```
library(readxl)
library(tseries)
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library(ggplot2)
library(vars)
```

```
## Loading required package: MASS
```

```
## Loading required package: strucchange
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: sandwich
```

```
## Loading required package: urca
```

```
## Loading required package: lmtest
```

```
library(forecast)
library(roll)
library(tstools)
```

```
##
## Attaching package: 'tstools'
```

```
## The following object is masked from 'package:forecast':
##
##     forecast
```

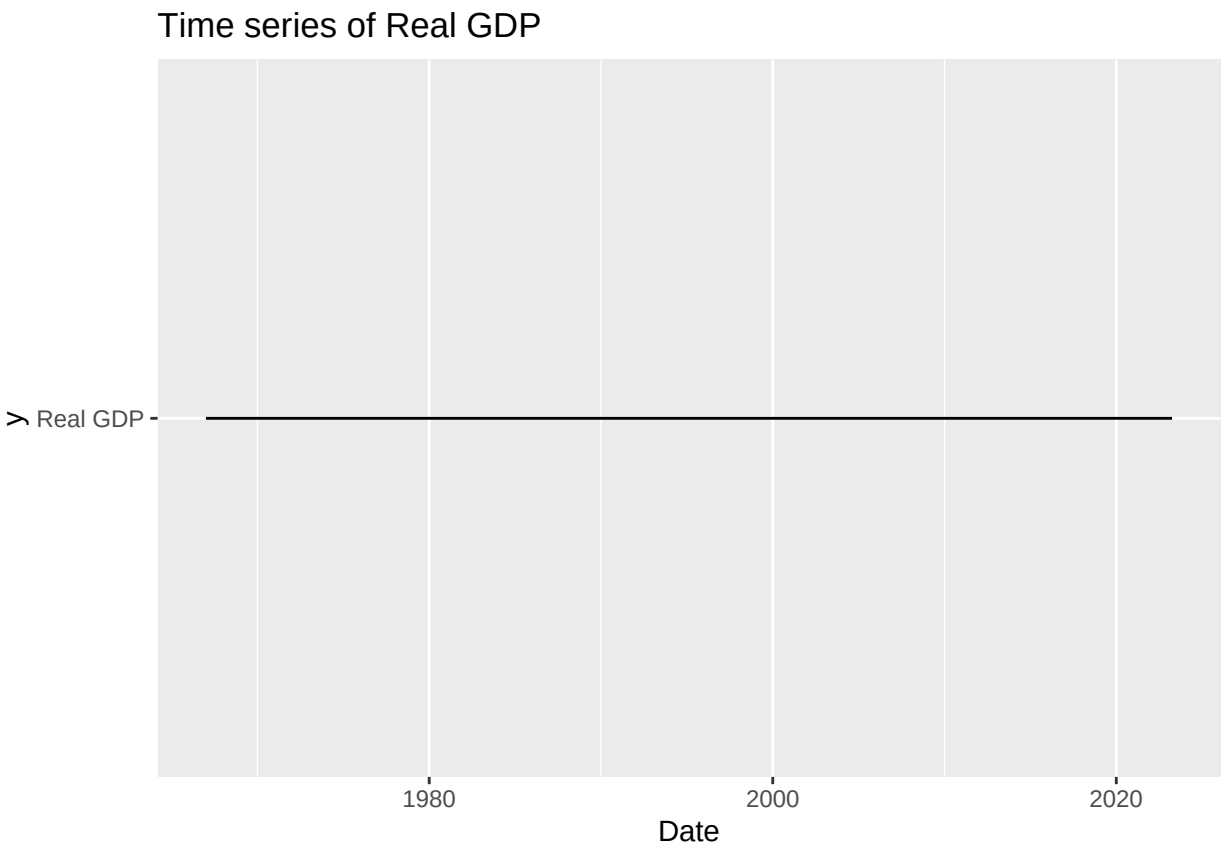
```
## The following object is masked from 'package:ggplot2':
##
##     %+%
```

```
## The following object is masked from 'package:utils':
##
##     zip
```

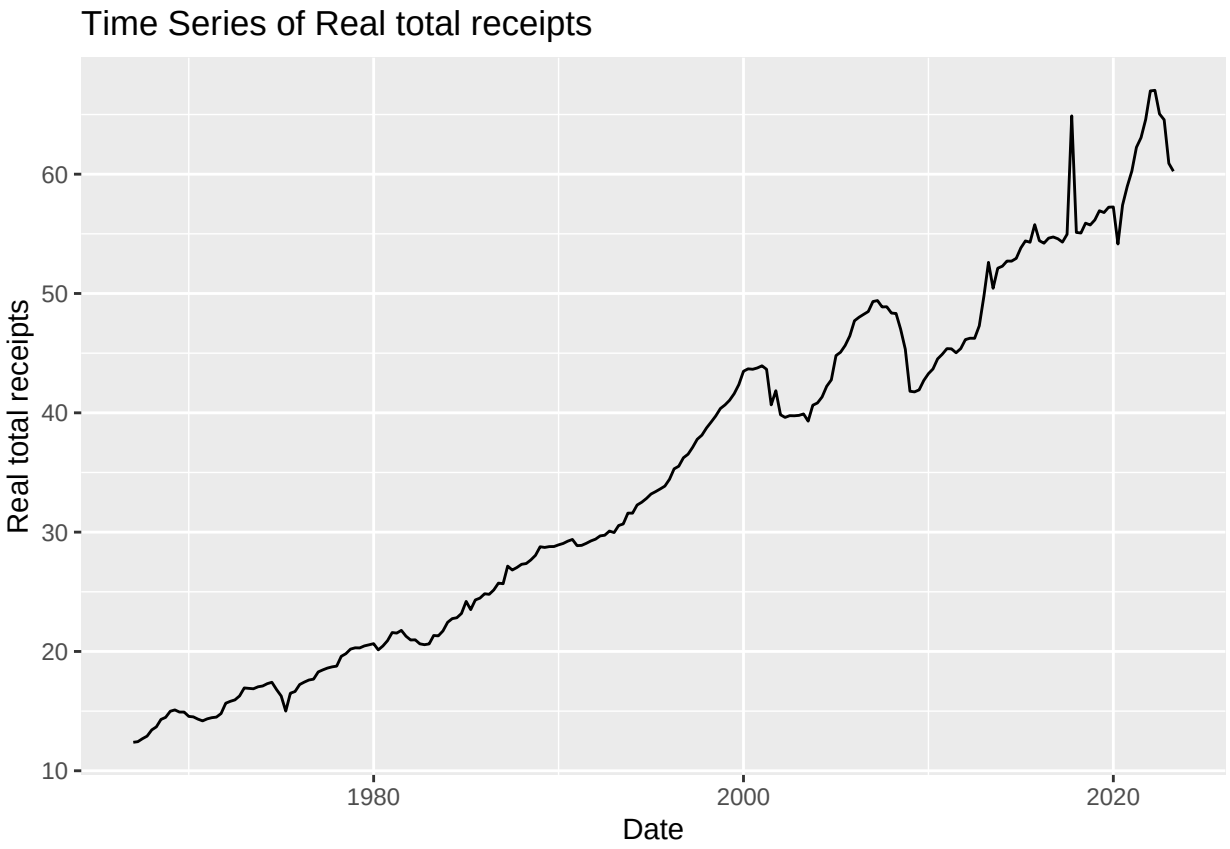
```r
library(MASS)
library(lmtest)
GDPDEF <- read_excel("GDPDEF.xls")

#descriptive statistics
summary(GDPDEF)
```

```
##       Date                      Federal Funds rate    Real GDP
##  Min.   :1967-01-01 00:00:00   Min.   : 0.060     Min.   : 4870
##  1st Qu.:1981-01-23 12:00:00   1st Qu.: 1.670     1st Qu.: 7316
##  Median :1995-02-15 00:00:00   Median : 5.030     Median :11337
##  Mean   :1995-02-15 00:00:00   Mean   : 4.963     Mean   :12239
##  3rd Qu.:2009-03-09 12:00:00   3rd Qu.: 6.900     3rd Qu.:16793
##  Max.   :2023-04-01 00:00:00   Max.   :17.790     Max.   :22225
##  Real Federal debt  Real deficit       Real total expenditures
##  Min.   : 18405    Min.   :-48.95425   Min.   : 14.73
##  1st Qu.: 22982    1st Qu.: -9.29734   1st Qu.: 24.32
##  Median : 73594    Median : -5.37361   Median : 38.76
##  Mean   : 89154    Mean   : -7.26808   Mean   : 42.00
##  3rd Qu.:129373    3rd Qu.: -2.83979   3rd Qu.: 61.61
##  Max.   :265528    Max.   : -0.01091   Max.   :103.10
##  Real total receipts
##  Min.   :12.39
##  1st Qu.:20.64
##  Median :33.29
##  Mean   :34.75
##  3rd Qu.:46.22
##  Max.   :67.03
```

```r
# graphs showing the time series trend of my data.


ggplot(GDPDEF, aes(x = Date)) +
  geom_line(aes(y = 'Real GDP',)) +
  labs(title = "Time series of Real GDP")
```




```
ggplot(GDPDEF, aes(x = Date)) +
  geom_line(aes(y = `Real total receipts`, color = "Real GDP"), col = "black") +
  labs(title = "Time Series of Real total receipts")
```




```
#stationarity test
Research <- ts(GDPDEF, start=c(1967,1), frequency = 4)
ffr <- Research[,"Federal Funds rate"]
debt <- Research[,"Real Federal debt"]
output <- Research[,"Real GDP"]
Government <- Research[,"Real total expenditures"]
taxes <- Research[,"Real total receipts"]
deficit <- Research[,"Real deficit"]
Dar.list <- list(ffr,debt,output,Government,taxes,deficit)
tes.pp <- lapply(Dar.list, function(h){
  macro.pp <- ur.pp(h, type = c("Z-tau"), model = c("constant"))
  summary(macro.pp)
})
tes.pp
```

```
## [[1]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.6361 -0.2554 -0.0728  0.3973  6.1695
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.14408    0.10024   1.437    0.152
## y.l1         0.97112    0.01598  60.787   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9199 on 223 degrees of freedom
## Multiple R-squared:  0.9431, Adjusted R-squared:  0.9428
## F-statistic:  3695 on 1 and 223 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: -2.1589
##
##          aux. Z statistics
## Z-tau-mu             1.714
##
## Critical values for Z statistics:
##                      1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
##
##
## [[2]]
##
## ####################################
## # Phillips-Perron Unit Root Test #
## ####################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7646.4  -633.9  -127.2   492.5 29479.9
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 151.05043  270.80052   0.558    0.578
## y.l1          1.01069    0.00238 424.737   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2559 on 223 degrees of freedom
## Multiple R-squared:  0.9988, Adjusted R-squared:  0.9988
## F-statistic: 1.804e+05 on 1 and 223 DF,  p-value: < 2.2e-16
##
```

```
##
## Value of test-statistic, type: Z-tau  is: 3.9694
##
##          aux. Z statistics
## Z-tau-mu            0.5449
##
## Critical values for Z statistics:
##                     1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
##
##
## [[3]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1735.41   -38.25     6.76    50.74  1377.57
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 37.469194  29.417724   1.274    0.204
## y.l1         1.003253   0.002222 451.582   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 172 on 223 degrees of freedom
## Multiple R-squared:  0.9989, Adjusted R-squared:  0.9989
## F-statistic: 2.039e+05 on 1 and 223 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: 1.8853
##
##          aux. Z statistics
## Z-tau-mu            1.4625
##
## Critical values for Z statistics:
##                     1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
##
##
## [[4]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
```

```
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -15.6375  -0.3602  -0.0918   0.2165  31.2304
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.67606    0.48755   1.387    0.167
## y.l1         0.99050    0.01056  93.829   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.094 on 223 degrees of freedom
## Multiple R-squared:  0.9753, Adjusted R-squared:  0.9752
## F-statistic:  8804 on 1 and 223 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: -0.4139
##
##          aux. Z statistics
## Z-tau-mu            1.1991
##
## Critical values for Z statistics:
##                     1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
##
##
## [[5]]
##
## ####################################
## # Phillips-Perron Unit Root Test #
## ####################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.9214 -0.2198 -0.0213  0.3416  9.7529
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.27981    0.20959   1.335    0.183
## y.l1         0.99806    0.00556 179.497   <2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.24 on 223 degrees of freedom
## Multiple R-squared:  0.9931, Adjusted R-squared:  0.9931
## F-statistic: 3.222e+04 on 1 and 223 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: -0.2334
##
##          aux. Z statistics
## Z-tau-mu            1.3718
##
## Critical values for Z statistics:
##                     1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
##
##
## [[6]]
##
## ####################################
## # Phillips-Perron Unit Root Test #
## ####################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -35.295  -0.460   0.334   0.887  13.060
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.07647    0.34035  -3.163  0.00178 **
## y.l1         0.86009    0.03464  24.828  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.46 on 223 degrees of freedom
## Multiple R-squared:  0.7343, Adjusted R-squared:  0.7332
## F-statistic: 616.4 on 1 and 223 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic, type: Z-tau  is: -3.6927
##
##          aux. Z statistics
## Z-tau-mu            -2.927
##
## Critical values for Z statistics:
##                     1pct      5pct    10pct
## critical values -3.46074 -2.874434 -2.57358
```

```r
d.ffr <- diff(log(ffr))
d.debt <- 100*diff(log(debt))
d.output <- 100*diff(log(output))
d.Government <- 100*diff(log(Government))
d.taxes <- 100*diff(log(taxes))
d.deficit <- 100*diff(log(-1*deficit))
d.Dar.list <- list(d.ffr,d.debt,d.output,d.Government,d.taxes,d.deficit)
testpp <- lapply(d.Dar.list, function(h){
  macro.pp <- ur.pp(h, type = c("Z-tau"), model = c("constant"))
  summary(macro.pp)
})
testpp
```

```
## [[1]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.95558 -0.07680  0.00285  0.07777  1.73797
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.001086   0.020687   0.053    0.958
## y.l1        0.295570   0.064078   4.613 6.72e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3096 on 222 degrees of freedom
## Multiple R-squared:  0.08746,    Adjusted R-squared:  0.08335
## F-statistic: 21.28 on 1 and 222 DF,  p-value: 6.717e-06
##
##
## Value of test-statistic, type: Z-tau  is: -11.2196
##
##          aux. Z statistics
## Z-tau-mu            0.0521
##
## Critical values for Z statistics:
##                      1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
##
##
## [[2]]
##
```

```
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.8216 -1.0390 -0.0131  0.8869 12.7592
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.86094    0.13296   6.475 6.01e-10 ***
## y.l1         0.28116    0.06358   4.422 1.53e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.653 on 222 degrees of freedom
## Multiple R-squared:  0.08095,    Adjusted R-squared:  0.07681
## F-statistic: 19.55 on 1 and 222 DF,  p-value: 1.531e-05
##
##
## Value of test-statistic, type: Z-tau  is: -11.8537
##
##          aux. Z statistics
## Z-tau-mu            6.7817
##
## Critical values for Z statistics:
##                       1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
##
##
## [[3]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.8949 -0.3569  0.0560  0.4012  6.8056
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept) 0.676671   0.085582   7.907 1.23e-13 ***
## y.l1        0.001139   0.067071   0.017    0.986
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.087 on 222 degrees of freedom
## Multiple R-squared:  1.298e-06,  Adjusted R-squared:  -0.004503
## F-statistic: 0.0002882 on 1 and 222 DF,  p-value: 0.9865
##
##
## Value of test-statistic, type: Z-tau  is: -14.9155
##
##          aux. Z statistics
## Z-tau-mu            7.9187
##
## Critical values for Z statistics:
##                      1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
##
##
## [[4]]
##
## ####################################
## # Phillips-Perron Unit Root Test #
## ####################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -18.818  -0.632   0.038   0.633  35.209
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.9722     0.2351   4.135 5.03e-05 ***
## y.l1         -0.3147     0.0637  -4.941 1.53e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.448 on 222 degrees of freedom
## Multiple R-squared:  0.09908,    Adjusted R-squared:  0.09502
## F-statistic: 24.41 on 1 and 222 DF,  p-value: 1.529e-06
##
##
## Value of test-statistic, type: Z-tau  is: -21.1744
##
##          aux. Z statistics
## Z-tau-mu            4.2421
##
## Critical values for Z statistics:
```

```
##                       1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
##
##
## [[5]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -15.0851  -0.7275   0.0497   0.9786  15.9581
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.79080    0.18113   4.366 1.94e-05 ***
## y.l1        -0.12168    0.06669  -1.825   0.0694 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.616 on 222 degrees of freedom
## Multiple R-squared:  0.01478,    Adjusted R-squared:  0.01034
## F-statistic: 3.329 on 1 and 222 DF,  p-value: 0.0694
##
##
## Value of test-statistic, type: Z-tau  is: -16.7131
##
##          aux. Z statistics
## Z-tau-mu            4.3376
##
## Critical values for Z statistics:
##                       1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
##
##
## [[6]]
##
## ###################################
## # Phillips-Perron Unit Root Test #
## ###################################
##
## Test regression with intercept
##
##
## Call:
## lm(formula = y ~ y.l1)
##
```

```
## Residuals:
##     Min      1Q  Median      3Q     Max
## -374.31  -10.56   -1.03    7.03  288.39
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.11161    2.96623   0.375 0.708200
## y.l1        -0.25400    0.06492  -3.913 0.000121 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 44.39 on 222 degrees of freedom
## Multiple R-squared:  0.06451,    Adjusted R-squared:  0.0603
## F-statistic: 15.31 on 1 and 222 DF,  p-value: 0.0001214
##
##
## Value of test-statistic, type: Z-tau  is: -19.841
##
##          aux. Z statistics
## Z-tau-mu            0.3847
##
## Critical values for Z statistics:
##                      1pct     5pct     10pct
## critical values -3.460864 -2.87449 -2.573609
```

```
#Svar model
#Estimate a VAR model to get the number of lags:
Research.1<- ts.intersect(d.ffr,d.deficit,d.taxes,d.output)
Research.2<- ts.intersect(d.ffr,d.debt,d.Government,d.deficit,d.taxes,d.output)
Research.3<- ts.intersect(d.ffr,d.Government,d.taxes,d.output)
var.1 <- VAR(Research.1, ic = "AIC", lag.max = 8)
var.1
```

```
##
## VAR Estimation Results:
## ========================
##
## Estimated coefficients for equation d.ffr:
## ==========================================
## Call:
## d.ffr = d.ffr.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + const
##
##      d.ffr.l1  d.deficit.l1    d.taxes.l1   d.output.l1         const
##  0.2882370437 -0.0001049314  0.0095549121 -0.0070525102 -0.0008564603
##
##
## Estimated coefficients for equation d.deficit:
## ==============================================
## Call:
## d.deficit = d.ffr.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + const
##
##     d.ffr.l1 d.deficit.l1   d.taxes.l1  d.output.l1        const
##   3.53137403  -0.29131830   0.01245412  -6.98999437   5.85708656
##
```

