var_thesis

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Đọc file

```
library(readxl)
```

```
## Warning: package 'readxl' was built under R version 4.2.3
```

```
library(vars)
```

```
## Warning: package 'vars' was built under R version 4.2.3
```

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

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

```
## Warning: package 'strucchange' was built under R version 4.2.3
```

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

```
## Warning: package 'zoo' was built under R version 4.2.3
```

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

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

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

```
## Warning: package 'sandwich' was built under R version 4.2.3
```

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

```
## Warning: package 'urca' was built under R version 4.2.3
```

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

```
data_final <- read_excel("D:/Thesis/data_final.xlsx")
attach(data_final)
VNI<-ts(VNI,start = c(1,1),frequency = 1)
GLD<-ts(GLD,start = c(1,1),frequency = 1)
OIL<-ts(OIL,start = c(1,1),frequency = 1)
EXR<-ts(EXR,start = c(1,1),frequency = 1)
```

Loại bỏ cột date và vn_index

```
#bỏ cột date
df <- subset(data_final, select = -date)
```

Kiểm định tính dừng

```
summary(ur.df(GLD,type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7301 -0.1269 -0.0233  0.1174  3.1483
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.255e-01  2.141e-01   2.454   0.0143 *
## z.lag.1     -9.438e-03  3.891e-03  -2.426   0.0154 *
## tt           2.367e-04  9.845e-05   2.404   0.0164 *
## z.diff.lag   1.204e-01  2.967e-02   4.058  5.3e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4477 on 1120 degrees of freedom
## Multiple R-squared:  0.01876,    Adjusted R-squared:  0.01613
## F-statistic: 7.136 on 3 and 1120 DF,  p-value: 9.491e-05
##
##
## Value of test-statistic is: -2.4255 2.8869 3.0572
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(VNI,type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -75.940  -3.890   0.458   6.718  55.424
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.250090   4.288002   1.924   0.0546 .
## z.lag.1     -0.006073   0.003211  -1.891   0.0589 .
## tt          -0.001119   0.001360  -0.823   0.4109
## z.diff.lag  -0.029452   0.029835  -0.987   0.3238
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.93 on 1120 degrees of freedom
## Multiple R-squared:  0.004248,   Adjusted R-squared:  0.00158
## F-statistic: 1.593 on 3 and 1120 DF,  p-value: 0.1895
##
##
## Value of test-statistic is: -1.8911 1.2508 1.8073
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(OIL,type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -14.5072  -0.7287   0.0058   0.8854  10.5609
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.0473827  0.3415520   3.067  0.00222 **
## z.lag.1     -0.0118818  0.0042019  -2.828  0.00477 **
## tt          -0.0001417  0.0001724  -0.822  0.41130
## z.diff.lag   0.0302345  0.0298114   1.014  0.31071
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.858 on 1120 degrees of freedom
## Multiple R-squared:  0.009059,   Adjusted R-squared:  0.006405
## F-statistic: 3.413 on 3 and 1120 DF,  p-value: 0.01696
##
##
## Value of test-statistic is: -2.8278 3.1845 4.7235
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(EXR,type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.59870 -0.00866 -0.00074  0.00864  0.63330
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.383e-01  7.332e-02   1.886  0.05950 .
## z.lag.1     -6.122e-03  3.263e-03  -1.877  0.06085 .
## tt           1.465e-05  8.354e-06   1.754  0.07964 .
## z.diff.lag  -7.840e-02  2.978e-02  -2.633  0.00859 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0455 on 1120 degrees of freedom
## Multiple R-squared:  0.009741,   Adjusted R-squared:  0.007089
## F-statistic: 3.672 on 3 and 1120 DF,  p-value: 0.0119
##
##
## Value of test-statistic is: -1.8765 1.566 1.7944
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(diff(GLD),type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.8103 -0.1178 -0.0182  0.1341  3.0816
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.259e-03  2.684e-02   0.308    0.758
## z.lag.1     -8.758e-01  3.973e-02 -22.041   <2e-16 ***
## tt           2.206e-05  4.132e-05   0.534    0.593
## z.diff.lag  -1.033e-02  2.987e-02  -0.346    0.730
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4488 on 1119 degrees of freedom
## Multiple R-squared:  0.4428, Adjusted R-squared:  0.4413
## F-statistic: 296.4 on 3 and 1119 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -22.0415 161.9446 242.9159
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(diff(VNI),type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -73.912  -4.014   0.206   6.590  55.904
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.2418576  0.8340224   0.290    0.772
## z.lag.1     -1.0051108  0.0429091 -23.424   <2e-16 ***
## tt          -0.0001831  0.0012837  -0.143    0.887
## z.diff.lag  -0.0271102  0.0298554  -0.908    0.364
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.94 on 1119 degrees of freedom
## Multiple R-squared:  0.5171, Adjusted R-squared:  0.5158
## F-statistic: 399.3 on 3 and 1119 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -23.4242 182.9001 274.3489
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(diff(OIL),type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -14.5040  -0.6865   0.0262   0.8853  10.3460
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.1383863  0.1110785   1.246 0.213083
## z.lag.1     -1.0701002  0.0415041 -25.783  < 2e-16 ***
## tt          -0.0002144  0.0001710  -1.254 0.210076
## z.diff.lag   0.0985882  0.0297213   3.317 0.000939 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.855 on 1119 degrees of freedom
## Multiple R-squared:  0.4923, Adjusted R-squared:  0.491
## F-statistic: 361.7 on 3 and 1119 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -25.783 221.5891 332.3831
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

