

```

> ##### FOF #####
>
> #### import the data ####
> getwd()

[1] "F:/git/R/0606"

> x=c("readxl","TSA","forecast", "FinTS","e1071","fGarch","MTS", "urca", "dynlm")
> lapply(x, require, character.only = T)

[[1]]
[1] TRUE

[[2]]
[1] TRUE

[[3]]
[1] TRUE

[[4]]
[1] TRUE

[[5]]
[1] TRUE

[[6]]
[1] TRUE

[[7]]
[1] TRUE

[[8]]
[1] TRUE

[[9]]
[1] TRUE

> rm(list=ls())
> data2 <- read_excel("F:\\data\\ts\\API.xlsx", sheet = "RR", col_types = c("skip", "skip",
> # fof2007
> retire = ts(data2[1], frequency = 4,start = c(2007,1),names = 'retire')
> fof = ts(data2[2], frequency = 4,start = c(2007,1),names = 'fof')
> #
> FinTS.stats(retire)

      Start Size      Mean Standard.Deviation  Skewness Excess.Kurtosis Minimum
1  2007    40 10926.12          2355.952 0.1958747      -1.398626      6965

```

```

Maximum
1 14878
> FinTS.stats(fof)
      Start Size      Mean Standard.Deviation  Skewness Excess.Kurtosis  Minimum
1 2007 40 909.7876      366.4115 0.1585325      -1.574529 413.1352
      Maximum
1 1459.184
> #
> GR_retire = diff(log(retire))
> GR_fof = diff(log(fof))
> ##### FOF #####
>
> #### import the data ####
> getwd()

[1] "F:/git/R/0606"
> x=c("readxl","TSA","forecast", "FinTS","e1071","fGarch","MTS", "urca", "dynlm")
> lapply(x, require, character.only = T)

[[1]]
[1] TRUE

[[2]]
[1] TRUE

[[3]]
[1] TRUE

[[4]]
[1] TRUE

[[5]]
[1] TRUE

[[6]]
[1] TRUE

[[7]]
[1] TRUE

[[8]]
[1] TRUE

[[9]]
[1] TRUE

```

```

> rm(list=ls())
> data2 <- read_excel("F:\\data\\ts\\API.xlsx", sheet = "RR", col_types = c("skip", "skip",
> # fof2007
> retire = ts(data2[1], frequency = 4, start = c(2007,1), names = 'retire')
> fof = ts(data2[2], frequency = 4, start = c(2007,1), names = 'fof')
> #
> FinTS.stats(retire)

      Start Size      Mean Standard.Deviation  Skewness Excess.Kurtosis Minimum
1  2007   40 10926.12          2355.952 0.1958747      -1.398626    6965
Maximum
1   14878

> FinTS.stats(fof)

      Start Size      Mean Standard.Deviation  Skewness Excess.Kurtosis Minimum
1  2007   40 909.7876          366.4115 0.1585325      -1.574529  413.1352
Maximum
1 1459.184

> #
> GR_retire = diff(log(retire))
> GR_fof = diff(log(fof))
> par(mfrow=c(1,1))
> #
> ts.plot(retire, fof*10, col = rainbow(8), gpars = list(xlab="year", ylab="number" ))
> #title("Time Trends of Retire and FOF in Last 10 Years")
> # legend(x=2007,y=9000, c("Retire","FOF*10"), text.col = rainbow(8), bty="n")
> legend(x=2007, y= 9500, c("Retire"), text.col=rainbow(8)[1], bty="n")
> legend(x=2007, y= 7500, c("FOF * 10"), text.col=rainbow(8)[2], bty="n")
> #
> ts.plot(GR_retire, GR_fof, col=rainbow(8))
> #title("Growth Rates of Retire and FOF in Last 10 years")
> legend(x=2010, y= -0.05, c("the Growth Rate of Retire"), text.col=rainbow(8)[1], bty="n")
> legend(x=2007, y= 0.22, c("the Growth Rate of FOF"), text.col=rainbow(8)[2], bty="n")
> # ts.plot(diff(fof), diff(retire),col=rainbow(8))
>
> ##### ADF-Test/PP-Test/KPSS-Test #####
>
> # df-test/pp-test kpss-test
> adf.test(diff(retire))

```

Augmented Dickey-Fuller Test

```

data: diff(retire)
Dickey-Fuller = -3.0769, Lag order = 3, p-value = 0.1517
alternative hypothesis: stationary

