

Final 2024 Take Home for Time Series

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Data Preparation

Load the necessary libraries for the analysis

```
library(readr)
library(dynlm)
```

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

```
##
```

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

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      as.Date, as.Date.numeric
```

```
library(vars)
```

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

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

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

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

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

```
library(car)
```

```
## Loading required package: carData
```

```
library(tseries)
```

```
## Registered S3 method overwritten by 'quantmod':
```

```
##   method      from
```

```
##   as.zoo.data.frame zoo
```

```
library(lpirfs)
```

```
library(urca)
```

Load the data

```
data <- read_csv("C:/Users/Jamiu/OneDrive - univ-lille.fr/Desktop/EGEI Second Semester - Ghent University/Time Series/EGEI Second Semester - Ghent University/Time Series/Time Series Data/Time Series Data.csv")
```

```
## Rows: 143 Columns: 5
```

```
## -- Column specification -----
```

```
## Delimiter: ","
## dbl (4): rpoil, p, y, oil consumption demand shocks
## date (1): date
##
## i Use `spec()`` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
spec(data)
```

```
## cols(
##   date = col_date(format = ""),
##   rpoil = col_double(),
##   p = col_double(),
##   y = col_double(),
##   `oil consumption demand shocks` = col_double()
## )
```

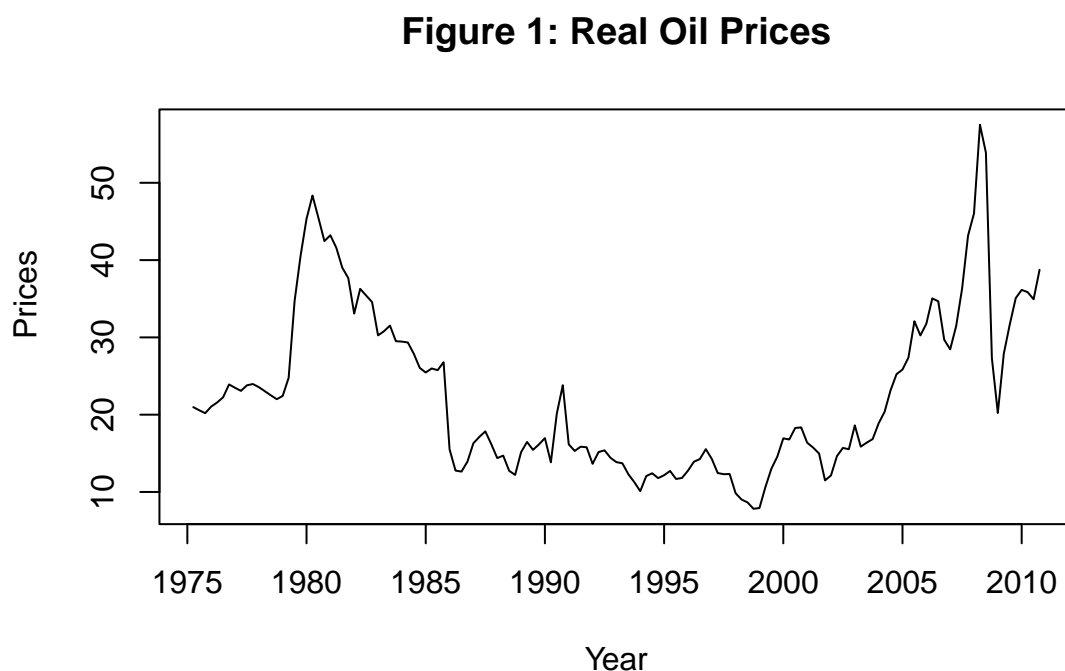
Data Preprocessing

```
realoilprices <- ts(data$rpoil, start = c(1975, 2), frequency = 4)
gdpdeflator <- ts(data$p, start = c(1975, 2), frequency = 4)
realgdp <- ts(data$y, start = c(1975, 2), frequency = 4)
SHOCKS <- ts(data$'oil consumption demand shocks', start = c(1975, 2), frequency = 4)
```

1. Plot the data, test for stationary and transformation if necessary

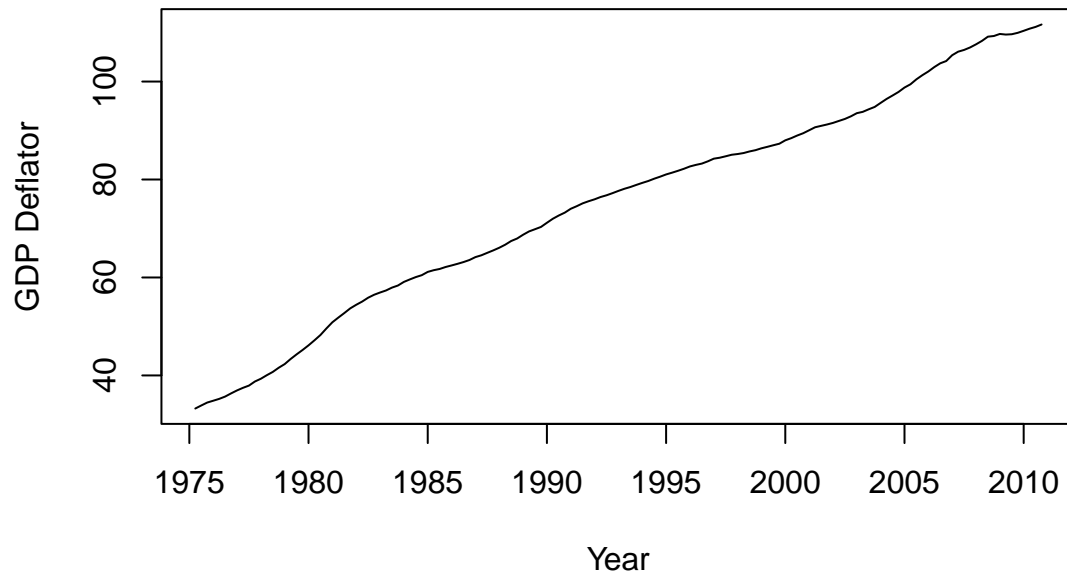
Plot the data