```
summary(ur.df(diff(EXR),type = "trend", selectlags = "AIC"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.59979 -0.00836 -0.00106  0.00843  0.63359
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  7.952e-04  2.727e-03   0.292    0.771
## z.lag.1     -1.090e+00  4.397e-02 -24.801   <2e-16 ***
## tt           1.138e-06  4.197e-06   0.271    0.786
## z.diff.lag   8.698e-03  2.990e-02   0.291    0.771
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04559 on 1119 degrees of freedom
## Multiple R-squared:  0.5404, Adjusted R-squared:  0.5392
## F-statistic: 438.7 on 3 and 1119 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -24.8015 205.0388 307.5578
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.96 -3.41 -3.12
## phi2  6.09  4.68  4.03
## phi3  8.27  6.25  5.34
```

chia train_test

```
# Xác định số lượng hàng cho tập huấn luyện
train_size <- round(0.8 * nrow(df))

# Chia dữ liệu
train_data <- df[1:train_size, ]  # 70% dữ liệu đầu tiên
test_data <- df[(train_size + 1):nrow(df), ]  # 30% dữ liệu còn lại
```

Chuyển chuỗi thành sai phân

```
#chuyển thành sai phân
# Tính độ chênh lệch giữa hàng sau và hàng trước
train_diff<- as.data.frame(lapply(train_data, diff))
```

Chọn bậc cho model VAR

```
VARselect(train_diff)
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##      6      1      1      6
##
## $criteria
##                 1          2          3          4          5          6
## AIC(n) -1.5021512 -1.5091399 -1.5188315 -1.5272097 -1.5223385 -1.5474583
## HQ(n)  -1.4609992 -1.4350664 -1.4118364 -1.3872931 -1.3495003 -1.3416986
## SC(n)  -1.3944833 -1.3153377 -1.2388949 -1.1611389 -1.0701333 -1.0091188
## FPE(n)  0.2226508  0.2211007  0.2189694  0.2171447  0.2182087  0.2128007
##                 7          8          9         10
## AIC(n) -1.5248131 -1.5123874 -1.5041695 -1.4877450
## HQ(n)  -1.2861319 -1.2407845 -1.1996451 -1.1502990
## SC(n)  -0.9003393 -0.8017792 -0.7074271 -0.6048682
## FPE(n)  0.2176818  0.2204132  0.2222444  0.2259404
```

Ước lượng model VAR