```

```

> summary(ur.df(diff(retire),lags=3)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-855.05  -41.91  163.29  469.74  770.84

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.64920    0.28057  -2.314   0.0275 *
z.diff.lag1  -0.05236    0.25661  -0.204   0.8397
z.diff.lag2  -0.07284    0.21765  -0.335   0.7401
z.diff.lag3  -0.04216    0.17733  -0.238   0.8136
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 477.6 on 31 degrees of freedom
Multiple R-squared:  0.3587,    Adjusted R-squared:  0.2759
F-statistic: 4.334 on 4 and 31 DF,  p-value: 0.00671

Value of test-statistic is: -2.3138

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(diff(retire))) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1809

Critical value for a significance level of:

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```

              10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(diff(retire))) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-1036.46  -146.86    38.13   352.54   635.49

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 117.0365    75.0543   1.559   0.128
y.l1         0.2149     0.1618   1.328   0.192

Residual standard error: 435 on 36 degrees of freedom
Multiple R-squared:  0.04672,    Adjusted R-squared:  0.02024
F-statistic: 1.764 on 1 and 36 DF,  p-value: 0.1925

Value of test-statistic, type: Z-alpha is: -28.6452

      aux. Z statistics
Z-tau-mu      1.546

> # df-test/pp-test kpss-test
> summary(ur.df(retire, lags = 3)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

```

Residuals:

	Min	1Q	Median	3Q	Max
	-1045.81	-178.96	42.52	376.46	673.75

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	0.013056	0.007953	1.642	0.110
z.diff.lag1	0.216847	0.178196	1.217	0.233
z.diff.lag2	-0.090237	0.181572	-0.497	0.623
z.diff.lag3	-0.064484	0.177694	-0.363	0.719

Residual standard error: 456.3 on 32 degrees of freedom

Multiple R-squared: 0.1611, Adjusted R-squared: 0.05628

F-statistic: 1.537 on 4 and 32 DF, p-value: 0.2151

Value of test-statistic is: 1.6417

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```
> summary(ur.kpss(retire)) #
```

```
#####  
# KPSS Unit Root Test #  
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0145

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

```
> summary(ur.pp(retire)) #
```

```
#####  
# Phillips-Perron Unit Root Test #  
#####
```

Test regression with intercept

Call:

```
lm(formula = y ~ y.l1)
```

```

Residuals:
      Min       1Q   Median       3Q      Max
-1201.00  -177.74    43.92   298.78   598.23

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  58.28597   344.82205    0.169   0.867
y.l1         1.00925     0.03118   32.370 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 441.4 on 37 degrees of freedom
Multiple R-squared:  0.9659,    Adjusted R-squared:  0.965
F-statistic: 1048 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: 0.2273

      aux. Z statistics
Z-tau-mu      0.2576

> summary(ur.df(log(retire),lags=3)) #
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
      Min       1Q   Median       3Q      Max
-0.126809 -0.016630  0.006701  0.032565  0.083800

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      0.0013069  0.0009398   1.391   0.1739
z.diff.lag1  0.3110140  0.1760780   1.766   0.0869 .
z.diff.lag2 -0.1607714  0.1820882  -0.883   0.3839
z.diff.lag3 -0.0741273  0.1749416  -0.424   0.6746
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

Residual standard error: 0.04828 on 32 degrees of freedom
Multiple R-squared: 0.1731, Adjusted R-squared: 0.06973
F-statistic: 1.675 on 4 and 32 DF, p-value: 0.1801

Value of test-statistic is: 1.3907

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

> summary(ur.kpss(log(retire))) #

```
#####
# KPSS Unit Root Test #
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.9983

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

> summary(ur.pp(log(retire))) #

```
#####
# Phillips-Perron Unit Root Test #
#####
```

Test regression with intercept

Call:

lm(formula = y ~ y.l1)

Residuals:

	Min	1Q	Median	3Q	Max
	-0.152481	-0.011965	0.004189	0.030196	0.079509

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.05752	0.33970	0.169	0.866
y.l1	0.99528	0.03665	27.160	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04822 on 37 degrees of freedom
Multiple R-squared: 0.9522, Adjusted R-squared: 0.9509
F-statistic: 737.7 on 1 and 37 DF, p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -0.4137

aux. Z statistics
Z-tau-mu 0.3023

> summary(ur.df(GR_retire,lags=3)) #

Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:

lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:

	Min	1Q	Median	3Q	Max
	-0.108118	-0.005006	0.018043	0.040857	0.093453

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	-0.760940	0.285093	-2.669	0.012 *
z.diff.lag1	0.122135	0.251060	0.486	0.630
z.diff.lag2	-0.005352	0.209715	-0.026	0.980
z.diff.lag3	-0.007293	0.176462	-0.041	0.967