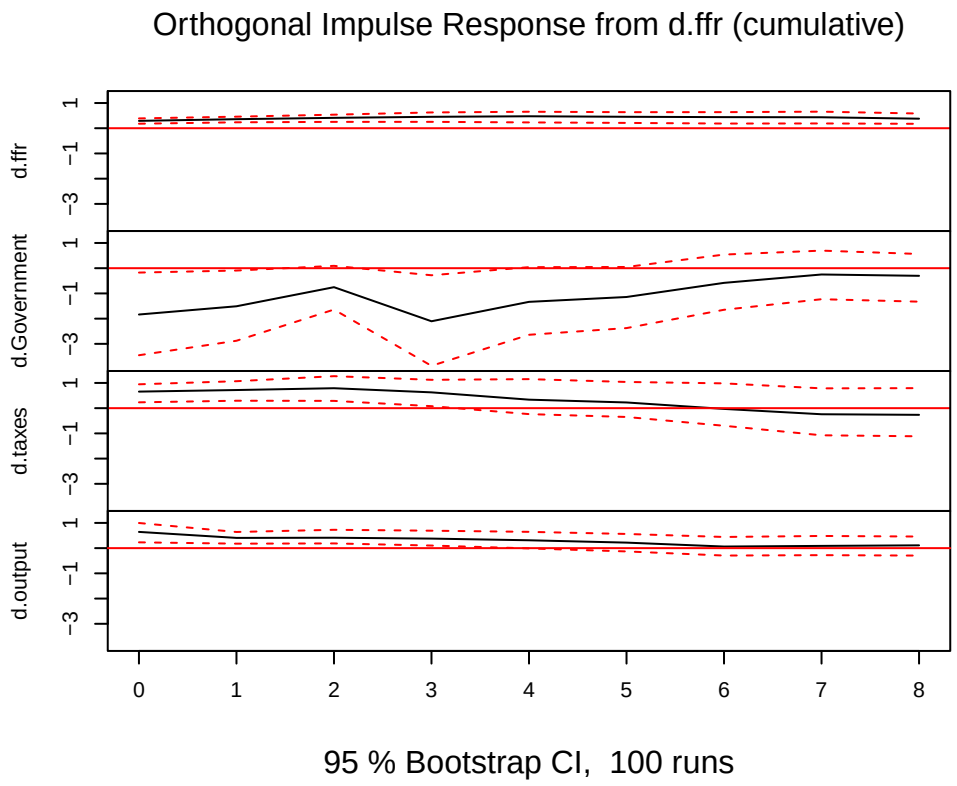
```
##
## Estimated coefficients for equation d.taxes:
## ============================================
## Call:
## d.taxes = d.ffr.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + const
##
##      d.ffr.l1  d.deficit.l1    d.taxes.l1   d.output.l1         const
## -0.7747238650  0.0004481005 -0.2166526243  0.6765480935  0.4007453798
##
##
## Estimated coefficients for equation d.output:
## ============================================
## Call:
## d.output = d.ffr.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + const
##
##     d.ffr.l1 d.deficit.l1   d.taxes.l1  d.output.l1        const
## -0.744511804  0.002247758  0.055639483  0.079193337  0.582241156
```

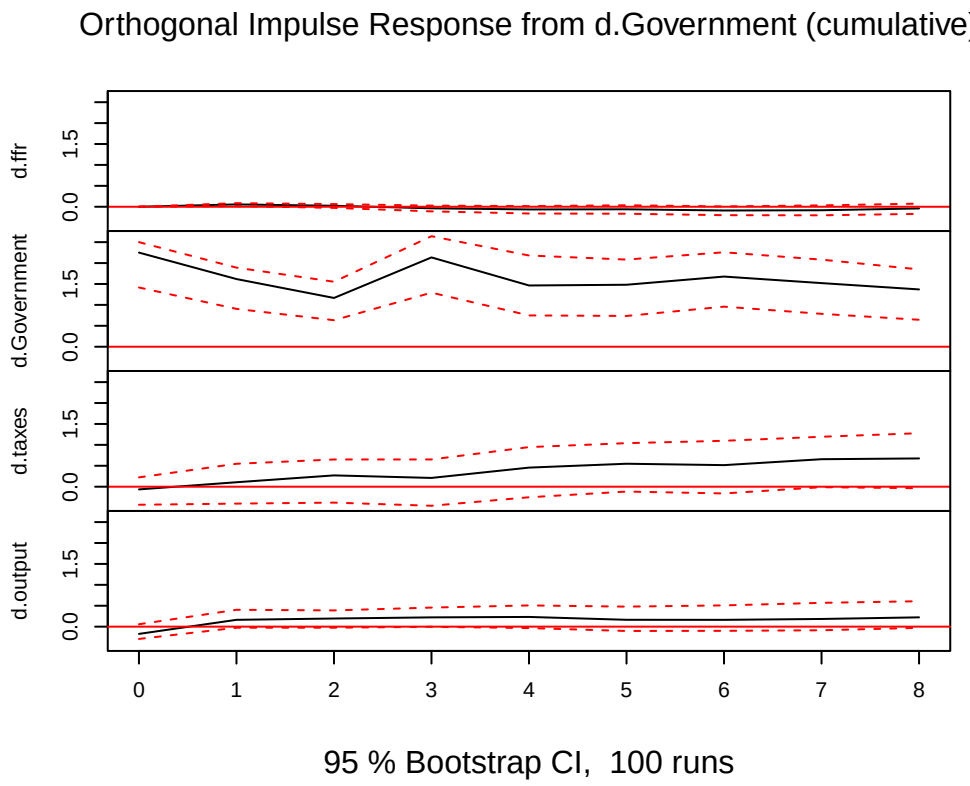
```
residual <- irf(var.1, n.ahead=8, cumulative = TRUE)
var.3 <- VAR(Research.3, ic = "AIC", lag.max = 8)
var.3
```