```
var_train <-VAR(train_diff,p=6,type = "const")
```

```
var_train
```

```
##
## VAR Estimation Results:
## ========================
##
## Estimated coefficients for equation GLD:
## ========================================
## Call:
## GLD = GLD.l1 + VNI.l1 + OIL.l1 + EXR.l1 + GLD.l2 + VNI.l2 + OIL.l2 + EXR.l2 + GLD.l3 + VNI.l3
+ OIL.l3 + EXR.l3 + GLD.l4 + VNI.l4 + OIL.l4 + EXR.l4 + GLD.l5 + VNI.l5 + OIL.l5 + EXR.l5 + GLD.
l6 + VNI.l6 + OIL.l6 + EXR.l6 + const
##
##        GLD.l1        VNI.l1        OIL.l1        EXR.l1        GLD.l2
## -2.528391e-02 -2.825146e-04  2.867471e-02  2.636977e-02 -1.221181e-01
##        VNI.l2        OIL.l2        EXR.l2        GLD.l3        VNI.l3
##  4.335421e-04 -1.259658e-02  7.434190e-02 -9.195158e-02  8.196632e-05
##        OIL.l3        EXR.l3        GLD.l4        VNI.l4        OIL.l4
##  1.193419e-02 -4.060431e-01  3.456847e-02  8.077877e-04  1.086830e-02
##        EXR.l4        GLD.l5        VNI.l5        OIL.l5        EXR.l5
##  1.859212e-01  4.097374e-03 -2.776197e-04  1.247439e-02 -4.447834e-02
##        GLD.l6        VNI.l6        OIL.l6        EXR.l6         const
## -1.459783e-02 -7.638374e-04  3.105863e-02 -1.285752e-01  2.794467e-02
##
##
## Estimated coefficients for equation VNI:
## ========================================
## Call:
## VNI = GLD.l1 + VNI.l1 + OIL.l1 + EXR.l1 + GLD.l2 + VNI.l2 + OIL.l2 + EXR.l2 + GLD.l3 + VNI.l3
+ OIL.l3 + EXR.l3 + GLD.l4 + VNI.l4 + OIL.l4 + EXR.l4 + GLD.l5 + VNI.l5 + OIL.l5 + EXR.l5 + GLD.
l6 + VNI.l6 + OIL.l6 + EXR.l6 + const
##
##        GLD.l1        VNI.l1        OIL.l1        EXR.l1        GLD.l2
##  -1.673977161  -0.034035427   0.334904270  -2.607590749  -0.324129094
##        VNI.l2        OIL.l2        EXR.l2        GLD.l3        VNI.l3
##   0.021302860   0.150683476  -4.337257775   1.280095374   0.002636733
##        OIL.l3        EXR.l3        GLD.l4        VNI.l4        OIL.l4
##   0.413071322 -11.100534865  -1.162605271   0.015010645   0.104735311
##        EXR.l4        GLD.l5        VNI.l5        OIL.l5        EXR.l5
## -12.014944104  -0.875539772  -0.026274734   0.462834691   4.969310798
##        GLD.l6        VNI.l6        OIL.l6        EXR.l6         const
##  -1.301769666   0.001778568  -0.494731963 -10.622436270   0.059398838
##
##
## Estimated coefficients for equation OIL:
## ========================================
## Call:
## OIL = GLD.l1 + VNI.l1 + OIL.l1 + EXR.l1 + GLD.l2 + VNI.l2 + OIL.l2 + EXR.l2 + GLD.l3 + VNI.l3
+ OIL.l3 + EXR.l3 + GLD.l4 + VNI.l4 + OIL.l4 + EXR.l4 + GLD.l5 + VNI.l5 + OIL.l5 + EXR.l5 + GLD.
l6 + VNI.l6 + OIL.l6 + EXR.l6 + const
##
##        GLD.l1        VNI.l1        OIL.l1        EXR.l1        GLD.l2
## -0.2839197765  0.0003763844  0.0301058660  0.3739816945 -0.4106333555
##        VNI.l2        OIL.l2        EXR.l2        GLD.l3        VNI.l3
```

```
## -0.0001434314 -0.0585389725  2.0596012378  0.2590466333  0.0038300625
##        OIL.l3        EXR.l3        GLD.l4        VNI.l4        OIL.l4
## -0.0240794416  0.6020762309  0.4906196599  0.0024943697  0.0041184727
##        EXR.l4        GLD.l5        VNI.l5        OIL.l5        EXR.l5
##  1.9463980814 -0.0707729610 -0.0030504651  0.0586820306  0.4271216992
##        GLD.l6        VNI.l6        OIL.l6        EXR.l6         const
## -0.3191883321 -0.0074228140 -0.0934042652 -1.5807581680  0.0305785534
##
##
## Estimated coefficients for equation EXR:
## =======================================
## Call:
## EXR = GLD.l1 + VNI.l1 + OIL.l1 + EXR.l1 + GLD.l2 + VNI.l2 + OIL.l2 + EXR.l2 + GLD.l3 + VNI.l3
+ OIL.l3 + EXR.l3 + GLD.l4 + VNI.l4 + OIL.l4 + EXR.l4 + GLD.l5 + VNI.l5 + OIL.l5 + EXR.l5 + GLD.
l6 + VNI.l6 + OIL.l6 + EXR.l6 + const
##
##        GLD.l1        VNI.l1        OIL.l1        EXR.l1        GLD.l2
##  4.677613e-05 -4.952261e-05 -7.101313e-04 -1.706102e-01  7.053020e-03
##        VNI.l2        OIL.l2        EXR.l2        GLD.l3        VNI.l3
## -1.387586e-04 -1.073674e-03 -1.608389e-02  4.177687e-04  5.781665e-06
##        OIL.l3        EXR.l3        GLD.l4        VNI.l4        OIL.l4
## -6.869843e-04  1.592566e-01  3.295359e-03 -1.089065e-04  4.830251e-04
##        EXR.l4        GLD.l5        VNI.l5        OIL.l5        EXR.l5
##  1.487900e-01  1.824262e-03 -2.776559e-04 -3.058225e-04  6.170137e-02
##        GLD.l6        VNI.l6        OIL.l6        EXR.l6         const
##  2.047257e-03 -1.079923e-04  6.673135e-04  1.867473e-02  8.294237e-04
```

kiểm định TTQ phần dư