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0501 on 31 degrees of freedom
Multiple R-squared: 0.3559, Adjusted R-squared: 0.2728
F-statistic: 4.282 on 4 and 31 DF, p-value: 0.00713

Value of test-statistic is: -2.6691

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```

> summary(ur.kpss(GR_retire)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1218

Critical value for a significance level of:
          10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(GR_retire)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.124986 -0.013397  0.003571  0.026942  0.096347

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.009042   0.007879   1.148  0.2587
y.l1         0.273667   0.158995   1.721  0.0938 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04664 on 36 degrees of freedom
Multiple R-squared:  0.07604,    Adjusted R-squared:  0.05037
F-statistic: 2.963 on 1 and 36 DF,  p-value: 0.09379

Value of test-statistic, type: Z-alpha is: -25.5607

          aux. Z statistics
Z-tau-mu          1.1248

```

```

> # df-test/pp-test kpss-test
> #
> summary(ur.df(fof)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-115.824  -25.939    8.554   30.464  182.785

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1         0.02646    0.01046   2.531  0.0159 *
z.diff.lag    -0.09110    0.17204  -0.530  0.5997
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 55.28 on 36 degrees of freedom
Multiple R-squared:  0.1626,    Adjusted R-squared:  0.116
F-statistic: 3.494 on 2 and 36 DF,  p-value: 0.04103

Value of test-statistic is: 2.5305

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(fof)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0743

Critical value for a significance level of:

```

```

              10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(fof)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
    Min       1Q   Median       3Q      Max
-127.92  -27.91   10.26   25.18  179.03

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.90547    23.30711   1.369   0.179
y.l1         0.99354     0.02417  41.110 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 53.76 on 37 degrees of freedom
Multiple R-squared:  0.9786,    Adjusted R-squared:  0.978
F-statistic: 1690 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -0.1639

      aux. Z statistics
Z-tau-mu      1.44

> summary(ur.df(diff(fof))) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

```

```

Residuals:
      Min       1Q   Median       3Q      Max
-101.21  -20.73   25.62   41.98  190.07

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.7513     0.2208  -3.403  0.00168 **
z.diff.lag   -0.1589     0.1662  -0.956  0.34566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 59.99 on 35 degrees of freedom
Multiple R-squared:  0.4597,    Adjusted R-squared:  0.4289
F-statistic: 14.89 on 2 and 35 DF,  p-value: 2.091e-05

Value of test-statistic is: -3.4031

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(diff(fof))) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1161

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(diff(fof))) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:

```

```

lm(formula = y ~ y.l1)

Residuals:
    Min       1Q   Median       3Q      Max
-131.109  -34.671    9.996   26.495  180.409

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  28.3908     9.8944   2.869  0.00684 **
y.l1         -0.1052     0.1670  -0.630  0.53280
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 54.12 on 36 degrees of freedom
Multiple R-squared:  0.0109,    Adjusted R-squared:  -0.01658
F-statistic: 0.3966 on 1 and 36 DF,  p-value: 0.5328

Value of test-statistic, type: Z-alpha is: -40.0703

      aux. Z statistics
Z-tau-mu      2.8849

> summary(ur.df(log(fof),lags=3)) #
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-0.235654 -0.029210  0.009452  0.041083  0.160717

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1       0.004970   0.002183   2.277  0.0296 *
z.diff.lag1   0.138442   0.173385   0.798  0.4305
z.diff.lag2  -0.137916   0.173951  -0.793  0.4337
z.diff.lag3  -0.192555   0.170644  -1.128  0.2675
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07144 on 32 degrees of freedom
Multiple R-squared:  0.2051,    Adjusted R-squared:  0.1057
F-statistic: 2.064 on 4 and 32 DF,  p-value: 0.1088

Value of test-statistic is: 2.2765

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(log(fof))) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0743

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(log(fof))) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.25946 -0.03200  0.01179  0.03291  0.16546

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.20848    0.17977   1.16    0.254
y.l1          0.97364    0.02673  36.43 <2e-16 ***

```

```

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07 on 37 degrees of freedom
Multiple R-squared:  0.9729,    Adjusted R-squared:  0.9721
F-statistic: 1327 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -1.0362

      aux. Z statistics
Z-tau-mu      1.1587

> summary(ur.df(GR_fof)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-0.19661 -0.00530  0.02530  0.06323  0.18321

