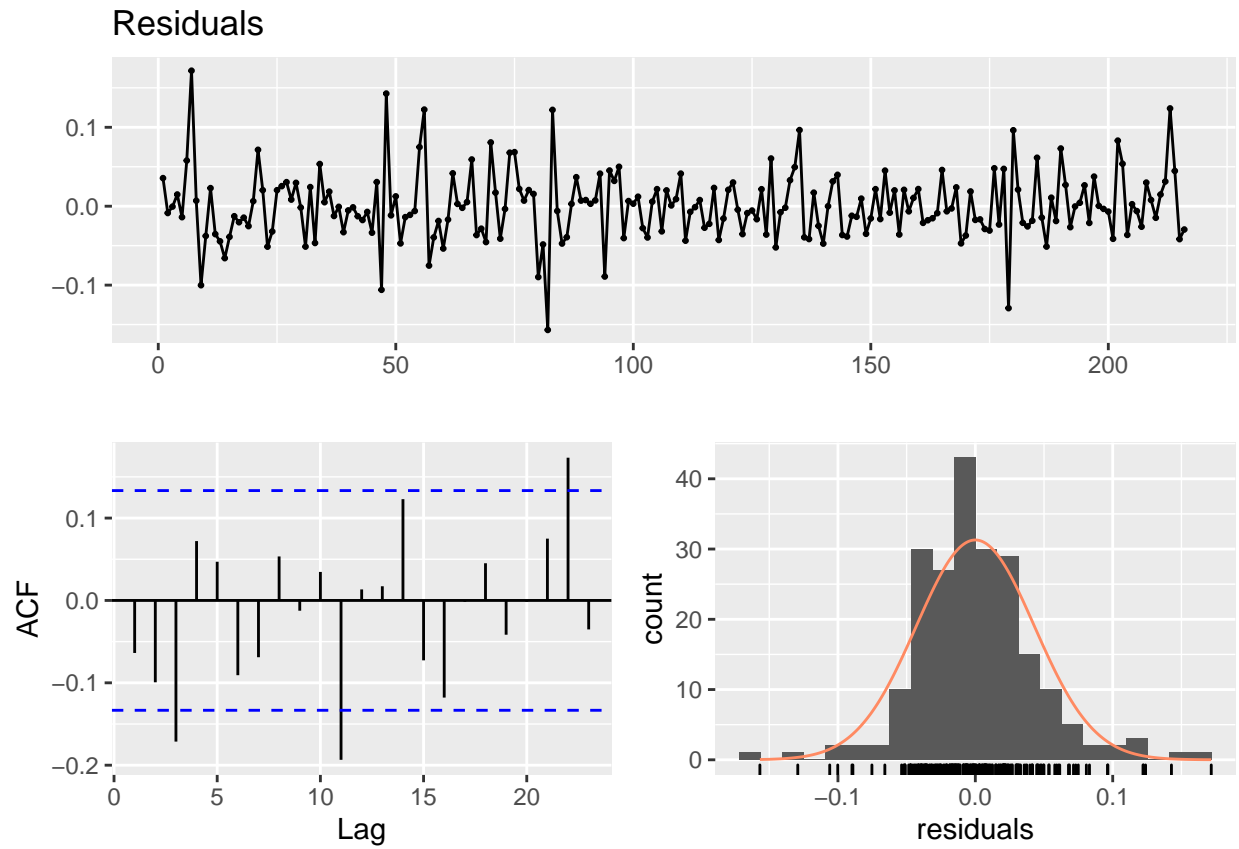
```
## [1] Estimando para VECN(K = 13)
```





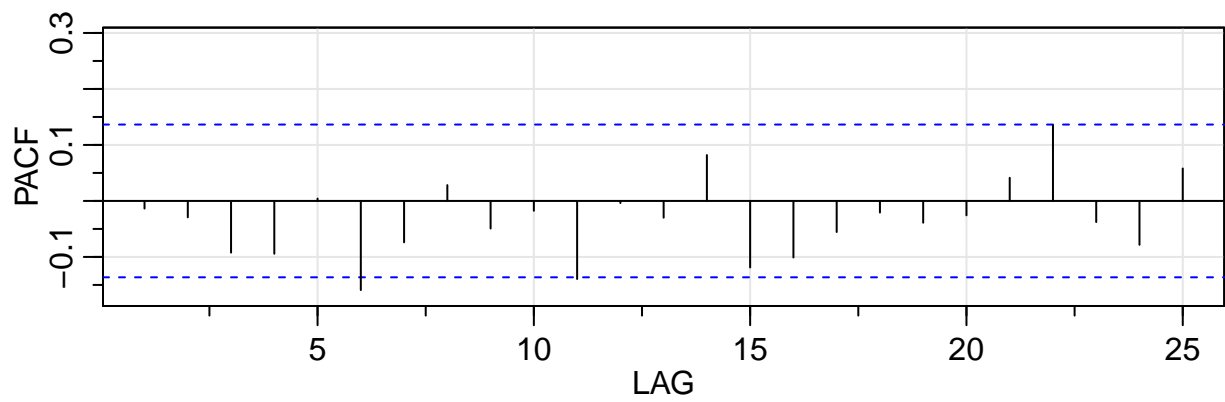
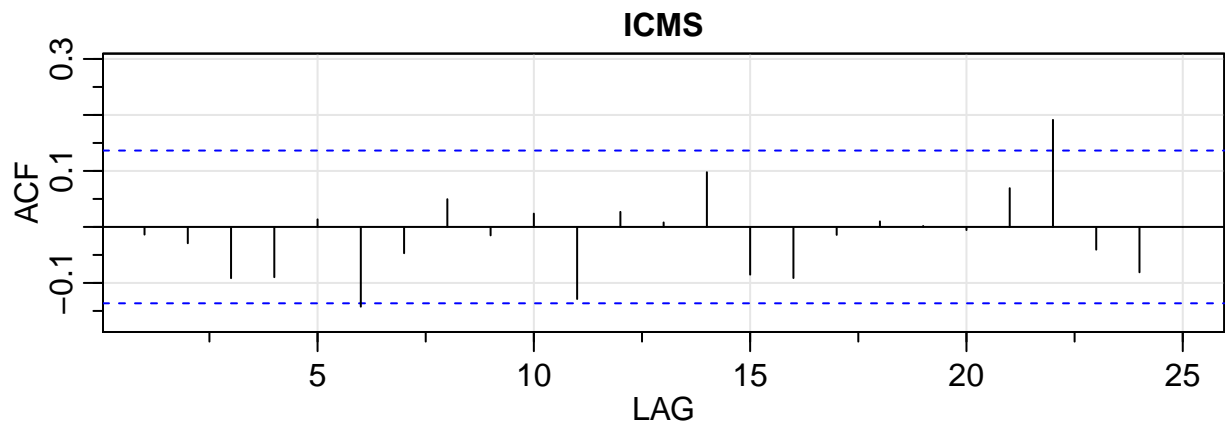
```
## [1] Estimando para VECN(K = 2)
```