```
serial.test(var_train)
```

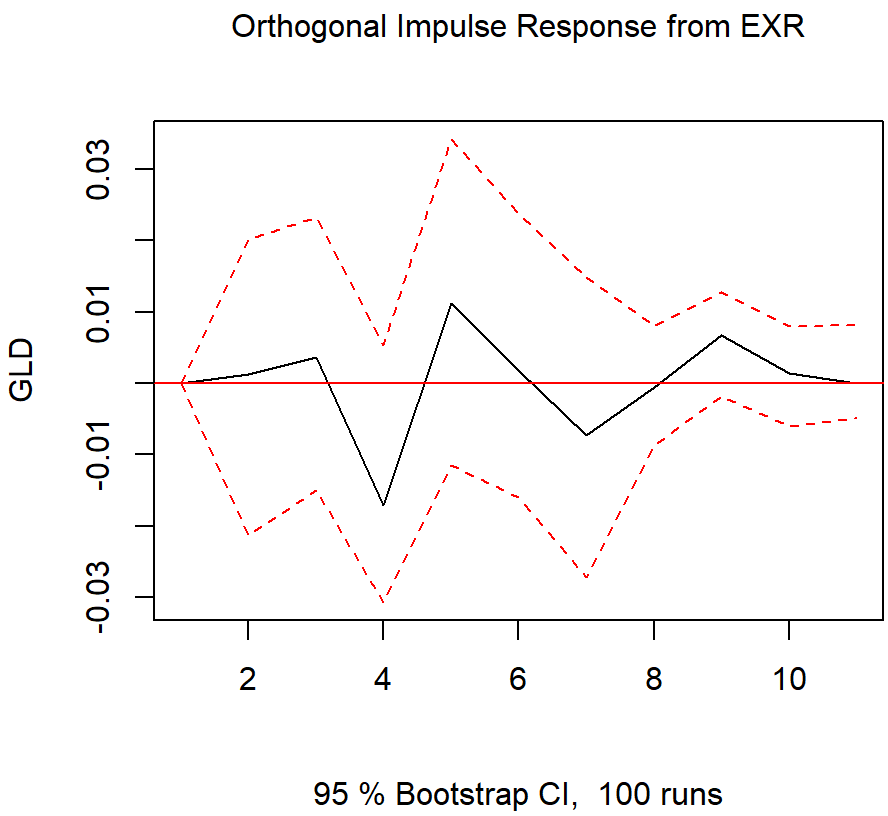
```
##
##  Portmanteau Test (asymptotic)
##
## data:  Residuals of VAR object var_train
## Chi-squared = 163.75, df = 160, p-value = 0.4031
```

hàm phản ứng của price với cú sốc của ty_gia

```
irf1 <- irf(var_train, impulse = "EXR", response = "GLD", boot = TRUE, runs = 100,ci=0.95)
irf1
```

```
##
## Impulse response coefficients
## $EXR
##                 GLD
##  [1,]  0.000000e+00
##  [2,]  1.209943e-03
##  [3,]  3.699911e-03
##  [4,] -1.702866e-02
##  [5,]  1.124570e-02
##  [6,]  1.830381e-03
##  [7,] -7.204300e-03
##  [8,] -5.047855e-04
##  [9,]  6.699079e-03
## [10,]  1.397038e-03
## [11,]  7.839632e-05
##
##
## Lower Band, CI= 0.95
## $EXR
##                GLD
##  [1,]  0.000000000
##  [2,] -0.021243700
##  [3,] -0.014980067
##  [4,] -0.030623626
##  [5,] -0.011433537
##  [6,] -0.015927287
##  [7,] -0.027187769
##  [8,] -0.008618234
##  [9,] -0.001744180
## [10,] -0.006040529
## [11,] -0.004836565
##
##
## Upper Band, CI= 0.95
## $EXR
##               GLD
##  [1,] 0.000000000
##  [2,] 0.020196605
##  [3,] 0.023283760
##  [4,] 0.005342262
##  [5,] 0.034155462
##  [6,] 0.023861574
##  [7,] 0.014875815
##  [8,] 0.008023143
##  [9,] 0.012801836
## [10,] 0.008039421
## [11,] 0.008079729
```

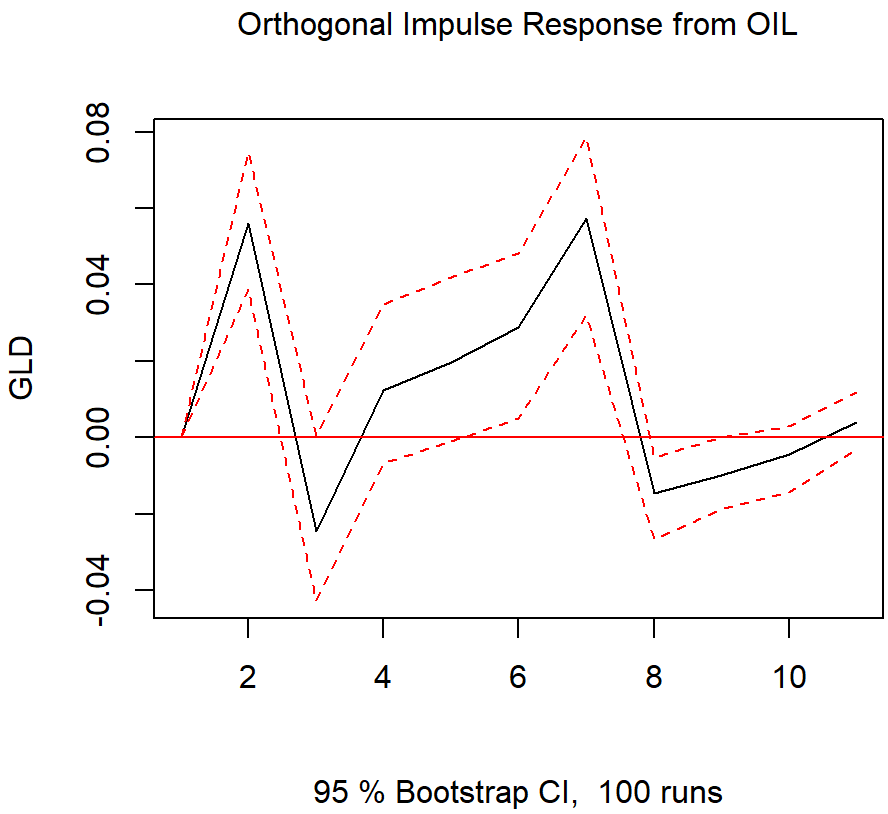
```
plot(irf1)
```