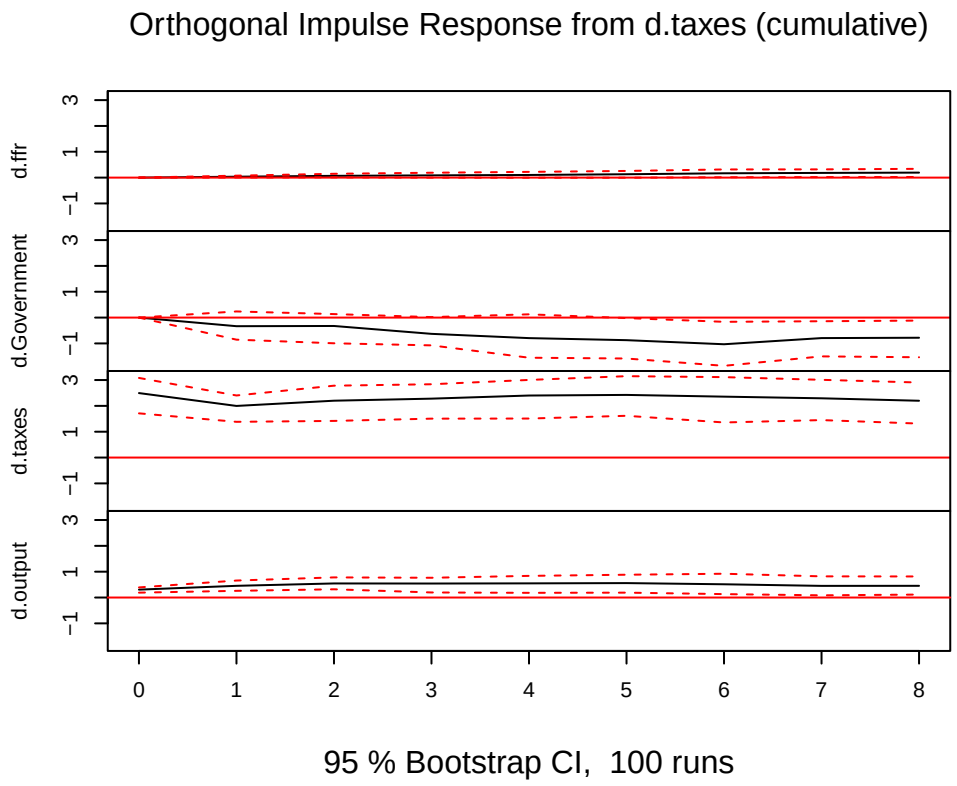
```
##
## VAR Estimation Results:
## =======================
##
## Estimated coefficients for equation d.ffr:
## ==========================================
## Call:
## d.ffr = d.ffr.l1 + d.Government.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2 + d.Government.l2 + d.taxes
##
##        d.ffr.l1 d.Government.l1      d.taxes.l1     d.output.l1        d.ffr.l2
##     0.251721747     0.030739438     0.005387519     0.072433095     0.007358845
## d.Government.l2      d.taxes.l2     d.output.l2        d.ffr.l3 d.Government.l3
##    -0.024923847     0.013344243    -0.022751029    -0.028455465    -0.028181236
##      d.taxes.l3     d.output.l3        d.ffr.l4 d.Government.l4      d.taxes.l4
##     0.009630798    -0.068275701     0.073279753    -0.022403729     0.010772062
##     d.output.l4        d.ffr.l5 d.Government.l5      d.taxes.l5     d.output.l5
##    -0.003043647    -0.162846315     0.011711689     0.006005481     0.019579697
##        d.ffr.l6 d.Government.l6      d.taxes.l6     d.output.l6           const
##    -0.104031415    -0.005275917     0.005095680     0.029227172    -0.031168781
##
##
## Estimated coefficients for equation d.Government:
## =================================================
## Call:
## d.Government = d.ffr.l1 + d.Government.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2 + d.Government.l2 + d
##
##        d.ffr.l1 d.Government.l1      d.taxes.l1     d.output.l1        d.ffr.l2
##      0.78788828     -0.34301320     -0.03673012     -0.79094343      0.20572469
## d.Government.l2      d.taxes.l2     d.output.l2        d.ffr.l3 d.Government.l3
##     -0.15890948     -0.07675124      0.50974062     -1.45500329      0.27147876
##      d.taxes.l3     d.output.l3        d.ffr.l4 d.Government.l4      d.taxes.l4
##     -0.18473886      0.13038146      0.88155688     -0.02349884     -0.15489732
```

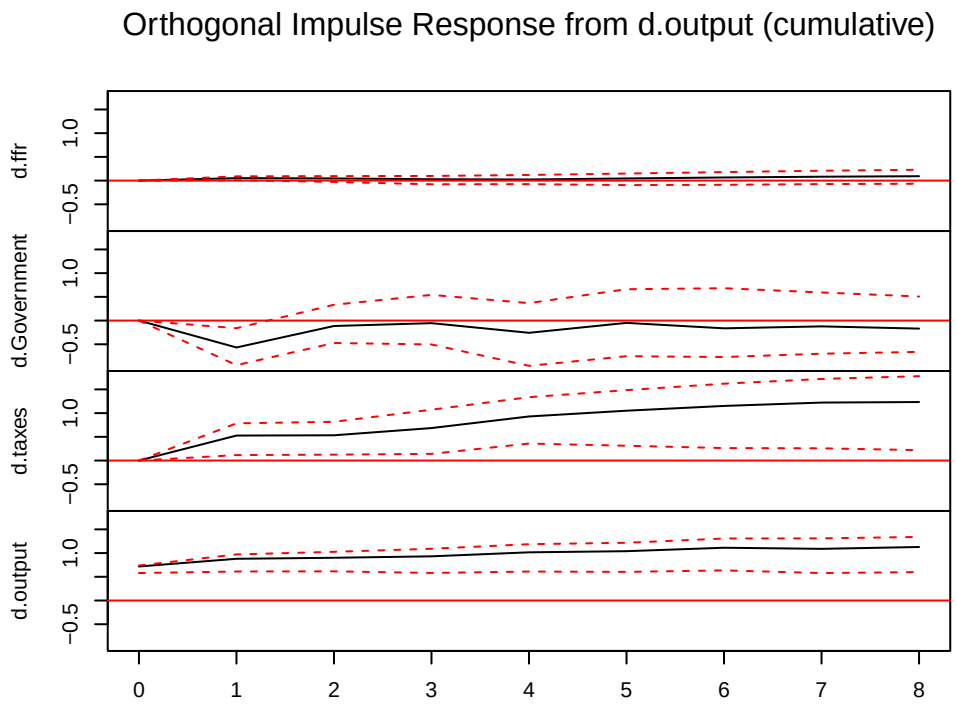
```
##     d.output.l4        d.ffr.l5 d.Government.l5      d.taxes.l5     d.output.l5
##      0.31878977      0.14801870     -0.02811327     -0.12134918      0.09110246
##        d.ffr.l6 d.Government.l6      d.taxes.l6     d.output.l6           const
##      3.26007324     -0.14632582     -0.07293459     -0.10217844      1.47378422
##
##
## Estimated coefficients for equation d.taxes:
## ============================================
## Call:
## d.taxes = d.ffr.l1 + d.Government.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2 + d.Government.l2 + d.tax
##
##        d.ffr.l1 d.Government.l1      d.taxes.l1     d.output.l1        d.ffr.l2
##    2.392444e-02    1.241270e-01   -2.894682e-01    7.349479e-01    6.726626e-01
## d.Government.l2      d.taxes.l2     d.output.l2        d.ffr.l3 d.Government.l3
##    2.998674e-02   -2.224447e-02    1.500081e-01   -1.143132e+00   -1.416431e-02
##      d.taxes.l3     d.output.l3        d.ffr.l4 d.Government.l4      d.taxes.l4
##    3.699659e-05    7.189262e-02   -6.564202e-01    1.005505e-01    2.210645e-02
##     d.output.l4        d.ffr.l5 d.Government.l5      d.taxes.l5     d.output.l5
##    3.995755e-01   -1.827115e-01    9.159705e-02    1.547341e-02    2.458250e-01
##        d.ffr.l6 d.Government.l6      d.taxes.l6     d.output.l6           const
##   -8.243804e-01    9.595755e-03   -2.776117e-02    3.906144e-02   -5.165879e-01
##
##
## Estimated coefficients for equation d.output:
## =============================================
## Call:
## d.output = d.ffr.l1 + d.Government.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2 + d.Government.l2 + d.ta
##
##        d.ffr.l1 d.Government.l1      d.taxes.l1     d.output.l1        d.ffr.l2
##   -3.309103e-01    1.678625e-01    3.104041e-02    2.272207e-01    1.554704e-02
## d.Government.l2      d.taxes.l2     d.output.l2        d.ffr.l3 d.Government.l3
##    4.274610e-02    4.308294e-02    1.117891e-01   -1.564354e-01    2.023876e-02
##      d.taxes.l3     d.output.l3        d.ffr.l4 d.Government.l4      d.taxes.l4
##    1.125914e-02   -9.758797e-02   -7.252481e-02   -4.358473e-02    1.855919e-02
##     d.output.l4        d.ffr.l5 d.Government.l5      d.taxes.l5     d.output.l5
##    9.021711e-02   -4.614802e-01   -3.308489e-02    2.342122e-02   -4.978494e-02
##        d.ffr.l6 d.Government.l6      d.taxes.l6     d.output.l6           const
##   -4.030850e-01    7.692129e-05   -7.377495e-03    5.477746e-02    2.250599e-01
```

```r
residual.3 <- irf(var.3, n.ahead=8, cumulative = TRUE)

plot(residual.3)
```

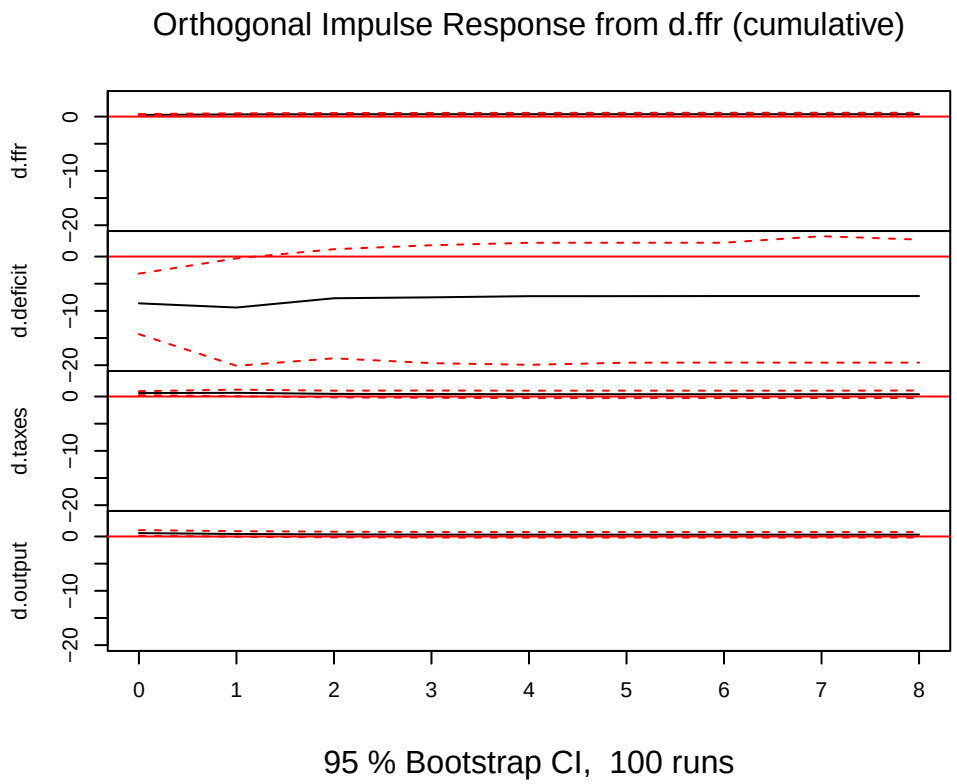

Orthogonal Impulse Response from d.ffr (cumulative)
d.ffr
d.Government
d.taxes
d.output
1
−1
−3
0
1
2
3
4
5
6
7
8
95 % Bootstrap CI, 100 runs