```
plot(realoilprices, main = "Figure 1: Real Oil Prices", ylab = "Real Oil
Prices", xlab = "Year")
```



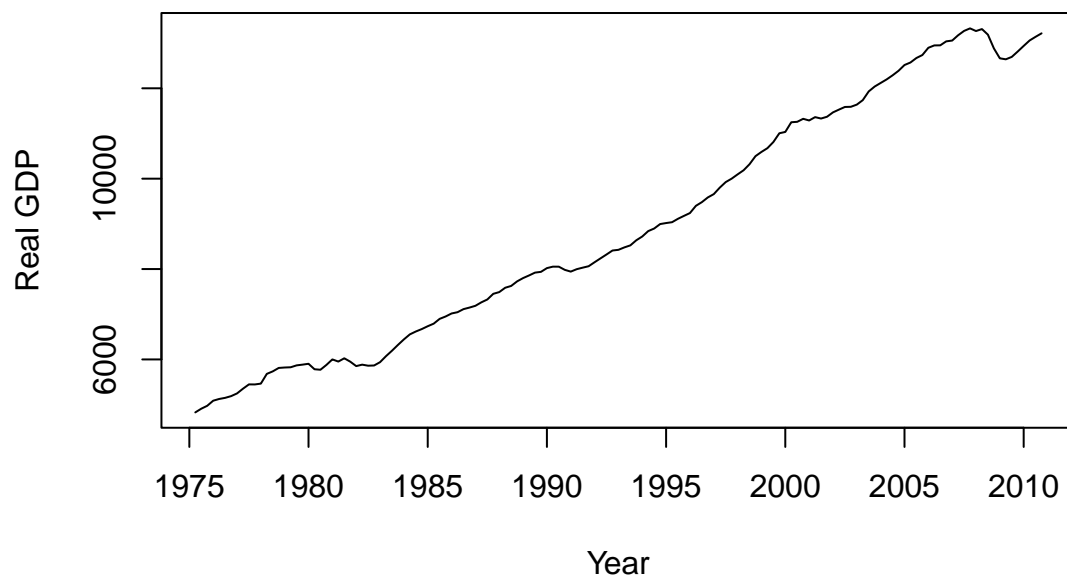
```
plot(gdpdeflator, main = "Figure 2: GDP Deflator", ylab = "GDP Deflator",  
     xlab = "Year")
```

Figure 2: GDP Deflator



```
plot(realgdp, main = "Figure 3: Real GDP", ylab = "Real GDP", xlab = "Year")
```

Figure 3: Real GDP



Test for stationarity

```
adfrw1 <- ur.df(realoilprices, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adfrw1)
```

```
##
## #####
## # 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
## -18.975  -1.147  -0.058   1.532  13.353
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.651742   0.912965   0.714   0.4766
## z.lag.1       -0.037583   0.029155  -1.289   0.1997
## tt            0.004424   0.007103   0.623   0.5345
## z.diff.lag1    0.401061   0.086322   4.646 8.13e-06 ***
## z.diff.lag2   -0.385562   0.093123  -4.140 6.17e-05 ***
## z.diff.lag3    0.144597   0.091304   1.584   0.1157
## z.diff.lag4   -0.199751   0.086875  -2.299   0.0231 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.3 on 131 degrees of freedom
## Multiple R-squared:  0.2214, Adjusted R-squared:  0.1858
## F-statistic: 6.209 on 6 and 131 DF,  p-value: 9.287e-06
##
##
## Value of test-statistic is: -1.289 0.821 1.108
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

```
adfrw2 <- ur.df(gdpdeflator, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adfrw2)
```

```
##
## #####
## # 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
## -0.55591 -0.08822 -0.00489  0.08127  0.58625
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.960038   0.244137   3.932 0.000136 ***
## z.lag.1      -0.021617   0.006317  -3.422 0.000829 ***
## tt           0.010809   0.003321   3.255 0.001445 **
## z.diff.lag1  0.344174   0.084551   4.071 8.06e-05 ***
## z.diff.lag2  0.199762   0.088834   2.249 0.026201 *
## z.diff.lag3  0.134249   0.088930   1.510 0.133551
## z.diff.lag4  0.123823   0.083563   1.482 0.140798
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1636 on 131 degrees of freedom
## Multiple R-squared:  0.5731, Adjusted R-squared:  0.5536
## F-statistic: 29.31 on 6 and 131 DF, p-value: < 2.2e-16
##
##
## Value of test-statistic is: -3.4222 6.3967 6.7222
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47

adfrw3 <- ur.df(realgdp, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adfrw3)

##
## #####
## # 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
## -280.345 -28.951  -1.764   36.780  199.858
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 175.42705   63.59396   2.759  0.00662 **
## z.lag.1      -0.03588    0.01487  -2.412  0.01722 *
```

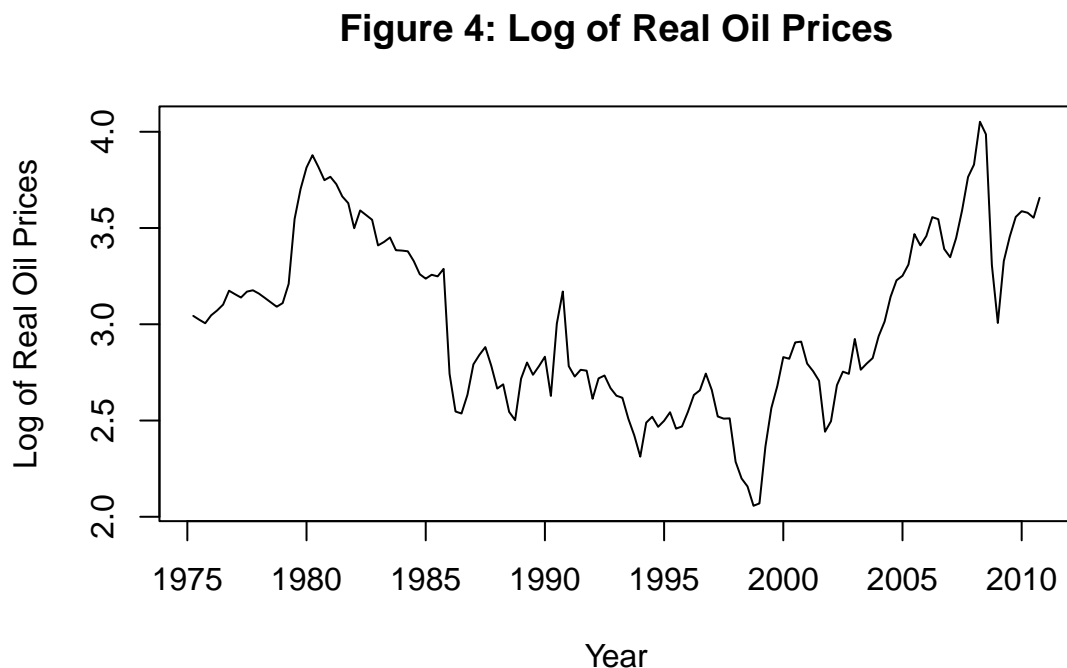
```
## tt          2.36968    0.97692    2.426    0.01662 *
## z.diff.lag1  0.40433    0.08403    4.812    4e-06 ***
## z.diff.lag2  0.16112    0.08490    1.898    0.05991 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 61.76 on 133 degrees of freedom
## Multiple R-squared:  0.2642, Adjusted R-squared:  0.2421
## F-statistic: 11.94 on 4 and 133 DF,  p-value: 2.554e-08
##
##
## Value of test-statistic is: -2.4121 6.6126 2.944
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

Transformation of the series