```
irf2 <- irf(var_train, impulse = "OIL", response = "GLD", boot = TRUE, runs = 100,ci=0.95)
irf2
```

```
##
## Impulse response coefficients
## $OIL
##                GLD
##  [1,]  0.000000000
##  [2,]  0.056136021
##  [3,] -0.024504030
##  [4,]  0.012321768
##  [5,]  0.019588975
##  [6,]  0.028852571
##  [7,]  0.057477143
##  [8,] -0.014527436
##  [9,] -0.009988475
## [10,] -0.004471563
## [11,]  0.003946244
##
##
## Lower Band, CI= 0.95
## $OIL
##                GLD
##  [1,]  0.0000000000
##  [2,]  0.0387335870
##  [3,] -0.0425312103
##  [4,] -0.0067347651
##  [5,] -0.0008930783
##  [6,]  0.0050166272
##  [7,]  0.0319915301
##  [8,] -0.0265402789
##  [9,] -0.0187774235
## [10,] -0.0143558936
## [11,] -0.0030823942
##
##
## Upper Band, CI= 0.95
## $OIL
##                GLD
##  [1,]  0.0000000000
##  [2,]  0.0746706141
##  [3,]  0.0005782564
##  [4,]  0.0350002221
##  [5,]  0.0419166525
##  [6,]  0.0482954761
##  [7,]  0.0785281767
##  [8,] -0.0052436509
##  [9,]  0.0001664058
## [10,]  0.0029499595
## [11,]  0.0117479589
```

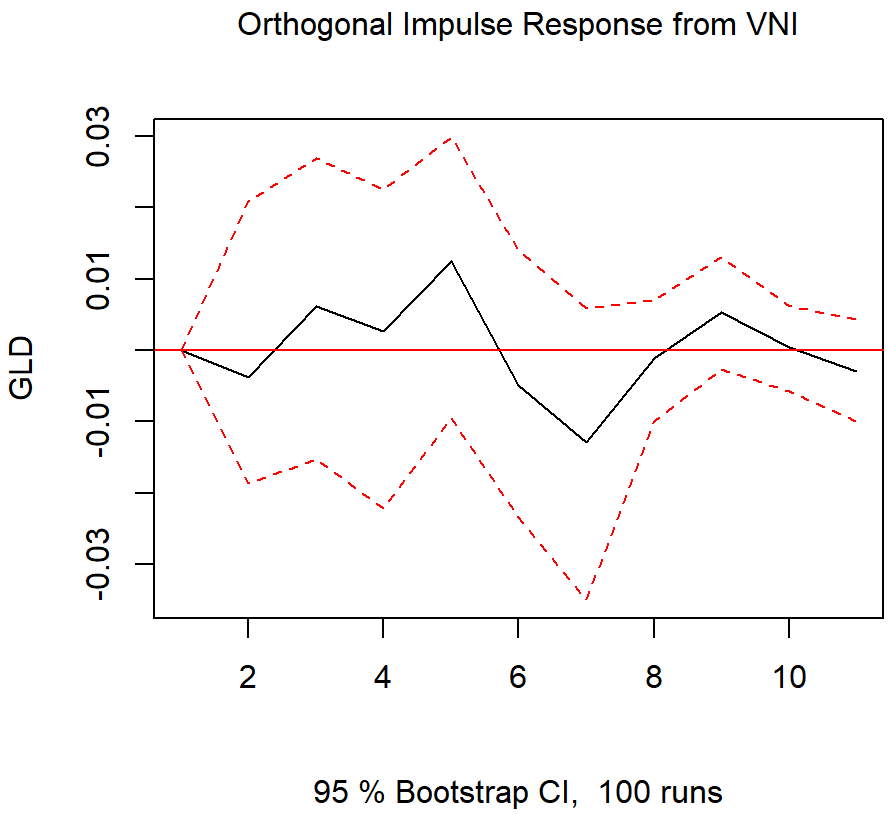
```
plot(irf2)
```