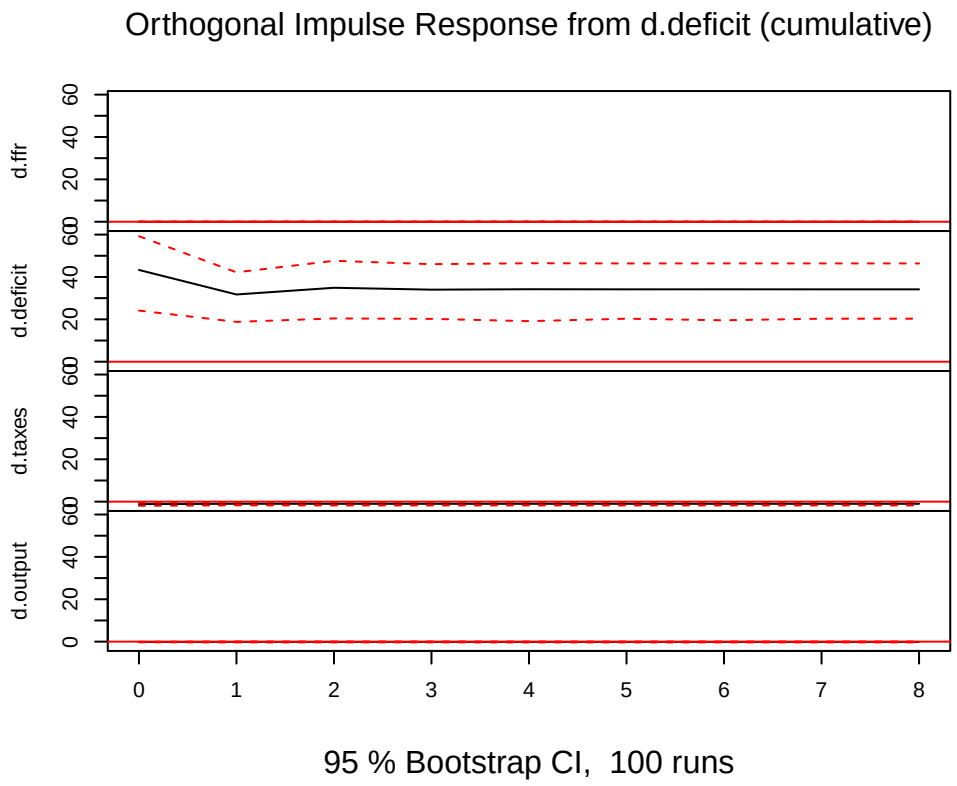

Orthogonal Impulse Response from d.Government (cumulative)
d.ffr
d.Government
d.taxes
d.output
0.0
1.5
0
1
2
3
4
5
6
7
8
95 % Bootstrap CI, 100 runs

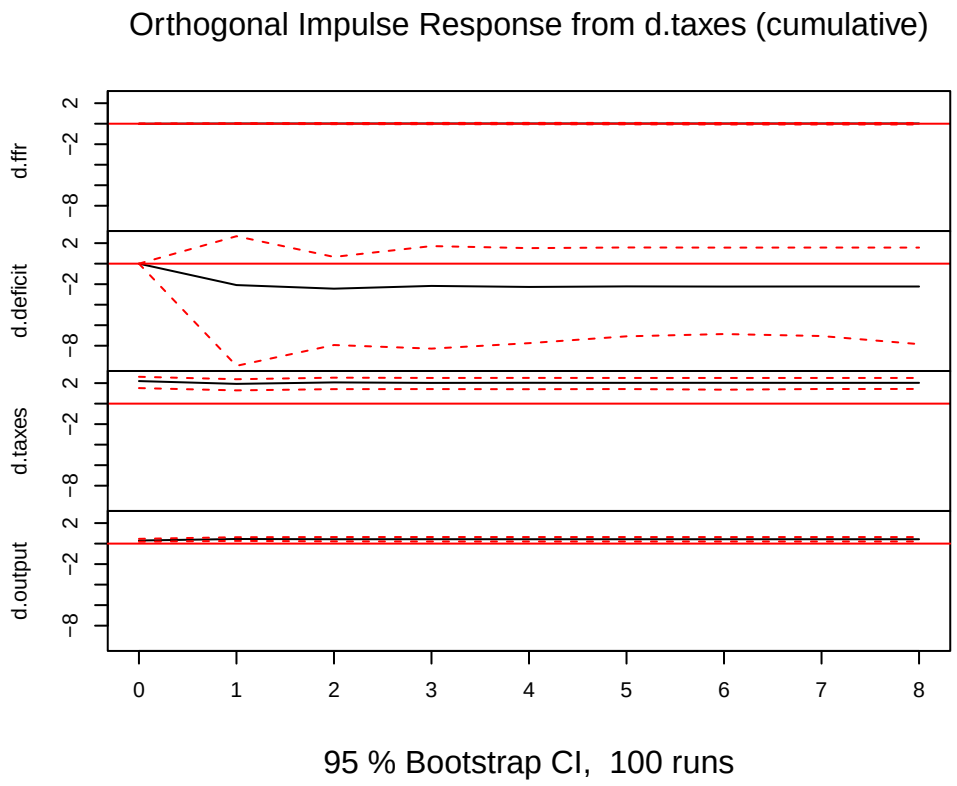

Orthogonal Impulse Response from d.taxes (cumulative)
d.ffr
d.Government
d.taxes
d.output
95 % Bootstrap CI, 100 runs

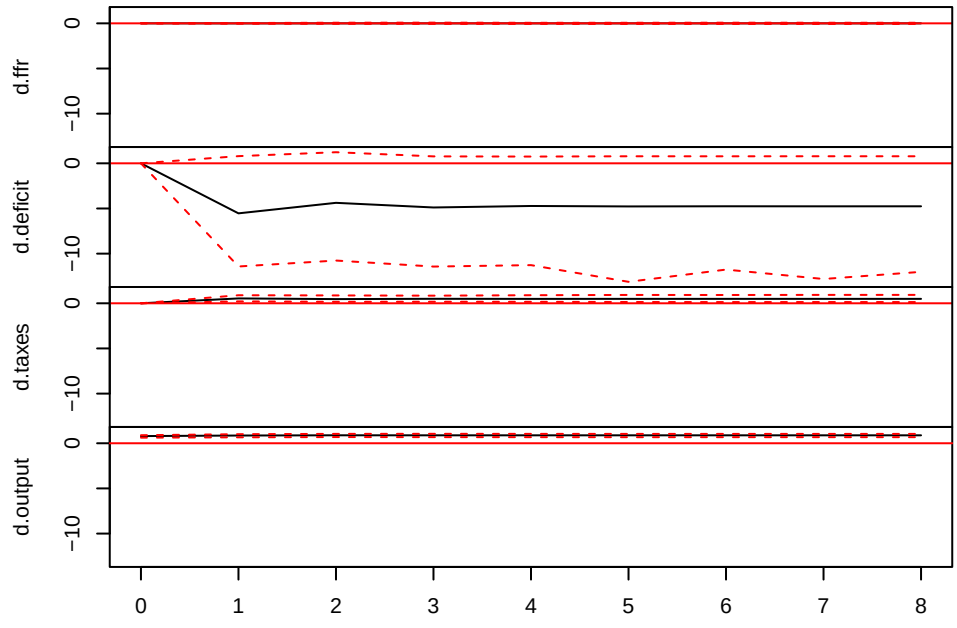



```
plot(residual)
```


Orthogonal Impulse Response from d.ffr (cumulative)
d.ffr
d.deficit
d.taxes
d.output
0
−10
−20
0
1
2
3
4
5
6
7
8
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.deficit (cumulative)
d.ffr
d.deficit
d.taxes
d.output
0
20
40
60
0
1
2
3
4
5
6
7
8
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.taxes (cumulative)
d.ffr
d.deficit
d.taxes
d.output
2
−2
−8
0
1
2
3
4
5
6
7
8
95 % Bootstrap CI, 100 runs




```
var.2 <- VAR(Research.2, ic = "AIC", lag.max = 8)
summary(var.2)
```

```
##
## VAR Estimation Results:
## =========================
## Endogenous variables: d.ffr, d.debt, d.Government, d.deficit, d.taxes, d.output
## Deterministic variables: const
## Sample size: 221
## Log Likelihood: -2671.2
## Roots of the characteristic polynomial:
## 0.8302 0.8004 0.8004 0.7816 0.7816 0.742 0.7259 0.7259 0.6927 0.6927 0.6345 0.6345 0.6034 0.6034 0.58
## Call:
## VAR(y = Research.2, lag.max = 8, ic = "AIC")
##
##
## Estimation results for equation d.ffr:
## ======================================
## d.ffr = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2 +
##
##                   Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1         2.422e-01  9.784e-02   2.476 0.014143 *
## d.debt.l1        2.839e-02  1.591e-02   1.784 0.076020 .
## d.Government.l1  2.506e-02  9.013e-03   2.780 0.005959 **
## d.deficit.l1    -4.051e-04  5.592e-04  -0.724 0.469685
```

```
## d.taxes.l1       3.931e-03  1.011e-02   0.389 0.697945
## d.output.l1      7.887e-02  2.859e-02   2.759 0.006355 **
## d.ffr.l2        -1.034e-03  9.686e-02  -0.011 0.991489
## d.debt.l2        6.839e-03  1.644e-02   0.416 0.677880
## d.Government.l2 -2.553e-02  8.911e-03  -2.865 0.004620 **
## d.deficit.l2     7.064e-05  5.860e-04   0.121 0.904177
## d.taxes.l2       1.709e-02  1.086e-02   1.573 0.117275
## d.output.l2     -4.738e-03  2.815e-02  -0.168 0.866537
## d.ffr.l3        -1.926e-02  9.928e-02  -0.194 0.846375
## d.debt.l3       -8.259e-03  1.582e-02  -0.522 0.602228
## d.Government.l3 -3.601e-02  8.744e-03  -4.118 5.63e-05 ***
## d.deficit.l3    -8.443e-05  5.856e-04  -0.144 0.885522
## d.taxes.l3       1.201e-02  1.097e-02   1.095 0.274761
## d.output.l3     -6.991e-02  2.865e-02  -2.440 0.015579 *
## d.ffr.l4        -1.161e-02  9.366e-02  -0.124 0.901467
## d.debt.l4       -1.425e-02  1.501e-02  -0.950 0.343477
## d.Government.l4 -2.741e-02  8.198e-03  -3.343 0.000993 ***
## d.deficit.l4     4.582e-04  5.678e-04   0.807 0.420678
## d.taxes.l4       1.160e-02  1.046e-02   1.109 0.268929
## d.output.l4      1.470e-02  2.868e-02   0.512 0.608889
## const           -1.358e-02  4.357e-02  -0.312 0.755528
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2928 on 196 degrees of freedom
## Multiple R-Squared: 0.2787,  Adjusted R-squared: 0.1904
## F-statistic: 3.155 on 24 and 196 DF,  p-value: 5.218e-06
##
##
## Estimation results for equation d.debt:
## =======================================
## d.debt = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l2
##
##                  Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1        -0.015888   0.507055  -0.031 0.975035
## d.debt.l1        0.106493   0.082474   1.291 0.198148
## d.Government.l1 -0.034450   0.046708  -0.738 0.461665
## d.deficit.l1    -0.003340   0.002898  -1.153 0.250474
## d.taxes.l1      -0.127432   0.052416  -2.431 0.015951 *
## d.output.l1     -0.047501   0.148161  -0.321 0.748855
## d.ffr.l2        -0.879097   0.501939  -1.751 0.081441 .
## d.debt.l2        0.040836   0.085207   0.479 0.632289
## d.Government.l2 -0.033918   0.046178  -0.734 0.463525
## d.deficit.l2     0.001058   0.003037   0.348 0.727913
## d.taxes.l2      -0.116292   0.056305  -2.065 0.040201 *
## d.output.l2     -0.011701   0.145904  -0.080 0.936165
## d.ffr.l3         0.211913   0.514478   0.412 0.680863
## d.debt.l3        0.157475   0.081984   1.921 0.056209 .
## d.Government.l3  0.011421   0.045313   0.252 0.801270
## d.deficit.l3    -0.001451   0.003035  -0.478 0.633092
## d.taxes.l3      -0.093553   0.056846  -1.646 0.101422
## d.output.l3     -0.009507   0.148494  -0.064 0.949016
## d.ffr.l4         0.518051   0.485381   1.067 0.287145
```