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.74202     0.19820  -3.744  0.00065 ***
z.diff.lag    0.02615     0.16466   0.159  0.87471
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07448 on 35 degrees of freedom
Multiple R-squared:  0.3649,    Adjusted R-squared:  0.3286
F-statistic: 10.05 on 2 and 35 DF,  p-value: 0.000355

Value of test-statistic is: -3.7439

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

```



```

> summary(ur.kpss(GR_fof)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.0954

Critical value for a significance level of:
          10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(GR_fof)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.230951 -0.023625  0.005496  0.038821  0.162127

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.02459    0.01252   1.964  0.0573 .
y.l1         0.14885    0.16290   0.914  0.3669
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06988 on 36 degrees of freedom
Multiple R-squared:  0.02267,    Adjusted R-squared:  -0.004481
F-statistic: 0.8349 on 1 and 36 DF,  p-value: 0.3669

Value of test-statistic, type: Z-alpha is: -28.5833

          aux. Z statistics
Z-tau-mu          1.9269

```

```

> ##### 
> # m1, r1
> # m1 = fof ~ retire
> m1 = lm(fof~retire)
> # r1 = m1$residuals
> r1 <- m1$residuals
> par(mfrow=c(1,1))
> plot(r1, xlab = 'time (seasonal)')
> # t = adf.test(resid, alternative = 'explosive')
> print(summary(m1))

Call:
lm(formula = fof ~ retire)

Residuals:
    Min       1Q   Median       3Q      Max 
-182.482  -26.622    1.348   38.330  145.811 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -7.552e+02  5.632e+01  -13.41 5.51e-16 ***
retire       1.524e-01  5.042e-03   30.22 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 74.18 on 38 degrees of freedom
Multiple R-squared:  0.9601,    Adjusted R-squared:  0.959 
F-statistic: 913.5 on 1 and 38 DF,  p-value: < 2.2e-16

> # print(t)
> 
> #
> summary(ur.df(r1)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max 
-79.277  -27.154    0.878   35.364  119.339 

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.3536     0.1112   -3.18  0.00303 **
z.diff.lag    0.1376     0.1547    0.89  0.37948
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 45.54 on 36 degrees of freedom
Multiple R-squared:  0.2193,    Adjusted R-squared:  0.1759
F-statistic: 5.056 on 2 and 36 DF,  p-value: 0.01161

Value of test-statistic is: -3.1799

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(r1)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.2674

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(r1)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max

```

-90.241 -29.743 -1.644 27.651 116.425

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.488	7.450	0.334	0.74
y.l1	0.722	0.103	7.006	2.78e-08 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 46.51 on 37 degrees of freedom

Multiple R-squared: 0.5702, Adjusted R-squared: 0.5586

F-statistic: 49.09 on 1 and 37 DF, p-value: 2.78e-08

Value of test-statistic, type: Z-alpha is: -10.0379

aux. Z statistics	
Z-tau-mu	0.3398

```
> # r1
> # 0.1524 (1, -0.15)
>
>
> #####
>
> # bind the data
> y = diff(fof); x = diff(retire)
> r <- r1[1:39]
> ecmdat1 <- cbind(y,x, r)
> # ECM
> # ecm1 <- dynlm(d1~ L(d1, 1) + L(d2, 1) + L(d2,0)+L(r1, 1), data = ecmdat1)
> ecm1 <- dynlm(y~ L(y, 1) +L(y,2)+L(y,3)+L(y,4)+ L(x, 1) + L(x,0)+L(r, 1), data = ecmdat1)
> # ecm1 <- dynlm(d1~ L(d1, 1) +L(d1,2)+L(d1,3)+L(d1,4)+L(r1, 1) + L(d2, 1), data = ecmdat1)
>
> summary(ecm1)
```

Time series regression with "ts" data:

Start = 2008(2), End = 2016(4)

Call:

```
dynlm(formula = y ~ L(y, 1) + L(y, 2) + L(y, 3) + L(y, 4) + L(x,
1) + L(x, 0) + L(r, 1), data = ecmdat1)
```

Residuals:

Min	1Q	Median	3Q	Max
-87.387	-20.436	1.006	16.815	142.580

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  22.13335    11.14436   1.986   0.0573 .
L(y, 1)      -0.46108     0.19994  -2.306   0.0290 *
L(y, 2)      -0.01601     0.12908  -0.124   0.9022
L(y, 3)      -0.03563     0.12999  -0.274   0.7861
L(y, 4)      -0.02875     0.13862  -0.207   0.8373
L(x, 1)       0.05842     0.02549   2.292   0.0300 *
L(x, 0)       0.09517     0.01852   5.138  2.1e-05 ***
L(r, 1)      -0.38373     0.16855  -2.277   0.0309 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 40.94 on 27 degrees of freedom
Multiple R-squared:  0.5683,    Adjusted R-squared:  0.4564
F-statistic: 5.078 on 7 and 27 DF,  p-value: 9e-04

> #
> r_ecm1 <- ecm1$residuals
> summary(ur.df(r_ecm1)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-84.623 -17.207   6.866  18.222 144.776

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -1.1622     0.2746  -4.232 0.000191 ***
z.diff.lag    0.1081     0.1870   0.578 0.567543
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 37.52 on 31 degrees of freedom
Multiple R-squared:  0.5034,    Adjusted R-squared:  0.4713
F-statistic: 15.71 on 2 and 31 DF,  p-value: 1.943e-05

```

```

Value of test-statistic is: -4.2323

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(r_ecm1)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1962

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(r_ecm1)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-87.857 -20.380   0.744  17.349 142.331

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.96851    6.38695   0.152   0.880
y.l1        -0.03837    0.18416  -0.208   0.836

Residual standard error: 37.18 on 32 degrees of freedom
Multiple R-squared:  0.001354,    Adjusted R-squared:  -0.02985
F-statistic: 0.0434 on 1 and 32 DF,  p-value: 0.8363

```

Value of test-statistic, type: Z-alpha is: -33.1763

aux. Z statistics
Z-tau-mu 0.1525

```
> #  
> ts.plot(retire, fof*10, col = rainbow(8), gpars = list(xlab="year", ylab="number" ))  
> #title("Time Trends of Retire and FOF in Last 10 Years")  
> # legend(x=2007,y=9000, c("Retire","FOF*10"), text.col = rainbow(8), bty="n")  
> legend(x=2007, y= 9500, c("Retire"), text.col=rainbow(8)[1], bty="n")  
> legend(x=2007, y= 7500, c("FOF * 10"), text.col=rainbow(8)[2], bty="n")  
> #  
> ts.plot(GR_retire, GR_fof, col=rainbow(8))  
> #title("Growth Rates of Retire and FOF in Last 10 years")  
> legend(x=2010, y= -0.05, c("the Growth Rate of Retire"), text.col=rainbow(8)[1], bty="n")  
> legend(x=2007, y= 0.22, c("the Growth Rate of FOF"), text.col=rainbow(8)[2], bty="n")  
> # ts.plot(diff(fof), diff(retire),col=rainbow(8))  
>  
> #### ADF-Test/PP-Test/KPSS-Test ####  
>  
> # df-test/pp-test kpss-test  
> adf.test(diff(retire))
```

Augmented Dickey-Fuller Test

data: diff(retire)
Dickey-Fuller = -3.0769, Lag order = 3, p-value = 0.1517
alternative hypothesis: stationary

```
> summary(ur.df(diff(retire),lags=3)) #
```

```
#####  
# Augmented Dickey-Fuller Test Unit Root Test #  
#####
```

Test regression none

Call:

```
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)
```

Residuals:

Min	1Q	Median	3Q	Max
-855.05	-41.91	163.29	469.74	770.84

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	-0.64920	0.28057	-2.314	0.0275 *
z.diff.lag1	-0.05236	0.25661	-0.204	0.8397
z.diff.lag2	-0.07284	0.21765	-0.335	0.7401
z.diff.lag3	-0.04216	0.17733	-0.238	0.8136

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 477.6 on 31 degrees of freedom
Multiple R-squared: 0.3587, Adjusted R-squared: 0.2759
F-statistic: 4.334 on 4 and 31 DF, p-value: 0.00671

Value of test-statistic is: -2.3138

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

> summary(ur.kpss(diff(retire))) #

```
#####
# KPSS Unit Root Test #
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1809

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

> summary(ur.pp(diff(retire))) #

```
#####
# Phillips-Perron Unit Root Test #
#####
```

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:

Min	1Q	Median	3Q	Max
-----	----	--------	----	-----

-1036.46 -146.86 38.13 352.54 635.49

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	117.0365	75.0543	1.559	0.128
y.l1	0.2149	0.1618	1.328	0.192

Residual standard error: 435 on 36 degrees of freedom
Multiple R-squared: 0.04672, Adjusted R-squared: 0.02024
F-statistic: 1.764 on 1 and 36 DF, p-value: 0.1925

Value of test-statistic, type: Z-alpha is: -28.6452

aux. Z statistics
Z-tau-mu 1.546