```
irf3 <- irf(var_train, impulse = "VNI", response = "GLD", boot = TRUE, runs = 100,ci=0.95)
irf3
```

```
##
## Impulse response coefficients
## $VNI
##                 GLD
##  [1,]  0.0000000000
##  [2,] -0.0038034394
##  [3,]  0.0062312985
##  [4,]  0.0026492153
##  [5,]  0.0124596646
##  [6,] -0.0048896602
##  [7,] -0.0128105936
##  [8,] -0.0011268707
##  [9,]  0.0052816464
## [10,]  0.0004954346
## [11,] -0.0029467997
##
##
## Lower Band, CI= 0.95
## $VNI
##                GLD
##  [1,]  0.000000000
##  [2,] -0.018652274
##  [3,] -0.015189508
##  [4,] -0.022109796
##  [5,] -0.009471852
##  [6,] -0.023353374
##  [7,] -0.034963675
##  [8,] -0.009907018
##  [9,] -0.002660856
## [10,] -0.005769761
## [11,] -0.009870282
##
##
## Upper Band, CI= 0.95
## $VNI
##               GLD
##  [1,] 0.000000000
##  [2,] 0.020934271
##  [3,] 0.026879474
##  [4,] 0.022566760
##  [5,] 0.029819377
##  [6,] 0.014046807
##  [7,] 0.005899156
##  [8,] 0.007044724
##  [9,] 0.013096994
## [10,] 0.006161890
## [11,] 0.004419150
```

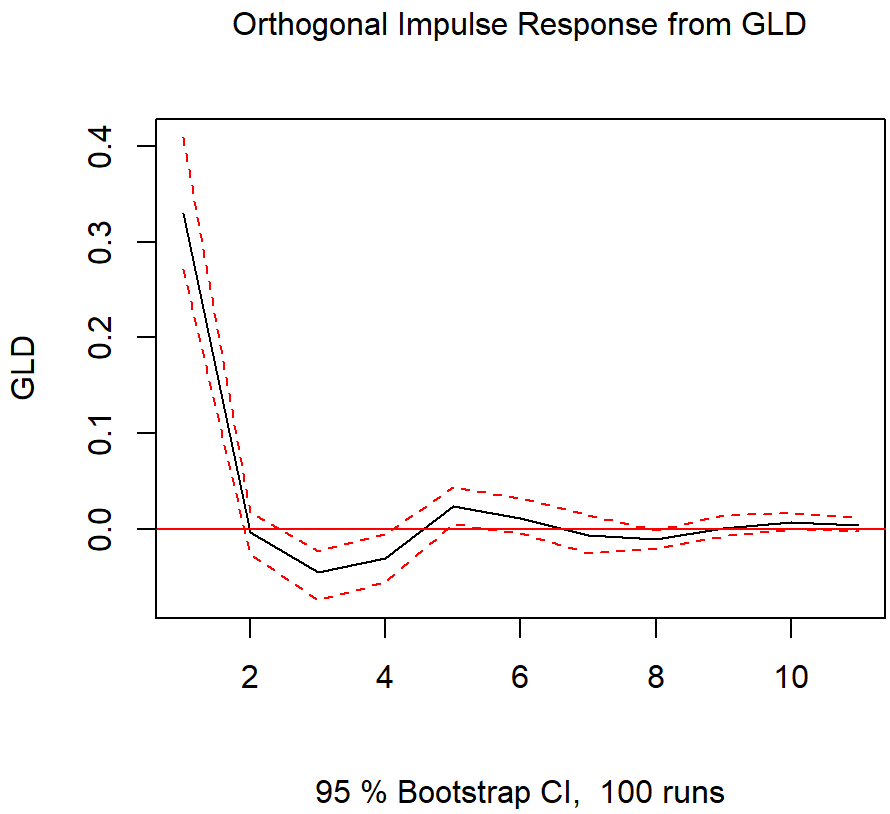
```
plot(irf3)
```




```
irf4 <- irf(var_train, impulse = "GLD", response = "GLD", boot = TRUE, runs = 100,ci=0.95)
irf4
```