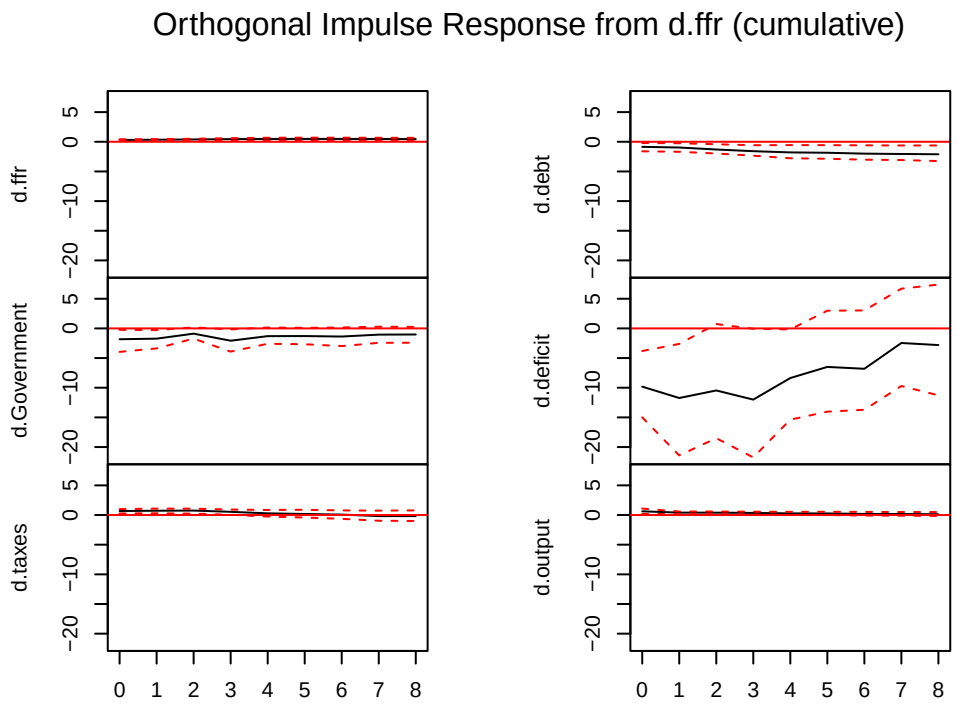
```
## d.debt.l4        0.359811   0.077787   4.626 6.77e-06 ***
## d.Government.l4  0.005999   0.042486   0.141 0.887859
## d.deficit.l4    -0.002101   0.002943  -0.714 0.475999
## d.taxes.l4      -0.007989   0.054231  -0.147 0.883036
## d.output.l4     -0.021259   0.148644  -0.143 0.886424
## const            0.755094   0.225777   3.344 0.000988 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 1.517 on 196 degrees of freedom
## Multiple R-Squared: 0.3117,  Adjusted R-squared: 0.2274
## F-statistic: 3.699 on 24 and 196 DF,  p-value: 1.717e-07
##
##
## Estimation results for equation d.Government:
## ============================================
## d.Government = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.
##
##                  Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1        -0.409437   0.981234  -0.417 0.676940
## d.debt.l1       -0.207975   0.159601  -1.303 0.194072
## d.Government.l1 -0.275191   0.090388  -3.045 0.002650 **
## d.deficit.l1    -0.003833   0.005608  -0.683 0.495126
## d.taxes.l1      -0.086670   0.101434  -0.854 0.393900
## d.output.l1     -0.701348   0.286716  -2.446 0.015322 *
## d.ffr.l2         1.177555   0.971333   1.212 0.226853
## d.debt.l2        0.048710   0.164889   0.295 0.767992
## d.Government.l2 -0.010395   0.089362  -0.116 0.907513
## d.deficit.l2    -0.003247   0.005877  -0.552 0.581238
## d.taxes.l2      -0.173371   0.108959  -1.591 0.113184
## d.output.l2      0.759248   0.282349   2.689 0.007783 **
## d.ffr.l3        -0.391813   0.995599  -0.394 0.694344
## d.debt.l3        0.452122   0.158653   2.850 0.004843 **
## d.Government.l3  0.137103   0.087689   1.564 0.119546
## d.deficit.l3    -0.003676   0.005873  -0.626 0.532153
## d.taxes.l3      -0.152853   0.110007  -1.389 0.166260
## d.output.l3     -0.128781   0.287359  -0.448 0.654537
## d.ffr.l4         0.481820   0.939291   0.513 0.608556
## d.debt.l4       -0.463047   0.150530  -3.076 0.002397 **
## d.Government.l4  0.005541   0.082218   0.067 0.946336
## d.deficit.l4     0.001656   0.005695   0.291 0.771464
## d.taxes.l4      -0.027206   0.104945  -0.259 0.795720
## d.output.l4     -0.188679   0.287650  -0.656 0.512636
## const            1.538558   0.436915   3.521 0.000534 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 2.936 on 196 degrees of freedom
## Multiple R-Squared: 0.4225,  Adjusted R-squared: 0.3518
## F-statistic: 5.974 on 24 and 196 DF,  p-value: 1.485e-13
##
##
```

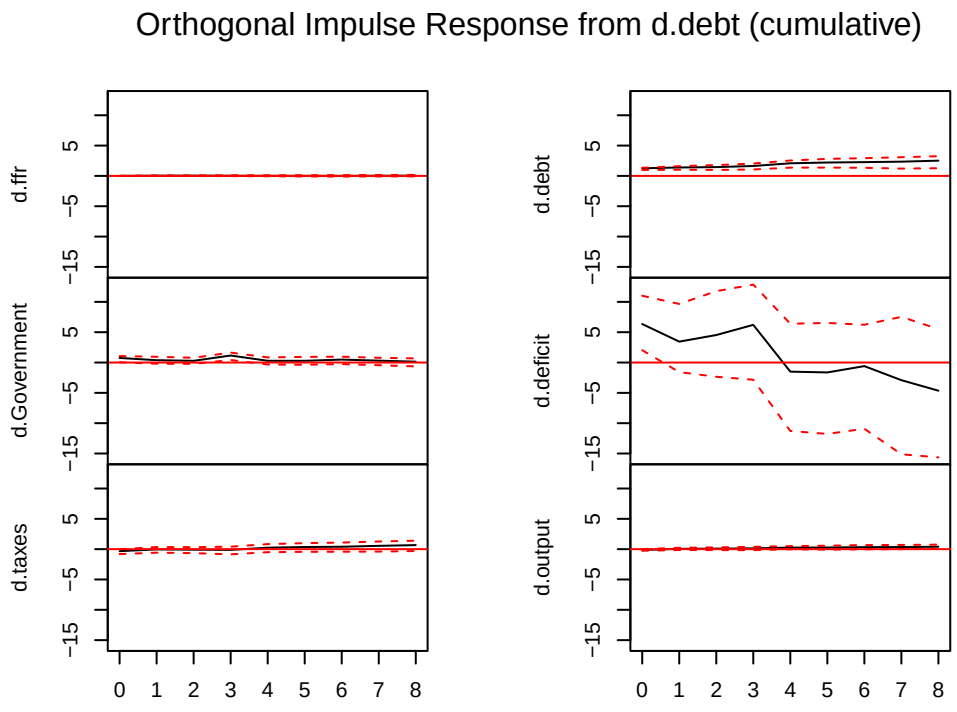
```
## Estimation results for equation d.deficit:
## ==========================================
## d.deficit = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.ffr
##
##                 Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1        -8.60690   14.43970  -0.596  0.55182
## d.debt.l1       -1.43940    2.34867  -0.613  0.54068
## d.Government.l1  0.56927    1.33014   0.428  0.66914
## d.deficit.l1    -0.35321    0.08253  -4.280 2.92e-05 ***
## d.taxes.l1      -0.32489    1.49269  -0.218  0.82793
## d.output.l1     -4.52288    4.21928  -1.072  0.28506
## d.ffr.l2         9.79381   14.29399   0.685  0.49405
## d.debt.l2        1.19424    2.42649   0.492  0.62315
## d.Government.l2  0.84088    1.31504   0.639  0.52329
## d.deficit.l2    -0.17653    0.08648  -2.041  0.04256 *
## d.taxes.l2      -1.58448    1.60342  -0.988  0.32428
## d.output.l2     -1.72987    4.15501  -0.416  0.67762
## d.ffr.l3        -2.20728   14.65108  -0.151  0.88040
## d.debt.l3        1.81874    2.33471   0.779  0.43692
## d.Government.l3  1.53846    1.29042   1.192  0.23462
## d.deficit.l3    -0.28608    0.08643  -3.310  0.00111 **
## d.taxes.l3      -3.47414    1.61884  -2.146  0.03310 *
## d.output.l3      2.72095    4.22874   0.643  0.52069
## d.ffr.l4         2.37618   13.82247   0.172  0.86369
## d.debt.l4       -5.48204    2.21517  -2.475  0.01418 *
## d.Government.l4 -1.01295    1.20991  -0.837  0.40349
## d.deficit.l4    -0.10253    0.08380  -1.224  0.22260
## d.taxes.l4      -0.86004    1.54436  -0.557  0.57824
## d.output.l4     -6.68158    4.23302  -1.578  0.11608
## const           16.39093    6.42958   2.549  0.01156 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 43.21 on 196 degrees of freedom
## Multiple R-Squared: 0.2169,  Adjusted R-squared: 0.1211
## F-statistic: 2.263 on 24 and 196 DF,  p-value: 0.001209
##
##
## Estimation results for equation d.taxes:
## ========================================
## d.taxes = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l1
##
##                  Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1         0.194482   0.843918   0.230  0.81798
## d.debt.l1        0.202551   0.137266   1.476  0.14165
## d.Government.l1  0.085136   0.077739   1.095  0.27480
## d.deficit.l1    -0.004510   0.004823  -0.935  0.35096
## d.taxes.l1      -0.292497   0.087239  -3.353  0.00096 ***
## d.output.l1      0.760818   0.246593   3.085  0.00233 **
## d.ffr.l2         0.235197   0.835402   0.282  0.77860
## d.debt.l2       -0.075929   0.141814  -0.535  0.59297
## d.Government.l2  0.020662   0.076856   0.269  0.78834
## d.deficit.l2    -0.006714   0.005054  -1.328  0.18563
```

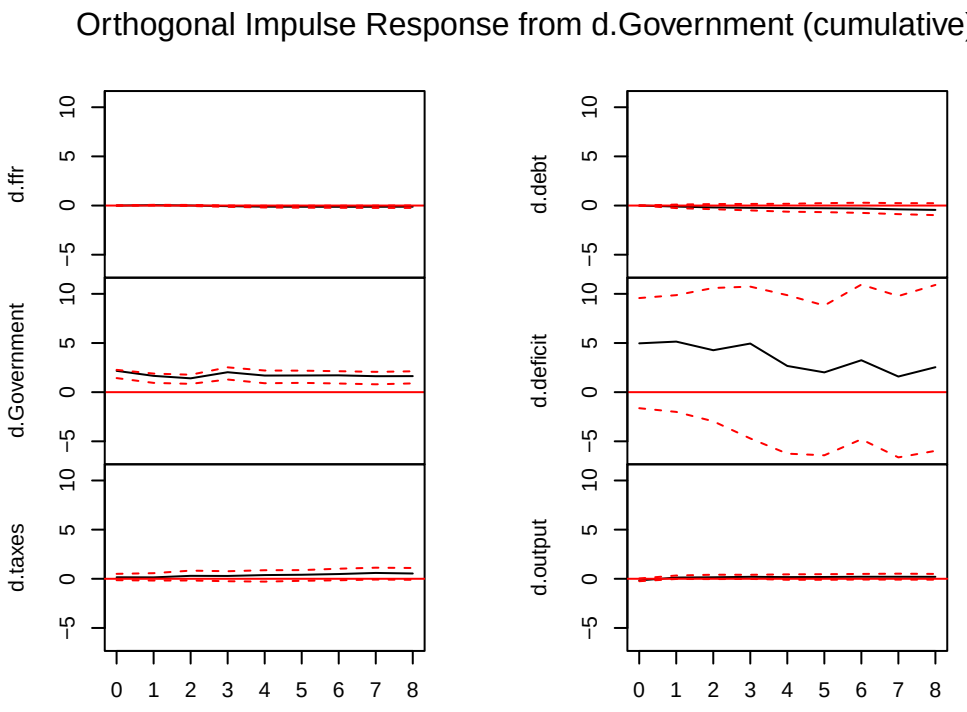
```
## d.taxes.l2      -0.045848   0.093711  -0.489  0.62521
## d.output.l2      0.111168   0.242836   0.458  0.64761
## d.ffr.l3        -1.128052   0.856272  -1.317  0.18924
## d.debt.l3       -0.065434   0.136450  -0.480  0.63209
## d.Government.l3  0.015133   0.075418   0.201  0.84118
## d.deficit.l3     0.001588   0.005051   0.314  0.75357
## d.taxes.l3       0.016366   0.094612   0.173  0.86284
## d.output.l3      0.154009   0.247146   0.623  0.53391
## d.ffr.l4        -0.385956   0.807845  -0.478  0.63335
## d.debt.l4        0.234843   0.129464   1.814  0.07121 .
## d.Government.l4  0.065709   0.070712   0.929  0.35390
## d.deficit.l4    -0.005869   0.004898  -1.198  0.23222
## d.taxes.l4      -0.038986   0.090259  -0.432  0.66627
## d.output.l4      0.482681   0.247396   1.951  0.05248 .
## const           -0.564689   0.375772  -1.503  0.13452
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 2.525 on 196 degrees of freedom
## Multiple R-Squared: 0.1825,  Adjusted R-squared: 0.08242
## F-statistic: 1.823 on 24 and 196 DF,  p-value: 0.01409
##
##
## Estimation results for equation d.output:
## =========================================
## d.output = d.ffr.l1 + d.debt.l1 + d.Government.l1 + d.deficit.l1 + d.taxes.l1 + d.output.l1 + d.ffr.l
##
##                   Estimate Std. Error t value Pr(>|t|)
## d.ffr.l1        -7.717e-02  3.412e-01  -0.226   0.8213
## d.debt.l1        9.379e-02  5.550e-02   1.690   0.0926 .
## d.Government.l1  1.486e-01  3.143e-02   4.728 4.32e-06 ***
## d.deficit.l1    -9.705e-05  1.950e-03  -0.050   0.9604
## d.taxes.l1       3.016e-02  3.527e-02   0.855   0.3935
## d.output.l1      2.156e-01  9.970e-02   2.163   0.0318 *
## d.ffr.l2         1.017e-01  3.378e-01   0.301   0.7636
## d.debt.l2        2.483e-02  5.734e-02   0.433   0.6654
## d.Government.l2  2.536e-02  3.107e-02   0.816   0.4154
## d.deficit.l2     5.143e-05  2.043e-03   0.025   0.9799
## d.taxes.l2       5.365e-02  3.789e-02   1.416   0.1583
## d.output.l2      5.937e-02  9.818e-02   0.605   0.5460
## d.ffr.l3        -1.045e-01  3.462e-01  -0.302   0.7631
## d.debt.l3       -2.797e-03  5.517e-02  -0.051   0.9596
## d.Government.l3  2.346e-02  3.049e-02   0.769   0.4427
## d.deficit.l3     8.386e-04  2.042e-03   0.411   0.6818
## d.taxes.l3       1.798e-02  3.825e-02   0.470   0.6388
## d.output.l3     -8.866e-02  9.992e-02  -0.887   0.3760
## d.ffr.l4        -7.547e-02  3.266e-01  -0.231   0.8175
## d.debt.l4        2.887e-02  5.234e-02   0.552   0.5819
## d.Government.l4 -3.203e-02  2.859e-02  -1.120   0.2640
## d.deficit.l4     1.093e-03  1.980e-03   0.552   0.5815
## d.taxes.l4       1.147e-02  3.649e-02   0.314   0.7535
## d.output.l4      1.495e-01  1.000e-01   1.495   0.1365
## const            6.580e-02  1.519e-01   0.433   0.6654
```