```
lrealoilprices <- log(realoilprices)
inflation <- (diff(gdpdeflator)/gdpdeflator[-length(gdpdeflator)])*100
lrealgdp <- log(realgdp)
```

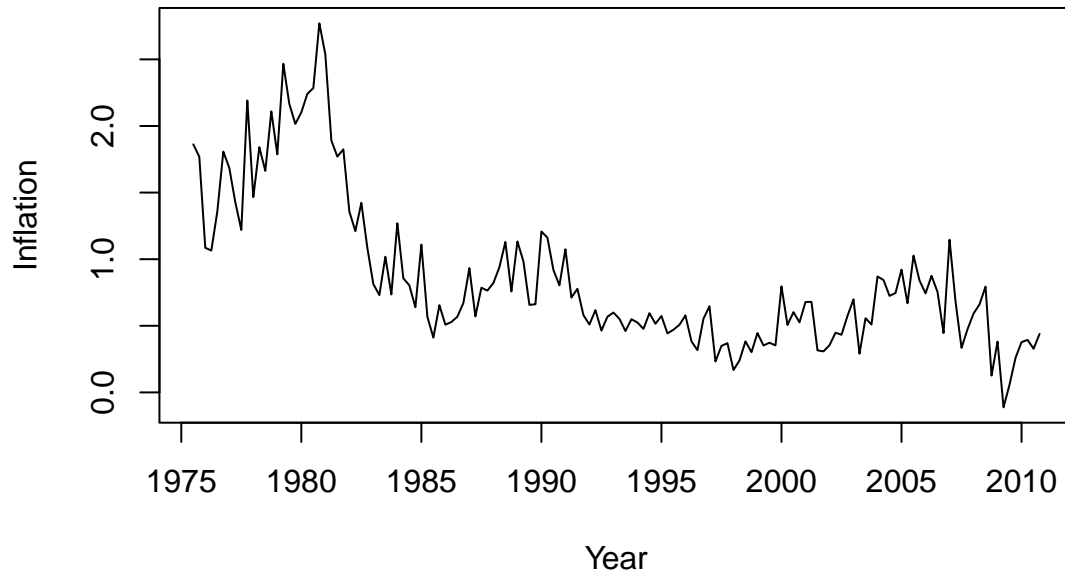
Plot the transformed data

```
plot(lrealoilprices, main = "Figure 4: Log of Real Oil Prices", ylab = "Log of Real Oil Prices",
     xlab = "Year")
```



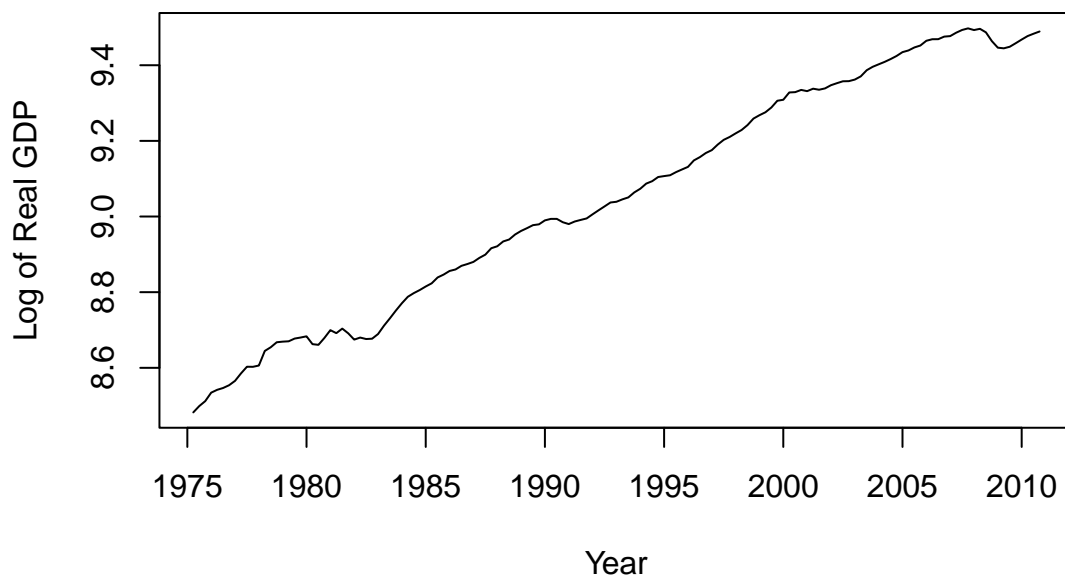
```
plot(inflation, main = "Figure 5: Inflation", ylab = "Inflation", xlab = "Year")
```

Figure 5: Inflation



```
plot(lrealgdp, main = "Figure 6: Log of Real GDP", ylab = "Log of Real GDP",  
     xlab = "Year")
```

Figure 6: Log of Real GDP



Test for stationarity of the transformed data

Level Stationarity testing

```
adflv1 <- ur.df(lrealoilprices, type = c("trend"), lags = 4,
               selectlags = "AIC")
summary(adflv1)
```

```
##
## #####
## # 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
## -0.55802 -0.05957 -0.00156  0.06381  0.42542
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.0890432  0.0855231   1.041 0.299719
## z.lag.1      -0.0326539  0.0264761  -1.233 0.219659
## tt           0.0001834  0.0002809   0.653 0.514880
## z.diff.lag1   0.3326520  0.0864505   3.848 0.000185 ***
## z.diff.lag2  -0.3004505  0.0908661  -3.307 0.001219 **
## z.diff.lag3   0.1594341  0.0895179   1.781 0.077225 .
## z.diff.lag4  -0.1709877  0.0871156  -1.963 0.051792 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1295 on 131 degrees of freedom
## Multiple R-squared:  0.16, Adjusted R-squared:  0.1215
## F-statistic: 4.158 on 6 and 131 DF, p-value: 0.0007381
##
##
## Value of test-statistic is: -1.2333 0.7938 1.1077
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

```
adflv2 <- ur.df(inflation, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adflv2)
```

```
##
## #####
## # 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
## -0.52988 -0.15139 -0.00651  0.13436  0.74496
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.1844225  0.0999349   1.845  0.0673 .
## z.lag.1      -0.1223814  0.0569460  -2.149  0.0335 *
## tt          -0.0012377  0.0007672  -1.613  0.1091
## z.diff.lag1 -0.4176538  0.0957064  -4.364 2.58e-05 ***
## z.diff.lag2 -0.1782439  0.1002439  -1.778  0.0777 .
## z.diff.lag3 -0.0913955  0.0950560  -0.961  0.3381
## z.diff.lag4  0.1307374  0.0840128   1.556  0.1221
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2399 on 130 degrees of freedom
## Multiple R-squared:  0.2676, Adjusted R-squared:  0.2338
## F-statistic: 7.916 on 6 and 130 DF, p-value: 2.783e-07
##
## Value of test-statistic is: -2.1491 1.6347 2.3102
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
adflv3 <- ur.df(lrealgdp, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adflv3)

##
## #####
## # 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
## -0.026094 -0.003227  0.000418  0.004159  0.032715
##
## Coefficients:
```