```
> # df-test/pp-test kpss-test  
> summary(ur.df(retire, lags = 3)) #
```

```
#####  
# Augmented Dickey-Fuller Test Unit Root Test #  
#####
```

Test regression none

Call:

```
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)
```

Residuals:

Min	1Q	Median	3Q	Max
-1045.81	-178.96	42.52	376.46	673.75

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	0.013056	0.007953	1.642	0.110
z.diff.lag1	0.216847	0.178196	1.217	0.233
z.diff.lag2	-0.090237	0.181572	-0.497	0.623
z.diff.lag3	-0.064484	0.177694	-0.363	0.719

Residual standard error: 456.3 on 32 degrees of freedom
Multiple R-squared: 0.1611, Adjusted R-squared: 0.05628
F-statistic: 1.537 on 4 and 32 DF, p-value: 0.2151

```

Value of test-statistic is: 1.6417

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(retire)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0145

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(retire)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-1201.00  -177.74    43.92   298.78   598.23

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  58.28597   344.82205   0.169   0.867
y.l1         1.00925    0.03118  32.370 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 441.4 on 37 degrees of freedom
Multiple R-squared:  0.9659,    Adjusted R-squared:  0.965
F-statistic: 1048 on 1 and 37 DF,  p-value: < 2.2e-16

```

Value of test-statistic, type: Z-alpha is: 0.2273

```
      aux. Z statistics
Z-tau-mu      0.2576
```

```
> summary(ur.df(log(retire),lags=3)) #
```

```
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####
```

Test regression none

Call:

```
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.126809	-0.016630	0.006701	0.032565	0.083800

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	0.0013069	0.0009398	1.391	0.1739
z.diff.lag1	0.3110140	0.1760780	1.766	0.0869 .
z.diff.lag2	-0.1607714	0.1820882	-0.883	0.3839
z.diff.lag3	-0.0741273	0.1749416	-0.424	0.6746

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04828 on 32 degrees of freedom

Multiple R-squared: 0.1731, Adjusted R-squared: 0.06973

F-statistic: 1.675 on 4 and 32 DF, p-value: 0.1801

Value of test-statistic is: 1.3907

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```
> summary(ur.kpss(log(retire))) #
```

```
#####
# KPSS Unit Root Test #
#####
```

```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.9983

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(log(retire))) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.152481 -0.011965  0.004189  0.030196  0.079509

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.05752    0.33970   0.169   0.866
y.l1         0.99528    0.03665  27.160 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04822 on 37 degrees of freedom
Multiple R-squared:  0.9522,    Adjusted R-squared:  0.9509
F-statistic: 737.7 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -0.4137

      aux. Z statistics
Z-tau-mu      0.3023

> summary(ur.df(GR_retire,lags=3)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

```

Test regression none

Call:

```
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.108118	-0.005006	0.018043	0.040857	0.093453

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	-0.760940	0.285093	-2.669	0.012 *
z.diff.lag1	0.122135	0.251060	0.486	0.630
z.diff.lag2	-0.005352	0.209715	-0.026	0.980
z.diff.lag3	-0.007293	0.176462	-0.041	0.967

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0501 on 31 degrees of freedom

Multiple R-squared: 0.3559, Adjusted R-squared: 0.2728

F-statistic: 4.282 on 4 and 31 DF, p-value: 0.00713

Value of test-statistic is: -2.6691

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```
> summary(ur.kpss(GR_retire)) #
```

```
#####  
# KPSS Unit Root Test #  
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1218

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

```
> summary(ur.pp(GR_retire)) #
```

```
#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.124986 -0.013397  0.003571  0.026942  0.096347

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.009042   0.007879   1.148   0.2587
y.l1         0.273667   0.158995   1.721   0.0938 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04664 on 36 degrees of freedom
Multiple R-squared:  0.07604,    Adjusted R-squared:  0.05037
F-statistic: 2.963 on 1 and 36 DF,  p-value: 0.09379

Value of test-statistic, type: Z-alpha is: -25.5607

      aux. Z statistics
Z-tau-mu      1.1248

> # df-test/pp-test kpss-test
> #
> summary(ur.df(fof)) #

#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
```

Min	1Q	Median	3Q	Max
-115.824	-25.939	8.554	30.464	182.785

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	0.02646	0.01046	2.531	0.0159 *
z.diff.lag	-0.09110	0.17204	-0.530	0.5997

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 55.28 on 36 degrees of freedom