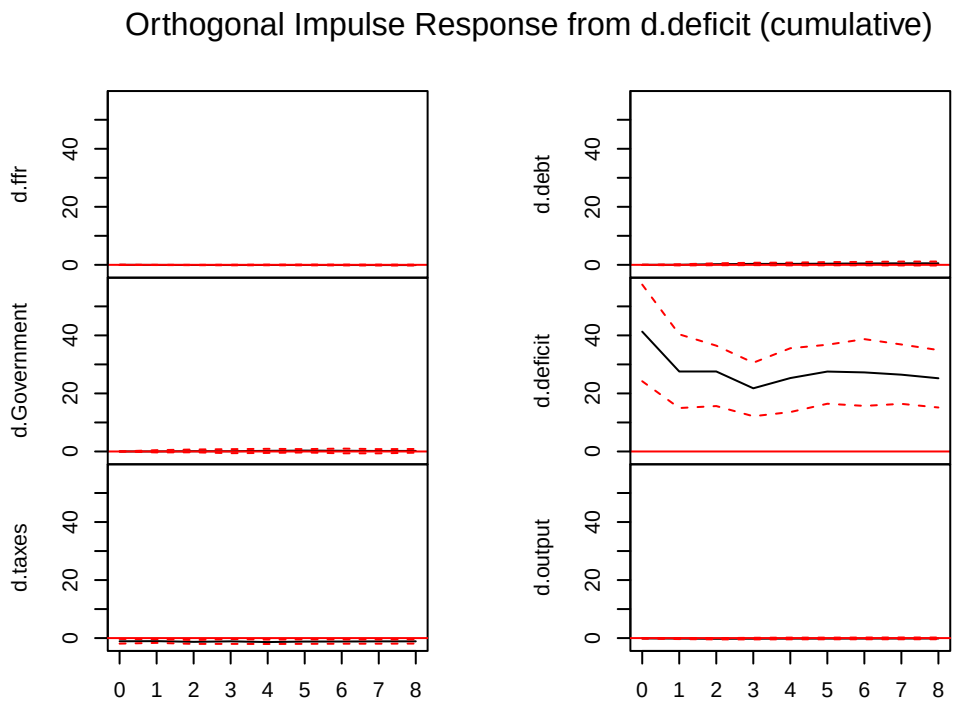
```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 1.021 on 196 degrees of freedom
## Multiple R-Squared: 0.2149,  Adjusted R-squared: 0.1188
## F-statistic: 2.236 on 24 and 196 DF,  p-value: 0.001414
##
##
##
## Covariance matrix of residuals:
##                 d.ffr  d.debt d.Government d.deficit  d.taxes d.output
## d.ffr         0.08573 -0.2494      -0.5352    -2.876   0.1973   0.1832
## d.debt       -0.24941  2.3025       2.5055    16.338  -0.9883  -0.7015
## d.Government -0.53515  2.5055       8.6225    33.527  -1.1474  -1.6020
## d.deficit    -2.87552 16.3383      33.5269  1867.263 -53.5705 -12.2648
## d.taxes       0.19732 -0.9883      -1.1474   -53.570   6.3781   1.1217
## d.output      0.18320 -0.7015      -1.6020   -12.265   1.1217   1.0425
##
## Correlation matrix of residuals:
##                d.ffr  d.debt d.Government d.deficit d.taxes d.output
## d.ffr         1.0000 -0.5614      -0.6224   -0.2273  0.2668   0.6128
## d.debt       -0.5614  1.0000       0.5623    0.2492 -0.2579  -0.4527
## d.Government -0.6224  0.5623       1.0000    0.2642 -0.1547  -0.5343
## d.deficit    -0.2273  0.2492       0.2642    1.0000 -0.4909  -0.2780
## d.taxes       0.2668 -0.2579      -0.1547   -0.4909  1.0000   0.4350
## d.output      0.6128 -0.4527      -0.5343   -0.2780  0.4350   1.0000
```

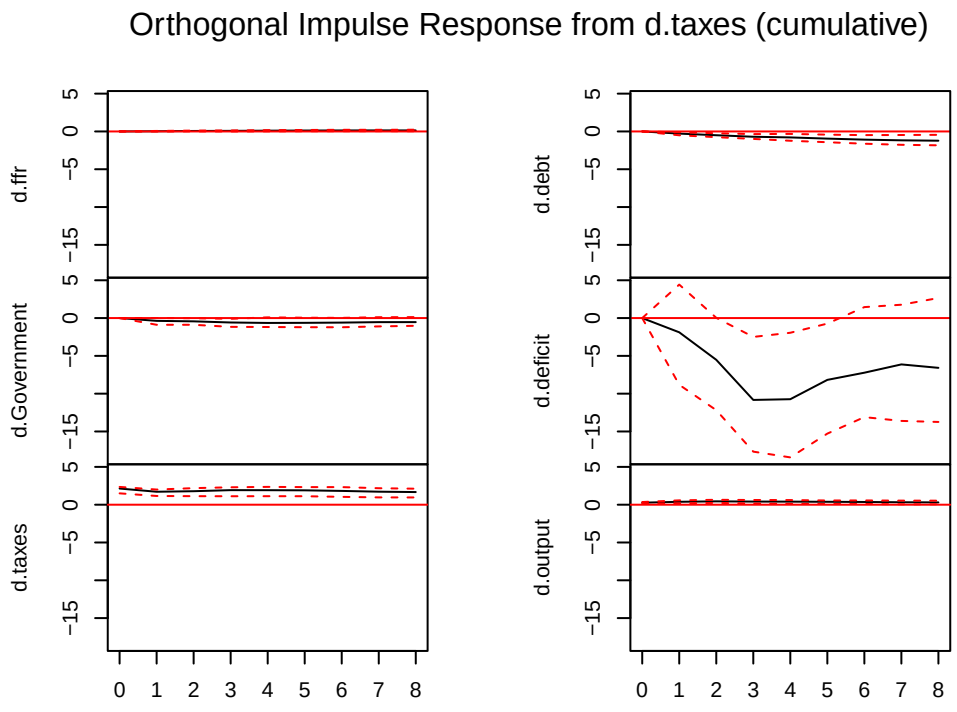
```
residual.2 <- irf(var.2, n.ahead=8, cumulative = TRUE)

plot(residual.2)
```

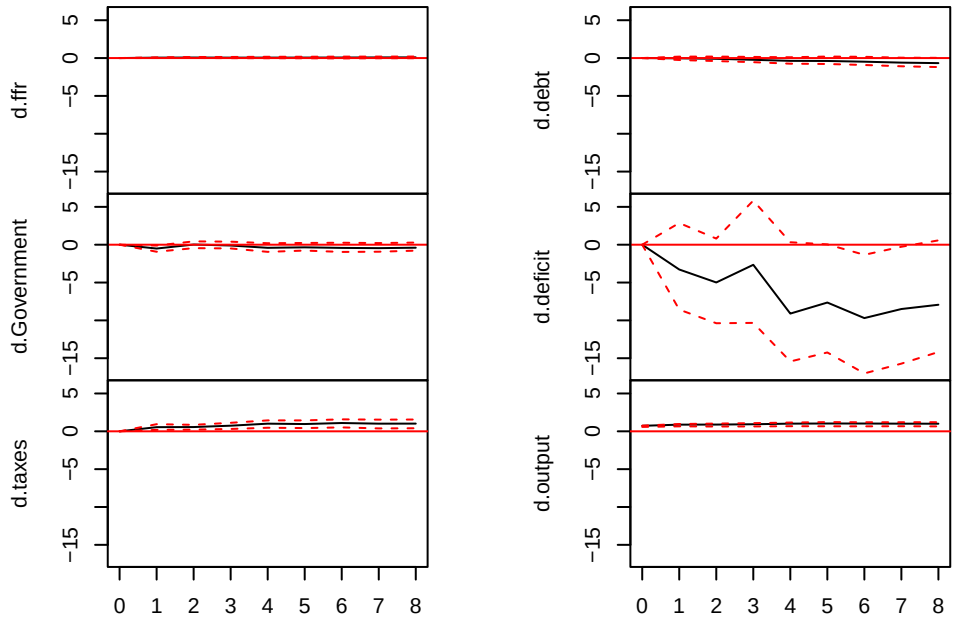

Orthogonal Impulse Response from d.ffr (cumulative)
d.ffr
d.Government
d.taxes
d.debt
d.deficit
d.output
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.debt (cumulative)
d.ffr
d.Government
d.taxes
d.debt
d.deficit
d.output
5
−5
−15
0 1 2 3 4 5 6 7 8
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.Government (cumulative)
d.ffr
d.Government
d.taxes
d.debt
d.deficit
d.output
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.deficit (cumulative)
d.ffr
d.Government
d.taxes
d.debt
d.deficit
d.output
0
20
40
0 1 2 3 4 5 6 7 8
95 % Bootstrap CI, 100 runs