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.3125224  0.1822339   1.715   0.0887 .
## z.lag.1      -0.0361212  0.0214277  -1.686   0.0942 .
## tt           0.0002511  0.0001610   1.559   0.1213
## z.diff.lag1  0.3598747  0.0860790   4.181 5.24e-05 ***
## z.diff.lag2  0.1224899  0.0876662   1.397   0.1647
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.007505 on 133 degrees of freedom
## Multiple R-squared:  0.1837, Adjusted R-squared:  0.1591
## F-statistic: 7.481 on 4 and 133 DF,  p-value: 1.821e-05
##
##
## Value of test-statistic is: -1.6857 7.1542 2.0887
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

Compute First Differenced Series

```
dlrealoilprices <- diff(lrealoilprices)
dinflation <- diff(inflation)
dlrealgdp <- diff(lrealgdp)
```

First difference Stationarity testing

```
adfdiff1 <- ur.df(dlrealoilprices, type = c("trend"), lags = 4,
                  selectlags = "AIC")
summary(adfdiff1)
```

```
##
## #####
## # 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
## -0.57449 -0.05584  0.00334  0.06815  0.44661
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0151529  0.0232254  -0.652   0.51528
## z.lag.1      -1.2179633  0.1768881  -6.886 2.21e-10 ***
## tt           0.0002738  0.0002809   0.975   0.33149
```

```

## z.diff.lag1 0.5035082 0.1513473 3.327 0.00114 **
## z.diff.lag2 0.2013466 0.1356350 1.484 0.14010
## z.diff.lag3 0.2976066 0.1037898 2.867 0.00483 **
## z.diff.lag4 0.1541412 0.0869417 1.773 0.07858 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1291 on 130 degrees of freedom
## Multiple R-squared:  0.4647, Adjusted R-squared:  0.44
## F-statistic: 18.81 on 6 and 130 DF, p-value: 1.133e-15
##
## Value of test-statistic is: -6.8855 15.8135 23.7197
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47

adfdiff2 <- ur.df(dinflation, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adfdiff2)

##
## #####
## # 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
## -0.64689 -0.15154 -0.00032  0.12012  0.76330
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0249643  0.0431544  -0.578   0.564
## z.lag.1      -1.7068300  0.2604409  -6.554 1.2e-09 ***
## tt           0.0001490  0.0005232   0.285   0.776
## z.diff.lag1  0.1923135  0.2139489   0.899   0.370
## z.diff.lag2 -0.0340288  0.1528646  -0.223   0.824
## z.diff.lag3 -0.1243724  0.0833403  -1.492   0.138
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2395 on 130 degrees of freedom
## Multiple R-squared:  0.7434, Adjusted R-squared:  0.7335
## F-statistic: 75.32 on 5 and 130 DF, p-value: < 2.2e-16
##
## Value of test-statistic is: -6.5536 14.3663 21.5425