```
##
## Impulse response coefficients
## $GLD
##                GLD
##  [1,]  0.330133248
##  [2,] -0.003336418
##  [3,] -0.044564390
##  [4,] -0.030842977
##  [5,]  0.024129870
##  [6,]  0.011576010
##  [7,] -0.005942730
##  [8,] -0.010178107
##  [9,]  0.001333103
## [10,]  0.007131879
## [11,]  0.004085327
##
##
## Lower Band, CI= 0.95
## $GLD
##                GLD
##  [1,]  0.2712045737
##  [2,] -0.0267595891
##  [3,] -0.0738805519
##  [4,] -0.0554213992
##  [5,]  0.0045933594
##  [6,] -0.0045181601
##  [7,] -0.0256264496
##  [8,] -0.0203238425
##  [9,] -0.0071576309
## [10,] -0.0005870318
## [11,] -0.0023560279
##
##
## Upper Band, CI= 0.95
## $GLD
##                GLD
##  [1,]  0.4088514941
##  [2,]  0.0174098846
##  [3,] -0.0229625984
##  [4,] -0.0054699286
##  [5,]  0.0432780600
##  [6,]  0.0318983024
##  [7,]  0.0143379132
##  [8,] -0.0009347865
##  [9,]  0.0141846168
## [10,]  0.0163618690
## [11,]  0.0123748738
```

```
plot(irf4)
```

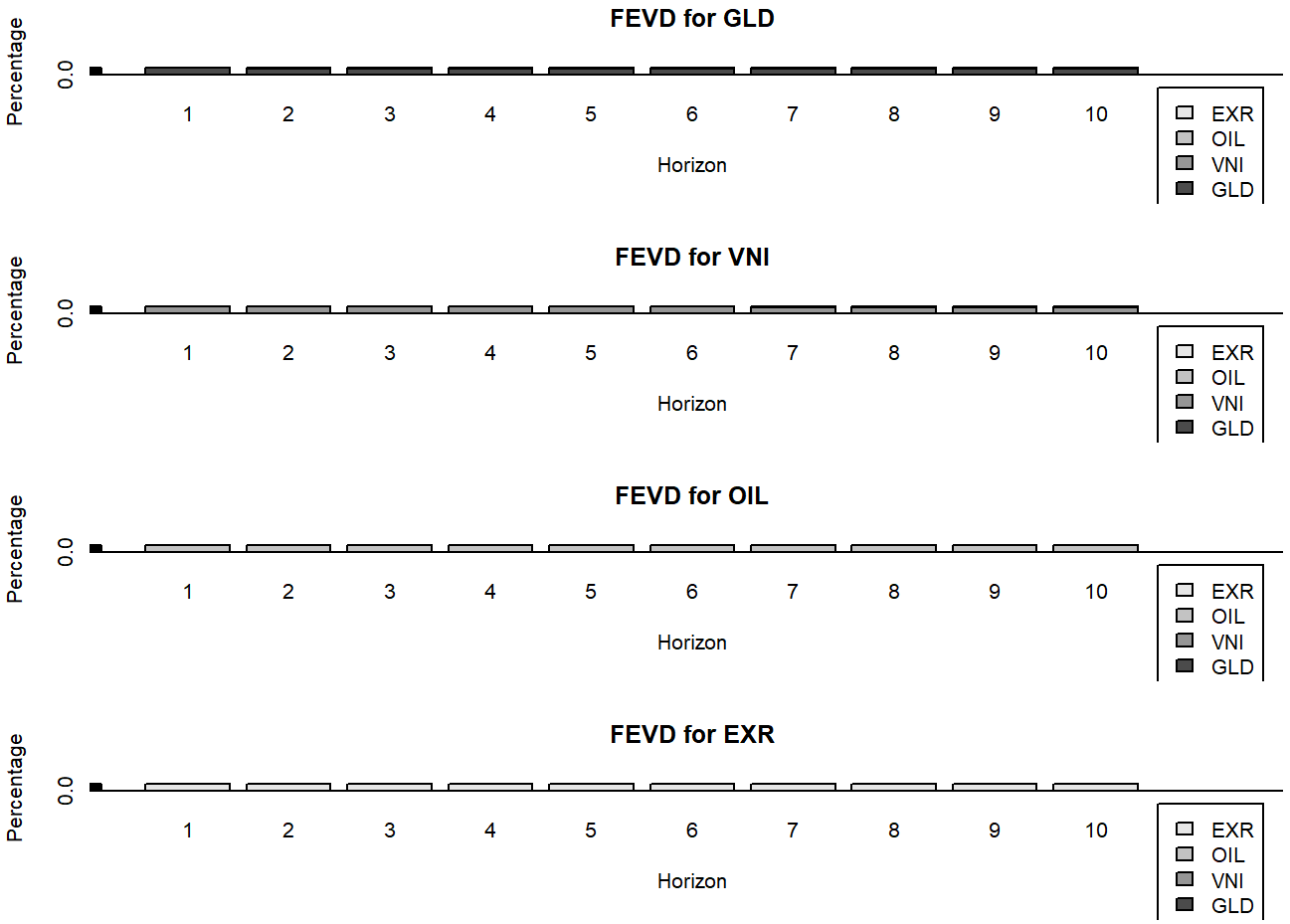


phân rã phương sai