Orthogonal Impulse Response from d.taxes (cumulative)
d.ffr
d.Government
d.taxes
d.debt
d.deficit
d.output
95 % Bootstrap CI, 100 runs




```
residual.2
```

```
##
## Impulse response coefficients
## $d.ffr
##           d.ffr     d.debt d.Government  d.deficit     d.taxes  d.output
##  [1,] 0.2928036 -0.8517928   -1.8276922  -9.820650  0.67390398 0.6256755
##  [2,] 0.3497228 -0.9669833   -1.7270427 -11.735155  0.72591357 0.4077798
##  [3,] 0.3949562 -1.2997811   -0.8860436 -10.460021  0.75023118 0.3973904
##  [4,] 0.4470589 -1.5831618   -2.0722698 -12.002501  0.54248365 0.3585972
##  [5,] 0.4790178 -1.7918228   -1.3057506  -8.366111  0.28421948 0.2734482
##  [6,] 0.4829118 -1.8506687   -1.2888638  -6.493504  0.17854610 0.2669013
##  [7,] 0.4824110 -1.9968019   -1.3732587  -6.807400  0.07965923 0.1836922
##  [8,] 0.4750307 -2.0578983   -1.0470192  -2.461789 -0.18145358 0.1671781
##  [9,] 0.4532786 -2.1052168   -1.0256787  -2.808824 -0.18004527 0.1382559
##
## $d.debt
##           d.ffr   d.debt d.Government  d.deficit     d.taxes    d.output
##  [1,] 0.00000000 1.255766    0.7554373  6.3492093 -0.32987592 -0.13418548
##  [2,] 0.04012670 1.390674    0.3847449  3.4431471 -0.04544022  0.05635306
##  [3,] 0.04645583 1.453891    0.2831338  4.5337252 -0.08915551  0.08577461
##  [4,] 0.03035344 1.638281    1.1524935  6.2121335 -0.12105060  0.13098670
##  [5,] 0.01875186 2.080718    0.2887173 -1.5008256  0.24093725  0.25409677
##  [6,] 0.01243227 2.207969    0.2837565 -1.6339266  0.35522766  0.26800441
##  [7,] 0.01217451 2.271398    0.4871283 -0.5924219  0.39539723  0.32846006
##  [8,] 0.02525527 2.349498    0.3083015 -2.9070109  0.54456670  0.34390334
```

```
##  [9,] 0.04425551 2.510111    0.1367145 -4.6469519  0.66820390  0.40054353
##
## $d.Government
##              d.ffr     d.debt d.Government d.deficit   d.taxes   d.output
##  [1,]  0.000000000  0.0000000     2.170572  4.967030 0.1536524 -0.1644966
##  [2,]  0.040012552 -0.1031344     1.656264  5.142313 0.1459510  0.1267354
##  [3,]  0.005092662 -0.1947819     1.408381  4.266441 0.2982638  0.1538742
##  [4,] -0.063429793 -0.2327175     2.027431  4.945624 0.2879342  0.1994476
##  [5,] -0.113879408 -0.2547918     1.690702  2.667075 0.3767147  0.1715524
##  [6,] -0.122697410 -0.2719027     1.698872  2.013786 0.4106875  0.1820100
##  [7,] -0.127658859 -0.3004324     1.711169  3.245831 0.4831903  0.2053184
##  [8,] -0.125850566 -0.3867600     1.624070  1.589416 0.5952751  0.2045226
##  [9,] -0.118830685 -0.4445408     1.632034  2.539875 0.5379829  0.1997569
##
## $d.deficit
##             d.ffr      d.debt d.Government d.deficit   d.taxes   d.output
##  [1,]  0.00000000 0.000000000   0.00000000  41.30174 -1.104579 -0.1077732
##  [2,] -0.02957299 0.007918634   0.01301534  27.55967 -1.049742 -0.1683344
##  [3,] -0.05063210 0.223987122   0.08586307  27.56575 -1.291549 -0.2369845
##  [4,] -0.06335803 0.328975964   0.08404767  21.76763 -1.120570 -0.2058805
##  [5,] -0.05158602 0.325157138   0.21393695  25.30173 -1.367153 -0.1803028
##  [6,] -0.05161315 0.398640218   0.29803721  27.53670 -1.195775 -0.1689036
##  [7,] -0.06303108 0.467515531   0.24435416  27.24820 -1.183354 -0.1603264
##  [8,] -0.07439235 0.520731660   0.17584647  26.46603 -1.131165 -0.1423574
##  [9,] -0.08047559 0.529513958   0.19470060  25.22346 -1.124282 -0.1353806
##
## $d.taxes
##            d.ffr     d.debt d.Government  d.deficit  d.taxes  d.output
##  [1,] 0.00000000  0.0000000    0.0000000   0.000000 2.138086 0.2628829
##  [2,] 0.02913794 -0.2849473   -0.3696808  -1.883622 1.712708 0.3840520
##  [3,] 0.06279115 -0.4999937   -0.4326003  -5.521717 1.785487 0.4439456
##  [4,] 0.07653472 -0.7024088   -0.5832410 -10.828736 1.925752 0.4132237
##  [5,] 0.10177596 -0.7911389   -0.6434705 -10.730581 1.917245 0.4056246
##  [6,] 0.11803117 -0.9490222   -0.6305875  -8.174103 1.900055 0.3836300
##  [7,] 0.13134333 -1.0847711   -0.5988171  -7.227517 1.823813 0.3573807
##  [8,] 0.13575715 -1.1734618   -0.5377320  -6.129288 1.720308 0.3222129
##  [9,] 0.13344802 -1.2243892   -0.5347091  -6.585230 1.669416 0.3041746
##
## $d.output
##            d.ffr      d.debt d.Government d.deficit   d.taxes  d.output
##  [1,] 0.00000000  0.00000000   0.00000000  0.000000 0.0000000 0.7247655
##  [2,] 0.05716011 -0.03442679  -0.50831301 -3.278031 0.5514148 0.8810387
##  [3,] 0.06967755 -0.09671124   0.02077431 -4.991669 0.5652446 0.8915401
##  [4,] 0.05624340 -0.22903380  -0.10771896 -2.657310 0.7430537 0.9327072
##  [5,] 0.05924672 -0.36877065  -0.41198584 -9.103398 1.0099256 1.0145607
##  [6,] 0.06564723 -0.38418990  -0.35127667 -7.643077 0.9612816 1.0327655
##  [7,] 0.07027313 -0.47945828  -0.42547667 -9.696907 1.0959558 1.0305615
##  [8,] 0.08492196 -0.60242145  -0.45408602 -8.499982 1.0106084 1.0115171
##  [9,] 0.09282555 -0.66922398  -0.39759486 -7.934267 1.0173539 1.0042905
##
##
## Lower Band, CI= 0.95
## $d.ffr
##           d.ffr    d.debt d.Government  d.deficit     d.taxes     d.output
```

```
##  [1,] 0.1696659 -1.608592    -3.958627 -14.987680  0.26969816  0.193995431
##  [2,] 0.2087864 -1.685655    -3.371173 -21.407280  0.29507314  0.158138264
##  [3,] 0.2257032 -1.974676    -1.717277 -18.506778  0.23623556  0.146002741
##  [4,] 0.2256830 -2.345890    -3.918359 -21.745422  0.04045819  0.079899368
##  [5,] 0.2273716 -2.778871    -2.588250 -15.384332 -0.25747230  0.015305474
##  [6,] 0.2242895 -2.862046    -2.670633 -14.039649 -0.41986355  0.008490417
##  [7,] 0.2228135 -3.018126    -2.979636 -13.716966 -0.64140653 -0.086011525
##  [8,] 0.2296416 -3.077001    -2.433353  -9.712127 -0.95925041 -0.110363780
##  [9,] 0.2212375 -3.251509    -2.415684 -11.282633 -1.00374410 -0.151426573
##
## $d.debt
##              d.ffr    d.debt d.Government  d.deficit    d.taxes     d.output
##  [1,]  0.000000000 0.9733291   0.04634581   2.035941 -0.8114928 -0.262975979
##  [2,] -0.001832574 1.0225844  -0.20017110  -1.580555 -0.5804705 -0.143611773
##  [3,] -0.017229932 0.9864682  -0.21996963  -2.345086 -0.6573775 -0.149233905
##  [4,] -0.038780762 1.0583061   0.42115255  -2.838205 -0.8578340 -0.161838849
##  [5,] -0.060460514 1.3643446  -0.33809255 -11.285966 -0.5013668 -0.020681552
##  [6,] -0.096266100 1.3717856  -0.36468384 -11.770794 -0.4410655 -0.076672979
##  [7,] -0.111180251 1.3386615  -0.26484308 -10.918634 -0.4279766 -0.021850037
##  [8,] -0.093710182 1.2050433  -0.43917940 -15.125621 -0.3989857  0.008549904
##  [9,] -0.082708462 1.2686520  -0.64450817 -15.641419 -0.3073486  0.065910728
##
## $d.Government
##              d.ffr     d.debt d.Government d.deficit     d.taxes    d.output
##  [1,]  0.000000000  0.0000000    1.4326998 -1.629083 -0.14151863 -0.24476450
##  [2,]  0.007415821 -0.2575634    0.9434466 -2.007694 -0.17743060 -0.01742723
##  [3,] -0.047318103 -0.3716844    0.8469266 -2.961847 -0.17204150 -0.03118223
##  [4,] -0.132250946 -0.4956431    1.2860446 -4.707494 -0.24790791 -0.01262364
##  [5,] -0.195492565 -0.6243833    0.9081228 -6.254347 -0.28729075 -0.10062498
##  [6,] -0.217386477 -0.6705816    0.9465549 -6.421311 -0.20421039 -0.10086110
##  [7,] -0.228647334 -0.7482677    0.8815462 -4.791678 -0.15175713 -0.07823031
##  [8,] -0.239251299 -0.8741725    0.7999713 -6.634489 -0.07679908 -0.08555970
##  [9,] -0.242009511 -0.9761026    0.8916158 -5.969055 -0.10458995 -0.09158220
##
## $d.deficit
##              d.ffr      d.debt d.Government d.deficit   d.taxes   d.output
##  [1,]  0.00000000  0.00000000    0.0000000  24.20087 -1.914752 -0.1660220
##  [2,] -0.06822041 -0.20057942   -0.3257104  14.96684 -1.649971 -0.3429913
##  [3,] -0.11295041 -0.13380972   -0.2882635  15.64525 -2.004802 -0.4497610
##  [4,] -0.14946702 -0.09539935   -0.5951466  12.13824 -1.994607 -0.4466318
##  [5,] -0.14624312 -0.18067732   -0.5055333  13.57708 -2.042721 -0.4258095
##  [6,] -0.16631889 -0.15209164   -0.3417410  16.44711 -1.988384 -0.4118932
##  [7,] -0.19077519 -0.15643954   -0.6393279  15.70062 -1.934822 -0.4058958
##  [8,] -0.21620601 -0.19806405   -0.6426016  16.40646 -1.927120 -0.4002942
##  [9,] -0.22646159 -0.22842251   -0.4244709  15.15143 -1.892534 -0.3913482
##
## $d.taxes
##              d.ffr     d.debt d.Government  d.deficit   d.taxes   d.output
##  [1,]  0.000000000  0.0000000    0.0000000   0.000000 1.5014052 0.15755162
##  [2,] -0.005742890 -0.5082457   -0.8889712  -8.824577 1.1533810 0.18489103
##  [3,]  0.010173100 -0.7545515   -0.8878540 -12.180085 1.1295321 0.24090723
##  [4,] -0.001785519 -0.9888628   -1.1631168 -17.666455 1.1156762 0.15907318
##  [5,]  0.015043175 -1.2307293   -1.1829699 -18.428531 1.1237957 0.11627066
##  [6,]  0.028480381 -1.4263843   -1.2070427 -15.281043 1.1222191 0.10599094
```

```