```

```
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47

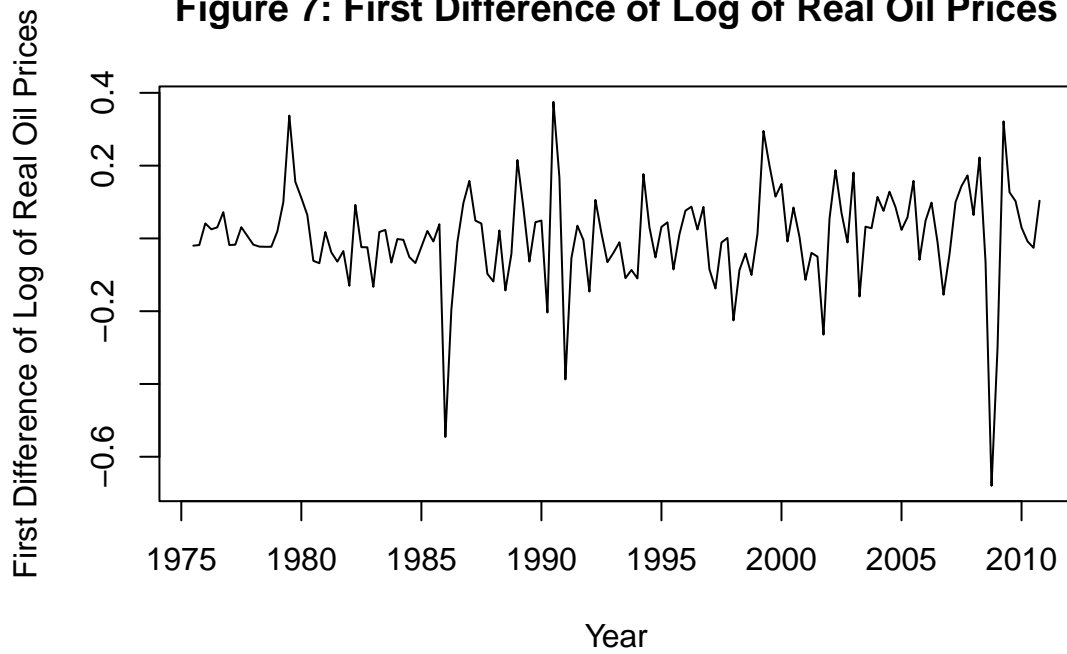
adfdiff3 <- ur.df(dlrealgdp, type = c("trend"), lags = 4, selectlags = "AIC")
summary(adfdiff3)
```

```
##
## #####
## # 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
## -0.027078 -0.003362  0.000317  0.003840  0.032263
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.425e-03  1.632e-03   3.324  0.00115 **
## z.lag.1      -5.725e-01  9.681e-02  -5.914 2.67e-08 ***
## tt           -2.034e-05  1.668e-05  -1.219  0.22501
## z.diff.lag   -9.160e-02  8.627e-02  -1.062  0.29028
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.007572 on 133 degrees of freedom
## Multiple R-squared:  0.3213, Adjusted R-squared:  0.306
## F-statistic: 20.99 on 3 and 133 DF,  p-value: 3.402e-11
##
##
## Value of test-statistic is: -5.9138 11.6591 17.4886
##
## Critical values for test statistics:
##      1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

Plot the first differenced series

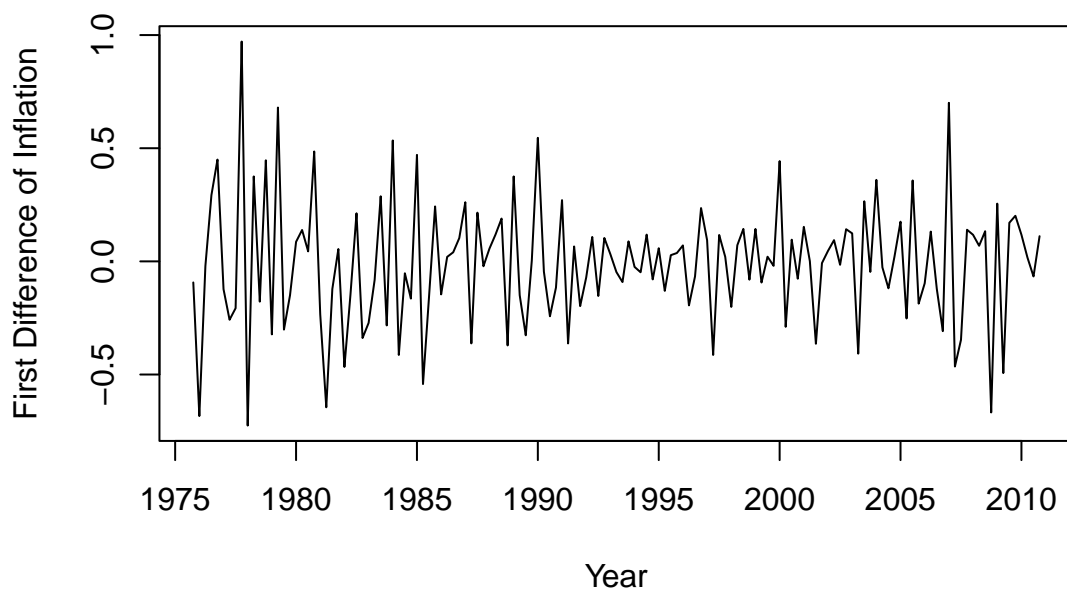
```
plot(dlrealoilprices, main = "Figure 7: First Difference of Log of Real Oil Prices",
     ylab = "First Difference of Log of Real Oil Prices", xlab = "Year")
```

Figure 7: First Difference of Log of Real Oil Prices



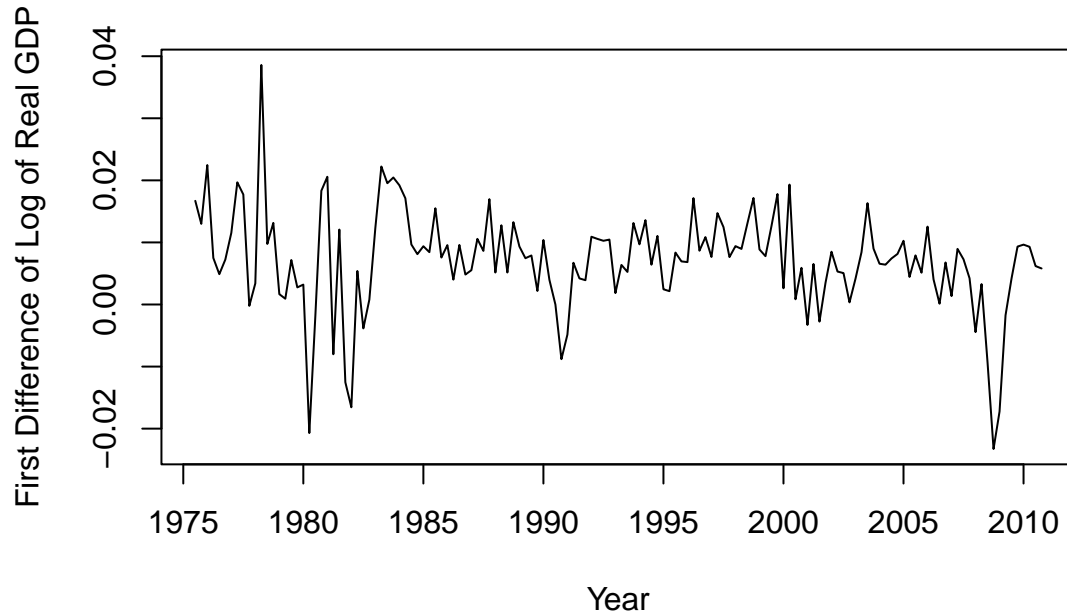
```
plot(dinflation, main = "Figure 8: First Difference of Inflation",  
     ylab = "First Difference of Inflation", xlab = "Year")
```

Figure 8: First Difference of Inflation



```
plot(dlrealgdp, main = "Figure 9: First Difference of Log of Real GDP",  
     ylab = "First Difference of Log of Real GDP", xlab = "Year")
```

Figure 9: First Difference of Log of Real GDP



2. Estimate a VAR model with the data

Combine the variables into a matrix

```
x = cbind(dlrealoilprices, dinflation, dlrealgdp)
colnames(x) <- c("dlrealoilprices", "dinflation", "dlrealgdp")
x <- x[-1, ]
```

Determine the VAR lag length using AIC criterion

```
VAR_lag <- VARselect(x, lag.max = 8, type = "const")
print(VAR_lag)
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##      3      1      1      3
##
## $criteria
##           1           2           3           4           5
## AIC(n) -1.648801e+01 -1.652458e+01 -1.655744e+01 -1.655632e+01 -1.652776e+01
## HQ(n)  -1.638204e+01 -1.633913e+01 -1.629251e+01 -1.621191e+01 -1.610387e+01
## SC(n)  -1.622723e+01 -1.606821e+01 -1.590548e+01 -1.570877e+01 -1.548462e+01
## FPE(n)  6.908300e-08  6.661806e-08  6.450092e-08  6.463936e-08  6.662123e-08
##           6           7           8
## AIC(n) -1.647810e+01 -1.638593e+01 -1.635583e+01
## HQ(n)  -1.597473e+01 -1.580308e+01 -1.569350e+01
## SC(n)  -1.523938e+01 -1.495162e+01 -1.472593e+01
```

```
## FPE(n) 7.018059e-08 7.721067e-08 7.991880e-08
```

Determine the VAR lag length, specifically for AIC

```
optimal_lag_AIC <- VAR_lag$selection["AIC(n)"]
print(optimal_lag_AIC)
```

```
## AIC(n)
##      3
```

3. Estimate the VAR model with the optimal lag length

```
VAR_model <- VAR(x, p = optimal_lag_AIC, type = "const")
summary_VAR_model <- summary(VAR_model)
print(summary_VAR_model)
```