```
fevd(var_train)
```

```
## $GLD
##             GLD          VNI        OIL          EXR
##  [1,] 1.0000000 0.0000000000 0.00000000 0.000000e+00
##  [2,] 0.9717635 0.0001289706 0.02809448 1.305171e-05
##  [3,] 0.9667250 0.0004642230 0.03267883 1.319914e-04
##  [4,] 0.9632636 0.0005190259 0.03359163 2.625772e-03
##  [5,] 0.9579883 0.0018352598 0.03650186 3.674613e-03
##  [6,] 0.9510824 0.0020217151 0.04322385 3.672069e-03
##  [7,] 0.9236587 0.0033079610 0.06904286 3.990490e-03
##  [8,] 0.9221182 0.0033097921 0.07058979 3.982259e-03
##  [9,] 0.9208204 0.0035328172 0.07130383 4.342963e-03
## [10,] 0.9206865 0.0035327141 0.07142447 4.356299e-03
##
## $VNI
##                GLD       VNI         OIL          EXR
##  [1,] 0.0001193536 0.9998806 0.000000000 0.000000e+00
##  [2,] 0.0012955542 0.9966820 0.001956623 6.583896e-05
##  [3,] 0.0013337155 0.9963322 0.002134239 1.998275e-04
##  [4,] 0.0023480900 0.9914623 0.005077366 1.112231e-03
##  [5,] 0.0029960487 0.9897634 0.005322156 1.918394e-03
##  [6,] 0.0033284969 0.9861067 0.008142969 2.421814e-03
##  [7,] 0.0047400643 0.9781975 0.012781525 4.280892e-03
##  [8,] 0.0048337256 0.9778889 0.012981564 4.295811e-03
##  [9,] 0.0048886092 0.9777972 0.012996005 4.318172e-03
## [10,] 0.0048896933 0.9777753 0.012996762 4.338200e-03
##
## $OIL
##                GLD          VNI       OIL          EXR
##  [1,] 0.007863032 6.712021e-05 0.9920698 0.000000e+00
##  [2,] 0.009820490 7.212063e-05 0.9900313 7.607766e-05
##  [3,] 0.014935945 9.941649e-05 0.9827417 2.222930e-03
##  [4,] 0.017309883 7.888863e-04 0.9796525 2.248724e-03
##  [5,] 0.028133713 8.839456e-04 0.9669022 4.080191e-03
##  [6,] 0.028054580 1.633819e-03 0.9660924 4.219193e-03
##  [7,] 0.035333138 4.847425e-03 0.9543692 5.450263e-03
##  [8,] 0.035313648 4.842268e-03 0.9542696 5.574505e-03
##  [9,] 0.036315139 4.864192e-03 0.9531181 5.702543e-03
## [10,] 0.036415062 4.970756e-03 0.9529062 5.707982e-03
##
## $EXR
##                GLD         VNI         OIL       EXR
##  [1,] 0.002525085 0.007924152 0.000636098 0.9889147
##  [2,] 0.002570754 0.007693358 0.001767419 0.9879685
##  [3,] 0.004863191 0.009399151 0.003428755 0.9823089
##  [4,] 0.004777403 0.009198207 0.003451831 0.9825726
##  [5,] 0.005304975 0.011186096 0.003779591 0.9797293
##  [6,] 0.005295906 0.019133141 0.004159721 0.9714112
##  [7,] 0.005713628 0.019581020 0.004398778 0.9703066
##  [8,] 0.005726931 0.019569804 0.004399894 0.9703034
##  [9,] 0.005757359 0.019995072 0.004461106 0.9697865
## [10,] 0.005794829 0.020230235 0.004459222 0.9695157
```

```
plot(fevd(var_train))
```



###

Dự báo tập test

```
# Sử dụng hàm predict để dự báo
forecast_horizon <- nrow(test_data)  # Số lượng dự báo bằng số lượng quan sát trong tập kiểm tra
forecast <- predict(var_train, n.ahead = forecast_horizon)

# Lấy dự báo cho gia_vang
predicted_gia_vang <- forecast$fcst$GLD[, 1]  # Dự báo giá vàng
```

```
y_train_last <- tail(train_data$GLD, 1)
```

```
# Khôi phục chuỗi gốc từ sai phân (tích lũy)
price_pred_genuine <- cumsum(predicted_gia_vang) + y_train_last  # Dự báo chuỗi gốc từ sai phân dự báo
```

```
actual_gia_vang <- test_data$GLD
```

```r
# Tính RMSE
rmse <- sqrt(mean((actual_gia_vang - price_pred_genuine)^2, na.rm = TRUE))

# In kết quả
cat("RMSE:", rmse, "\n")
```

```
## RMSE: 3.929542
```

```r
# Tính MAPE
mape <- mean(abs((actual_gia_vang - price_pred_genuine) / actual_gia_vang), na.rm = TRUE) * 100

# In kết quả
cat("MAPE:", mape, "%\n")
```

```
## MAPE: 3.905269 %
```