Multiple R-squared: 0.1626, Adjusted R-squared: 0.116

F-statistic: 3.494 on 2 and 36 DF, p-value: 0.04103

Value of test-statistic is: 2.5305

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

> summary(ur.kpss(fof)) #

```
#####
# KPSS Unit Root Test #
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0743

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

> summary(ur.pp(fof)) #

```
#####
# Phillips-Perron Unit Root Test #
#####
```

Test regression with intercept

Call:

lm(formula = y ~ y.l1)

```

Residuals:
      Min       1Q   Median       3Q      Max
-127.92  -27.91   10.26   25.18  179.03

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  31.90547   23.30711   1.369   0.179
y.l1         0.99354    0.02417  41.110 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 53.76 on 37 degrees of freedom
Multiple R-squared:  0.9786,    Adjusted R-squared:  0.978
F-statistic: 1690 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -0.1639

      aux. Z statistics
Z-tau-mu      1.44

> summary(ur.df(diff(fof))) #
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
      Min       1Q   Median       3Q      Max
-101.21  -20.73   25.62   41.98  190.07

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.7513     0.2208  -3.403  0.00168 **
z.diff.lag   -0.1589     0.1662  -0.956  0.34566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 59.99 on 35 degrees of freedom
Multiple R-squared:  0.4597,    Adjusted R-squared:  0.4289

```


F-statistic: 14.89 on 2 and 35 DF, p-value: 2.091e-05

Value of test-statistic is: -3.4031

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```
> summary(ur.kpss(diff(fof))) #
```

```
#####  
# KPSS Unit Root Test #  
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1161

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

```
> summary(ur.pp(diff(fof))) #
```

```
#####  
# Phillips-Perron Unit Root Test #  
#####
```

Test regression with intercept

Call:

```
lm(formula = y ~ y.l1)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-131.109	-34.671	9.996	26.495	180.409

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	28.3908	9.8944	2.869	0.00684 **
y.l1	-0.1052	0.1670	-0.630	0.53280

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 54.12 on 36 degrees of freedom

Multiple R-squared: 0.0109, Adjusted R-squared: -0.01658
 F-statistic: 0.3966 on 1 and 36 DF, p-value: 0.5328

Value of test-statistic, type: Z-alpha is: -40.0703

aux. Z statistics
 Z-tau-mu 2.8849

> summary(ur.df(log(fof),lags=3)) #

```
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####
```

Test regression none

Call:

lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:

	Min	1Q	Median	3Q	Max
	-0.235654	-0.029210	0.009452	0.041083	0.160717

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	0.004970	0.002183	2.277	0.0296 *
z.diff.lag1	0.138442	0.173385	0.798	0.4305
z.diff.lag2	-0.137916	0.173951	-0.793	0.4337
z.diff.lag3	-0.192555	0.170644	-1.128	0.2675

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07144 on 32 degrees of freedom

Multiple R-squared: 0.2051, Adjusted R-squared: 0.1057

F-statistic: 2.064 on 4 and 32 DF, p-value: 0.1088

Value of test-statistic is: 2.2765

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

> summary(ur.kpss(log(fof))) #

```
#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 1.0743

Critical value for a significance level of:
          10pct  5pct  2.5pct  1pct
critical values 0.347 0.463  0.574 0.739

> summary(ur.pp(log(fof))) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-0.25946 -0.03200  0.01179  0.03291  0.16546

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.20848    0.17977    1.16   0.254
y.l1         0.97364    0.02673   36.43 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07 on 37 degrees of freedom
Multiple R-squared:  0.9729,    Adjusted R-squared:  0.9721
F-statistic: 1327 on 1 and 37 DF,  p-value: < 2.2e-16

Value of test-statistic, type: Z-alpha is: -1.0362

          aux. Z statistics
Z-tau-mu          1.1587

> summary(ur.df(GR_fof)) #
```

```
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min       1Q   Median       3Q      Max
-0.19661 -0.00530  0.02530  0.06323  0.18321

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
z.lag.1      -0.74202     0.19820  -3.744  0.00065 ***
z.diff.lag    0.02615     0.16466   0.159  0.87471
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07448 on 35 degrees of freedom
Multiple R-squared:  0.3649,    Adjusted R-squared:  0.3286
F-statistic: 10.05 on 2 and 35 DF,  p-value: 0.000355

Value of test-statistic is: -3.7439

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(GR_fof)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.0954

Critical value for a significance level of:
      10pct  5pct 2.5pct 1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(GR_fof)) #
```

```
#####
# Phillips-Perron Unit Root Test #
#####
```