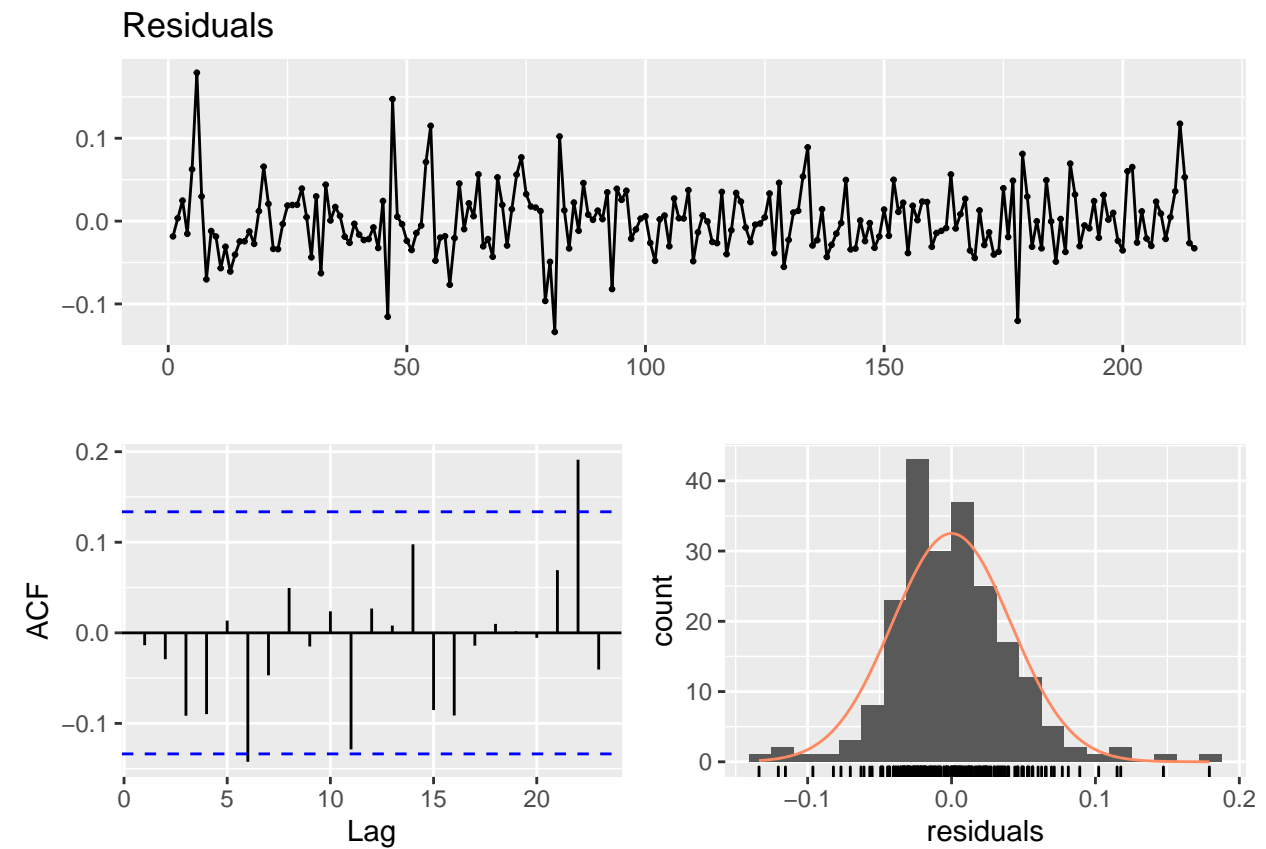




```
## [1] Estimando para VECN(K = 3)
```







```
comparacao %>% knitr::kable(digits = 3, align = 'c')
```

	Critérios	Portmanteau_pvalue	LjungBox_pvalue	BG_pvalue	JB_pvalue
VECM(K = 13)	AIC(n)	0.000	0.000	0.000	0
VECM(K = 2)	HQ(n)	0.169	0.065	0.029	0
VECM(K = 3)	SC(n)	0.133	0.046	0.050	0
4	FPE(n)	NA	NA	NA	NA