```
##
## VAR Estimation Results:
## =====
## Endogenous variables: dlrealoilprices, dinflation, dlrealgdp
## Deterministic variables: const
## Sample size: 138
## Log Likelihood: 587.727
## Roots of the characteristic polynomial:
## 0.7021 0.7014 0.7014 0.5845 0.5403 0.5403 0.4523 0.2868 0.2868
## Call:
## VAR(y = x, p = optimal_lag_AIC, type = "const")
##
##
## Estimation results for equation dlrealoilprices:
## =====
## dlrealoilprices = dlrealoilprices.l1 + dinflation.l1 + dlrealgdp.l1 + dlrealoilprices.l2 + dinflation
##
##              Estimate Std. Error t value Pr(>|t|)
## dlrealoilprices.l1 0.292575 0.088945 3.289 0.00130 **
## dinflation.l1      0.003068 0.047238 0.065 0.94831
## dlrealgdp.l1       1.140489 1.546168 0.738 0.46209
## dlrealoilprices.l2 -0.269927 0.089499 -3.016 0.00309 **
## dinflation.l2      0.045890 0.050177 0.915 0.36213
## dlrealgdp.l2       -0.490332 1.594950 -0.307 0.75902
## dlrealoilprices.l3 0.069464 0.088825 0.782 0.43564
## dinflation.l3      0.087524 0.046160 1.896 0.06020 .
## dlrealgdp.l3       -0.383392 1.514977 -0.253 0.80062
## const             0.003700 0.017393 0.213 0.83189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.1319 on 128 degrees of freedom
## Multiple R-Squared: 0.1479, Adjusted R-squared: 0.08801
## F-statistic: 2.469 on 9 and 128 DF, p-value: 0.01248
##
##
## Estimation results for equation dinflation:
```

```

## =====
## dinflation = dlrealoilprices.l1 + dinflation.l1 + dlrealgdp.l1 + dlrealoilprices.l2 + dinflation.l2 +
##
##
##           Estimate Std. Error t value Pr(>|t|)
## dlrealoilprices.l1  0.15894    0.15859   1.002 0.318161
## dinflation.l1      -0.59384    0.08423  -7.050 9.91e-11 ***
## dlrealgdp.l1       5.95850    2.75690   2.161 0.032533 *
## dlrealoilprices.l2  0.11690    0.15958   0.733 0.465191
## dinflation.l2      -0.35485    0.08947  -3.966 0.000121 ***
## dlrealgdp.l2      -0.55369    2.84389  -0.195 0.845942
## dlrealoilprices.l3  0.26381    0.15838   1.666 0.098223 .
## dinflation.l3      -0.27235    0.08231  -3.309 0.001216 **
## dlrealgdp.l3       2.96526    2.70129   1.098 0.274388
## const             -0.07434    0.03101  -2.397 0.017975 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2352 on 128 degrees of freedom
## Multiple R-Squared:  0.3125, Adjusted R-squared:  0.2642
## F-statistic: 6.465 on 9 and 128 DF, p-value: 1.506e-07
##
##
## Estimation results for equation dlrealgdp:
## =====
## dlrealgdp = dlrealoilprices.l1 + dinflation.l1 + dlrealgdp.l1 + dlrealoilprices.l2 + dinflation.l2 +
##
##
##           Estimate Std. Error t value Pr(>|t|)
## dlrealoilprices.l1 -0.0058792  0.0050467  -1.165 0.246204
## dinflation.l1      0.0024298  0.0026802   0.907 0.366334
## dlrealgdp.l1       0.3353519  0.0877284   3.823 0.000205 ***
## dlrealoilprices.l2 -0.0013960  0.0050781  -0.275 0.783824
## dinflation.l2      0.0073407  0.0028470   2.578 0.011056 *
## dlrealgdp.l2       0.1038590  0.0904962   1.148 0.253249
## dlrealoilprices.l3 -0.0081552  0.0050399  -1.618 0.108095
## dinflation.l3      0.0039380  0.0026191   1.504 0.135152
## dlrealgdp.l3      -0.0066967  0.0859586  -0.078 0.938024
## const             0.0040688  0.0009868   4.123 6.68e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.007486 on 128 degrees of freedom
## Multiple R-Squared:  0.2183, Adjusted R-squared:  0.1633
## F-statistic: 3.971 on 9 and 128 DF, p-value: 0.0001727
##
##
##
## Covariance matrix of residuals:
##           dlrealoilprices dinflation dlrealgdp
## dlrealoilprices      0.0174065  0.0067343 1.276e-04
## dinflation           0.0067343  0.0553404 1.817e-04
## dlrealgdp            0.0001276  0.0001817 5.604e-05
##

```

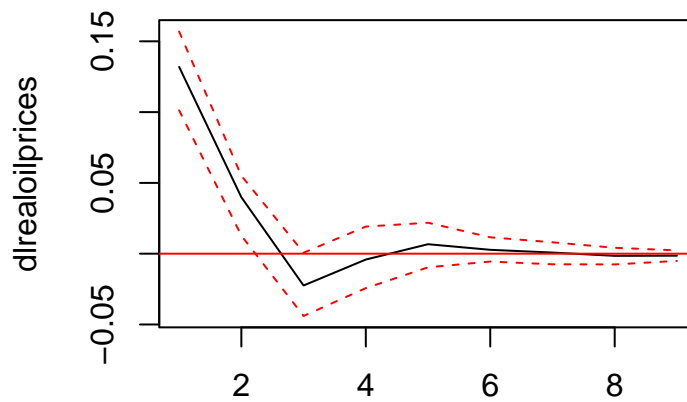


```
## Correlation matrix of residuals:
##           dlrealoilprices dinflation dlrealgdp
## dlrealoilprices      1.0000    0.2170    0.1292
## dinflation           0.2170    1.0000    0.1032
## dlrealgdp            0.1292    0.1032    1.0000
```

Impulse Response Function for horizon 8

```
irf1 <- irf(VAR_model, impulse = "dlrealoilprices", response = "dlrealoilprices",
             n.ahead = 8)
plot(irf1)
```

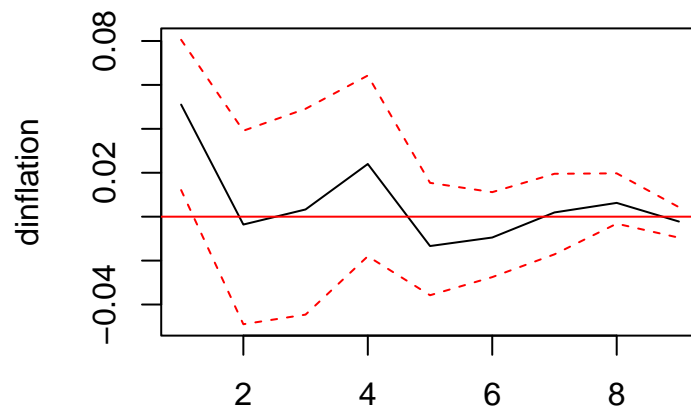
Orthogonal Impulse Response from dlrealoilprices



95 % Bootstrap CI, 100 runs