##  [7,]  0.032554455 -1.6233045   -1.2142411 -13.101854 1.0351901 0.09289264
##  [8,]  0.034922948 -1.7665014   -1.1010783 -13.603335 0.9660824 0.05596818
##  [9,]  0.026952906 -1.8349372   -1.0211688 -13.739995 0.9579833 0.05584268
##
## $d.output
##              d.ffr     d.debt d.Government  d.deficit   d.taxes  d.output
##  [1,]  0.000000000  0.0000000    0.0000000   0.000000 0.0000000 0.5807742
##  [2,]  0.007849628 -0.2544848   -0.9327412  -8.577107 0.1947669 0.6560699
##  [3,]  0.012479992 -0.3919804   -0.4558061 -10.377632 0.2246686 0.6334095
##  [4,] -0.009392091 -0.5418207   -0.4934332 -10.332690 0.3119914 0.6456953
##  [5,] -0.019995259 -0.7416927   -0.9437856 -15.427502 0.4741292 0.6772944
##  [6,] -0.023459007 -0.7812613   -0.7772521 -14.238059 0.4254695 0.6654188
##  [7,] -0.043586827 -0.9143590   -0.9574606 -17.005186 0.5175050 0.6587214
##  [8,] -0.025364983 -1.0848888   -0.9295163 -15.714097 0.3853729 0.6748373
##  [9,] -0.021653196 -1.1905877   -0.7868380 -14.178846 0.4061814 0.6527857
##
##
## Upper Band, CI= 0.95
## $d.ffr
##           d.ffr     d.debt d.Government   d.deficit   d.taxes  d.output
##  [1,] 0.4211262 -0.2041072   -0.2355577 -3.81423168 0.9965577 1.0936119
##  [2,] 0.4474692 -0.2468125   -0.2865042 -2.61722011 1.0835103 0.5919594
##  [3,] 0.5145044 -0.4162141    0.1742060  0.73624726 1.0739917 0.5868546
##  [4,] 0.6100573 -0.5763397   -0.1711337 -0.06138423 0.9229043 0.5648653
##  [5,] 0.6815019 -0.5611179    0.1423558 -0.17220912 0.8557482 0.5396212
##  [6,] 0.6935717 -0.5702605    0.1048958  2.98443207 0.8878552 0.5510140
##  [7,] 0.6916935 -0.5975277    0.1460416  3.02933815 0.7795674 0.5283469
##  [8,] 0.6748590 -0.6208612    0.2870019  6.69812558 0.7399467 0.5029367
##  [9,] 0.6663228 -0.6171525    0.2513541  7.38560223 0.7768697 0.4993727
##
## $d.debt
##            d.ffr   d.debt d.Government d.deficit      d.taxes   d.output
##  [1,] 0.00000000 1.339365    1.0648951 11.009825 -0.004541135 0.01360007
##  [2,] 0.07942220 1.602292    0.9477080  9.660746  0.342469220 0.22566598
##  [3,] 0.08886012 1.785559    0.7863424 11.768034  0.331941901 0.28977096
##  [4,] 0.10116473 2.042895    1.6394627 12.850107  0.406306635 0.38651842
##  [5,] 0.10542885 2.536194    0.8483604  6.397541  0.828893543 0.50251052
##  [6,] 0.11571507 2.810080    0.9255134  6.524418  0.995194268 0.56874300
##  [7,] 0.13019954 2.922292    0.9668561  6.232852  1.084981938 0.67334558
##  [8,] 0.15057414 3.079965    0.7802063  7.531506  1.263071087 0.69450117
##  [9,] 0.16854500 3.250298    0.6811101  5.522736  1.397720947 0.74731203
##
## $d.Government
##              d.ffr     d.debt d.Government d.deficit   d.taxes   d.output
##  [1,]  0.000000000 0.00000000     2.269238  9.572706 0.5034148 0.03047716
##  [2,]  0.070924154 0.09925463     1.891408  9.868737 0.5706137 0.33263980
##  [3,]  0.062109553 0.15068772     1.773260 10.596695 0.8309409 0.41553927
##  [4,]  0.005081627 0.16413678     2.525506 10.734617 0.7688058 0.40656660
##  [5,] -0.017718193 0.17899946     2.201616  9.863998 0.8714647 0.45175613
##  [6,] -0.013275387 0.24489081     2.189088  8.814695 0.8834072 0.46690971
##  [7,] -0.011164116 0.28609431     2.131810 10.941499 1.0272002 0.49498081
##  [8,] -0.003484538 0.24464002     2.066172  9.777843 1.1292160 0.52257329
##  [9,]  0.005707571 0.23909337     2.122163 10.906566 1.0995651 0.49467801
##
```

```
## $d.deficit
##             d.ffr    d.debt d.Government d.deficit    d.taxes    d.output
##  [1,] 0.000000000 0.0000000    0.0000000  57.50861 -0.2948677 -0.04818334
##  [2,] 0.014018145 0.1914716    0.4515842  40.36784 -0.3782824  0.02339797
##  [3,] 0.002623535 0.5137932    0.6757714  36.46113 -0.6737110 -0.01846018
##  [4,] 0.036820925 0.7220974    0.7998976  30.59531 -0.3375947  0.09940225
##  [5,] 0.076689781 0.7665145    0.9113602  35.57325 -0.5286424  0.15811675
##  [6,] 0.091659053 0.9384661    0.8064240  36.78679 -0.4444646  0.15799620
##  [7,] 0.084705440 1.0173719    0.9869450  38.71188 -0.4823709  0.18609280
##  [8,] 0.077319045 1.1202194    0.8056979  36.86732 -0.4887513  0.20416030
##  [9,] 0.071472692 1.1438282    0.8477153  34.94779 -0.4560624  0.19505498
##
## $d.taxes
##             d.ffr     d.debt d.Government   d.deficit  d.taxes  d.output
##  [1,] 0.00000000  0.0000000  0.000000000  0.00000000 2.350092 0.3529103
##  [2,] 0.06747365 -0.1140606  0.008865642  4.42787561 2.002853 0.5734534
##  [3,] 0.11411290 -0.2350983 -0.020868287  0.03463963 2.189201 0.6479355
##  [4,] 0.13399714 -0.3490983 -0.097328791 -2.49324586 2.303609 0.6199443
##  [5,] 0.17291945 -0.3263293  0.094571583 -1.94267097 2.356988 0.6117646
##  [6,] 0.19478799 -0.4229726  0.048814776 -0.73271564 2.326541 0.5580410
##  [7,] 0.21716248 -0.4841359  0.024669182  1.45250854 2.326270 0.5651935
##  [8,] 0.21960836 -0.4681602  0.114102816  1.76565137 2.179862 0.5391969
##  [9,] 0.22994288 -0.4486265  0.127540829  2.65105113 2.114836 0.5315526
##
## $d.output
##             d.ffr     d.debt d.Government   d.deficit   d.taxes  d.output
##  [1,] 0.00000000 0.00000000    0.0000000  0.00000000 0.0000000 0.7510750
##  [2,] 0.09785985 0.19148278   -0.1141984  2.86396624 0.9406605 0.9650041
##  [3,] 0.14319864 0.19759083    0.4378695  0.80503889 0.8550054 1.0206932
##  [4,] 0.14544698 0.15148834    0.3988687  5.82659386 1.1241521 1.0792368
##  [5,] 0.17135501 0.10697366    0.1944918  0.32280228 1.4433132 1.1611930
##  [6,] 0.17440330 0.20223886    0.2266633  0.04030919 1.4409720 1.2164914
##  [7,] 0.18947645 0.16588515    0.2579214 -1.33821380 1.5819931 1.1946783
##  [8,] 0.19576255 0.04976893    0.2124738 -0.27206861 1.5424657 1.1974012
##  [9,] 0.20182996 0.02952010    0.2803340  0.56857334 1.5581893 1.2054273
```

```
#Granger Casuality
causality(var.1, cause = "d.ffr")
```

```
## $Granger
##
##  Granger causality H0: d.ffr do not Granger-cause d.deficit d.taxes
##  d.output
##
## data:  VAR object var.1
## F-Test = 2.8948, df1 = 3, df2 = 876, p-value = 0.03438
##
##
## $Instant
##
##  H0: No instantaneous causality between: d.ffr and d.deficit d.taxes
##  d.output
##
## data:  VAR object var.1
```

```
## Chi-squared = 58.17, df = 3, p-value = 1.446e-12
```

```
causality(var.1, cause = "d.deficit")
```

```
## $Granger
##
##  Granger causality H0: d.deficit do not Granger-cause d.ffr d.taxes
##  d.output
##
## data:  VAR object var.1
## F-Test = 1.0697, df1 = 3, df2 = 876, p-value = 0.3611
##
##
## $Instant
##
##  H0: No instantaneous causality between: d.deficit and d.ffr d.taxes
##  d.output
##
## data:  VAR object var.1
## Chi-squared = 44.283, df = 3, p-value = 1.314e-09
```

```
# Forecast error variance decomposition

fevd(var.2, n.ahead = 8)
```

```
## $d.ffr
##          d.ffr     d.debt d.Government   d.deficit     d.taxes   d.output
## [1,] 1.0000000 0.00000000   0.00000000 0.000000000 0.000000000 0.00000000
## [2,] 0.9155961 0.01656949   0.01647535 0.008999795 0.008736947 0.03362236
## [3,] 0.8904829 0.01614466   0.02759312 0.012894986 0.019386369 0.03349801
## [4,] 0.8489320 0.01729388   0.06806826 0.013403999 0.019657216 0.03264461
## [5,] 0.8246779 0.01779013   0.08756183 0.014086780 0.024434753 0.03144862
## [6,] 0.8216772 0.01806882   0.08790344 0.014033285 0.026632876 0.03168437
## [7,] 0.8191658 0.01801412   0.08784730 0.015117216 0.028083169 0.03177240
## [8,] 0.8154639 0.01939386   0.08742820 0.016150280 0.028107735 0.03345603
##
## $d.debt
##          d.ffr    d.debt d.Government    d.deficit    d.taxes     d.output
## [1,] 0.3151144 0.6848856  0.000000000 0.000000e+00 0.00000000 0.0000000000
## [2,] 0.3044109 0.6572382  0.004382568 2.583581e-05 0.03345419 0.0004883312
## [3,] 0.3209564 0.6041331  0.007191504 1.766080e-02 0.04814489 0.0019133135
## [4,] 0.3283174 0.5766235  0.007229248 2.039751e-02 0.05946207 0.0079702611
## [5,] 0.3140620 0.5900716  0.006763257 1.864383e-02 0.05687623 0.0135831371
## [6,] 0.3101250 0.5857498  0.006747749 2.005908e-02 0.06387763 0.0134407940
## [7,] 0.3111321 0.5763345  0.006878533 2.117227e-02 0.06845773 0.0160248203
## [8,] 0.3081557 0.5705704  0.009079356 2.176258e-02 0.06996944 0.0204625315
##
## $d.Government
##          d.ffr     d.debt d.Government    d.deficit    d.taxes   d.output
## [1,] 0.3874107 0.06618540    0.5464039 0.000000e+00 0.00000000 0.00000000
## [2,] 0.3553193 0.07509156    0.5276778 1.796422e-05 0.01449277 0.02740060
## [3,] 0.3865356 0.06843397    0.4798360 5.216391e-04 0.01339514 0.05127768
## [4,] 0.4177051 0.11267788    0.4143087 4.188123e-04 0.01248264 0.04240688
```

```
## [5,] 0.4133264 0.15162465    0.3779112 1.526321e-03 0.01140047 0.04421098
## [6,] 0.4130271 0.15150940    0.3776244 2.007774e-03 0.01140300 0.04442838
## [7,] 0.4118821 0.15372297    0.3761452 2.195729e-03 0.01142663 0.04462735
## [8,] 0.4147400 0.15426877    0.3727280 2.488466e-03 0.01155829 0.04421644
##
## $d.deficit
##           d.ffr     d.debt d.Government d.deficit     d.taxes    d.output
## [1,] 0.05165055 0.02158906   0.01321259 0.9135478 0.000000000 0.000000000
## [2,] 0.04807129 0.02341256   0.01186152 0.9097911 0.001703703 0.005159793
## [3,] 0.04839300 0.02375830   0.01211497 0.9012421 0.007983537 0.006508139
## [4,] 0.04786518 0.02425726   0.01192107 0.8864972 0.020664073 0.008795233
## [5,] 0.05085902 0.04865490   0.01348956 0.8412078 0.019486373 0.026302366
## [6,] 0.05198207 0.04829386   0.01357093 0.8369827 0.022150021 0.027020393
## [7,] 0.05184829 0.04859536   0.01417571 0.8341843 0.022459141 0.028737232
## [8,] 0.05917688 0.05024080   0.01515548 0.8237688 0.022682187 0.028975810
##
## $d.taxes
##           d.ffr     d.debt d.Government d.deficit   d.taxes   d.output
## [1,] 0.07120430 0.01706127  0.003701594 0.1912950 0.7167379 0.00000000
## [2,] 0.06573634 0.02729905  0.003405639 0.1759919 0.6838161 0.04375092
## [3,] 0.06498307 0.02722282  0.006657871 0.1820565 0.6758589 0.04322084
## [4,] 0.06987525 0.02689057  0.006556778 0.1829655 0.6668310 0.04688094
## [5,] 0.07562077 0.04314689  0.007312273 0.1828339 0.6368220 0.05426414
## [6,] 0.07652363 0.04454714  0.007409413 0.1853306 0.6320242 0.05416501
## [7,] 0.07739994 0.04452059  0.008061338 0.1843571 0.6294001 0.05626100
## [8,] 0.08498742 0.04668838  0.009558741 0.1817568 0.6207058 0.05630292
##
## $d.output
##          d.ffr     d.debt d.Government  d.deficit    d.taxes  d.output
## [1,] 0.3754954 0.01727100   0.02595496 0.01114110 0.06628743 0.5038501
## [2,] 0.3500629 0.04331297   0.08922089 0.01218803 0.06682234 0.4383928
## [3,] 0.3473456 0.04365100   0.08908922 0.01581886 0.06912527 0.4349701
## [4,] 0.3460090 0.04493992   0.09007446 0.01646399 0.06936533 0.4331473
## [5,] 0.3434502 0.05550936   0.08855756 0.01657940 0.06778189 0.4281216
## [6,] 0.3431434 0.05560266   0.08855377 0.01666256 0.06808551 0.4279521
## [7,] 0.3453028 0.05787579   0.08816687 0.01656800 0.06799404 0.4240925
## [8,] 0.3448724 0.05794977   0.08800470 0.01678214 0.06880592 0.4235850
```