```
irf2 <- irf(VAR_model, impulse = "dlrealoilprices", response = "dinflation",
             n.ahead = 8)
plot(irf2)
```

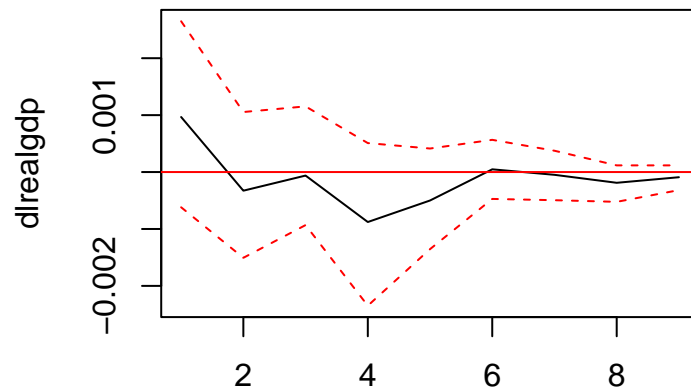
Orthogonal Impulse Response from dlrealoilprices



95 % Bootstrap CI, 100 runs

```
irf3 <- irf(VAR_model, impulse = "dlrealoilprices", response = "dlrealgdp",  
            n.ahead = 8)  
plot(irf3)
```

Orthogonal Impulse Response from dlrealoilprices



95 % Bootstrap CI, 100 runs

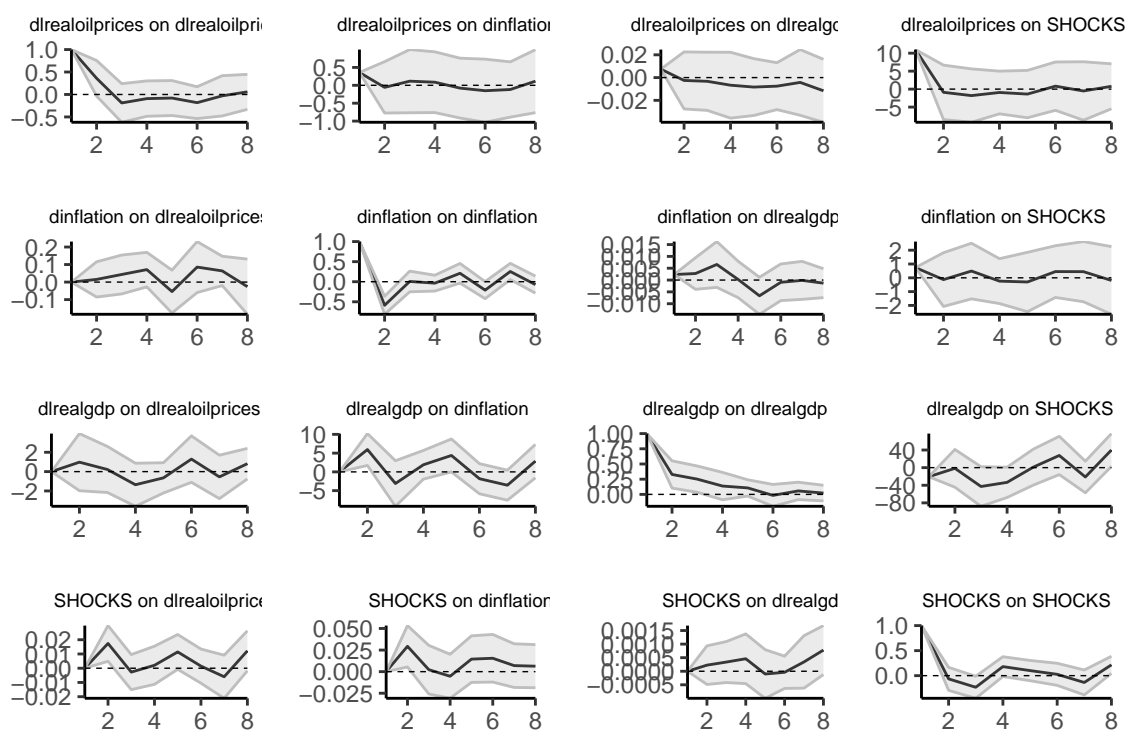
4. Estimate Local projections for the four variables

Combine the variables into a matrix

```
x1 = cbind(drealoilprices, dinflation, drealgdp, SHOCKS)
colnames(x1) <- c("drealoilprices", "dinflation", "drealgdp", "SHOCKS")
x1 <- x1[-c(1, 2), ]
x1_ts <- ts(x1, start = c(1975, 4), frequency = 4)
x1_df <- as.data.frame(x1_ts)
```

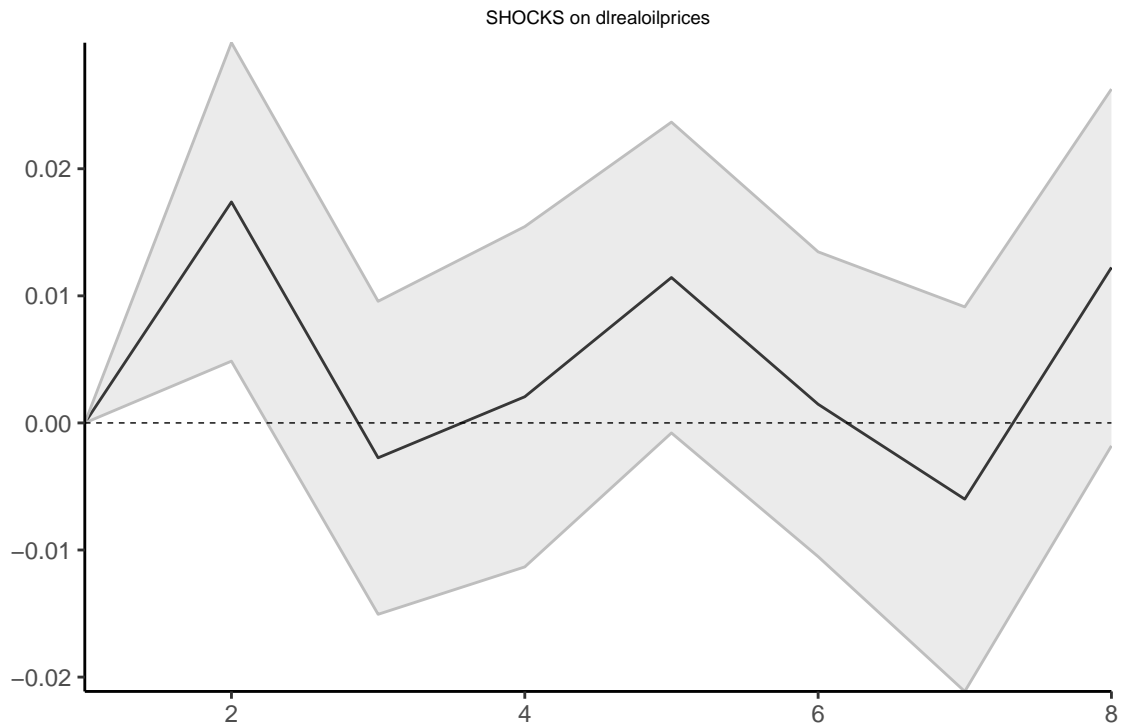
Estimate the LP model with the optimal lag length

```
lp <- lp_lin(x1_df, lags_endog_lin = optimal_lag_AIC, trend = 0,
            shock_type = 1, confint = 1.96, hor = 8, use_nw = TRUE)
plot(lp)
```

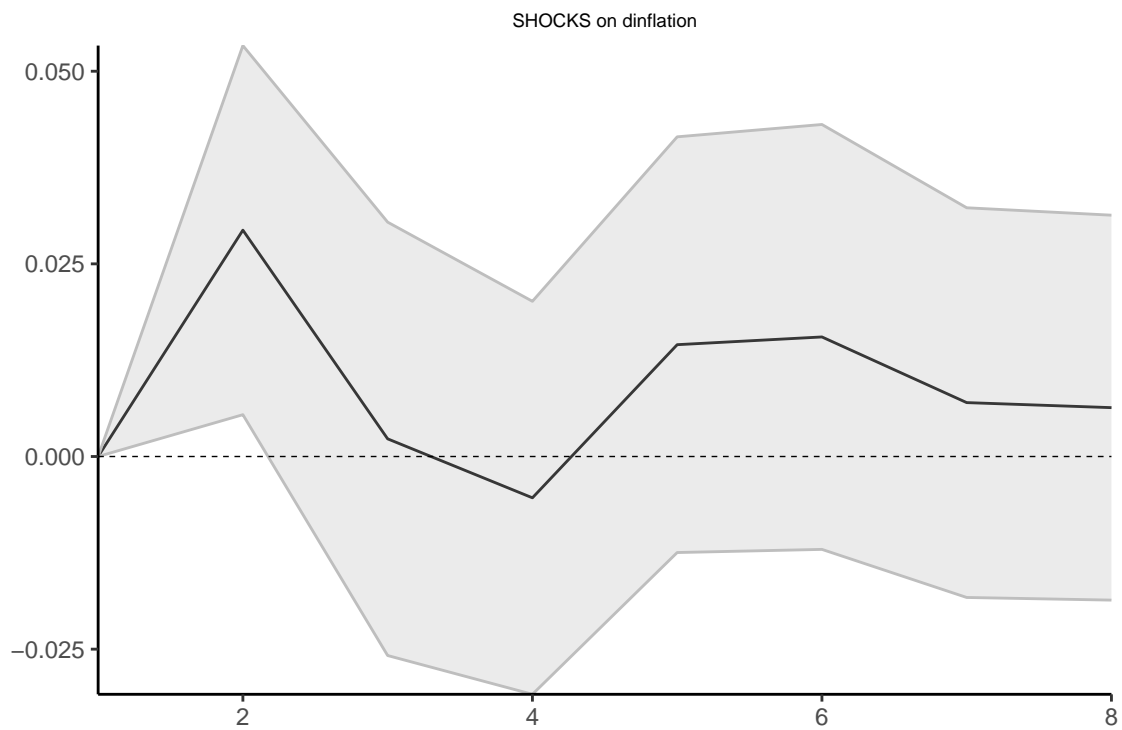


LP IRF plot

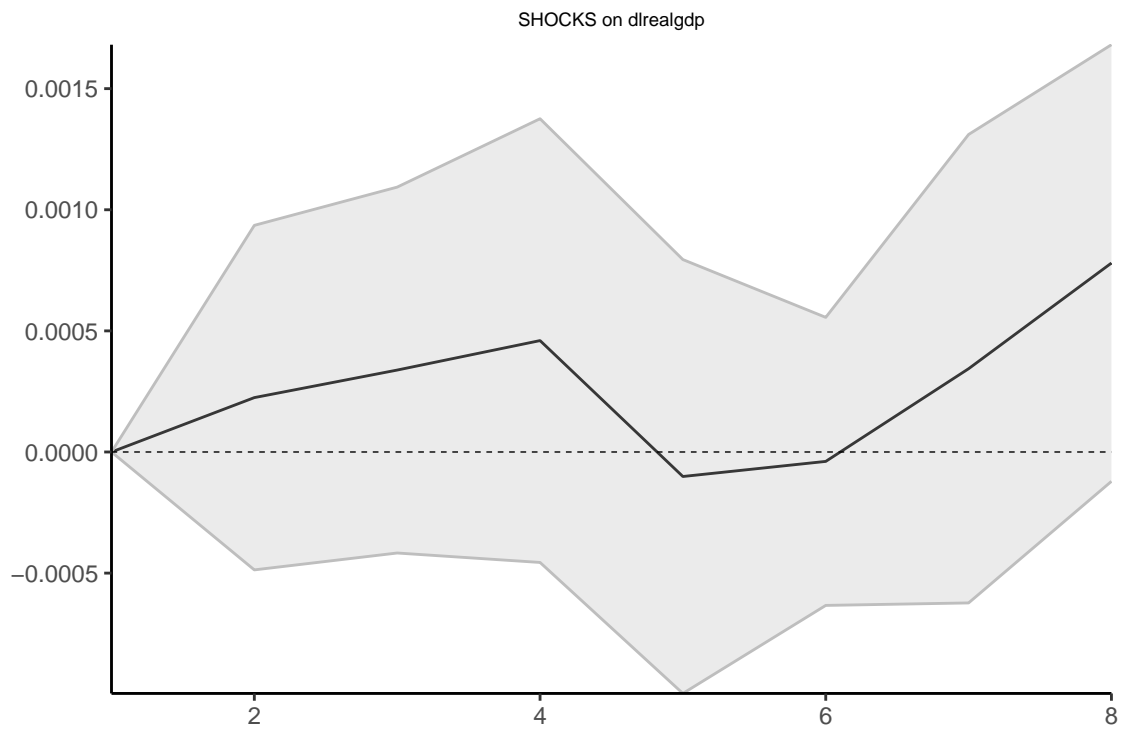
```
linear_plots <- plot_lin(lp)
linear_plots[[4]] # IRF for drealoilprices
```



```
linear_plots[[8]] # IRF for dinflation
```



```
linear_plots[[12]] # IRF for drealgdp
```



```
linear_plots[[16]] # IRF for SHOCKS
```