Test regression with intercept

```
Call:
lm(formula = y ~ y.l1)
```

```
Residuals:
      Min       1Q   Median       3Q      Max
-0.230951 -0.023625  0.005496  0.038821  0.162127
```

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.02459    0.01252   1.964   0.0573 .
y.l1         0.14885    0.16290   0.914   0.3669
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.06988 on 36 degrees of freedom
Multiple R-squared:  0.02267,    Adjusted R-squared:  -0.004481
F-statistic: 0.8349 on 1 and 36 DF,  p-value: 0.3669
```

Value of test-statistic, type: Z-alpha is: -28.5833

```
      aux. Z statistics
Z-tau-mu      1.9269
```

```
> #####
> # m1, r1
> # m1 = fof ~ retire
> m1 = lm(fof~retire)
> # r1 = m1$residuals
> r1 <- m1$residuals
> par(mfrow=c(1,1))
> plot(r1, xlab = 'time (seasonal)')
> # t = adf.test(resid, alternative = 'explosive')
> print(summary(m1))
```

```
Call:
lm(formula = fof ~ retire)
```

```
Residuals:
```

	Min	1Q	Median	3Q	Max
	-182.482	-26.622	1.348	38.330	145.811

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-7.552e+02	5.632e+01	-13.41	5.51e-16 ***
retire	1.524e-01	5.042e-03	30.22	< 2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 74.18 on 38 degrees of freedom

Multiple R-squared: 0.9601, Adjusted R-squared: 0.959

F-statistic: 913.5 on 1 and 38 DF, p-value: < 2.2e-16

> # print(t)

>

> #

> summary(ur.df(r1)) #

```
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####
```

Test regression none

Call:

lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:

	Min	1Q	Median	3Q	Max
	-79.277	-27.154	0.878	35.364	119.339

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	-0.3536	0.1112	-3.18	0.00303 **
z.diff.lag	0.1376	0.1547	0.89	0.37948

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 45.54 on 36 degrees of freedom

Multiple R-squared: 0.2193, Adjusted R-squared: 0.1759

F-statistic: 5.056 on 2 and 36 DF, p-value: 0.01161

Value of test-statistic is: -3.1799

```

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ur.kpss(r1)) #

#####
# KPSS Unit Root Test #
#####

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.2674

Critical value for a significance level of:
      10pct  5pct 2.5pct  1pct
critical values 0.347 0.463 0.574 0.739

> summary(ur.pp(r1)) #

#####
# Phillips-Perron Unit Root Test #
#####

Test regression with intercept

Call:
lm(formula = y ~ y.l1)

Residuals:
      Min       1Q   Median       3Q      Max
-90.241 -29.743  -1.644  27.651 116.425

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    2.488      7.450   0.334    0.74
y.l1           0.722      0.103   7.006 2.78e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 46.51 on 37 degrees of freedom
Multiple R-squared:  0.5702,    Adjusted R-squared:  0.5586
F-statistic: 49.09 on 1 and 37 DF,  p-value: 2.78e-08

```

Value of test-statistic, type: Z-alpha is: -10.0379

```
      aux. Z statistics
Z-tau-mu      0.3398
```

```
> # r1
> # 0.1524 (1, -0.15)
>
>
> #####
>
> # bind the data
> y = diff(fof); x = diff(retire)
> r <- r1[1:39]
> ecmdat1 <- cbind(y,x, r)
> # ECM
> # ecm1 <- dynlm(d1~ L(d1, 1) + L(d2, 1) + L(d2,0)+L(r1, 1), data = ecmdat1)
> ecm1 <- dynlm(y~ L(y, 1) +L(y,2)+L(y,3)+L(y,4)+ L(x, 1) + L(x,0)+L(r, 1), data = ecmdat1)
> # ecm1 <- dynlm(d1~ L(d1, 1) +L(d1,2)+L(d1,3)+L(d1,4)+L(r1, 1) + L(d2, 1), data = ecmdat1)
>
> summary(ecm1)
```

Time series regression with "ts" data:
Start = 2008(2), End = 2016(4)

Call:
dynlm(formula = y ~ L(y, 1) + L(y, 2) + L(y, 3) + L(y, 4) + L(x,
1) + L(x, 0) + L(r, 1), data = ecmdat1)

Residuals:

	Min	1Q	Median	3Q	Max
	-87.387	-20.436	1.006	16.815	142.580

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	22.13335	11.14436	1.986	0.0573 .
L(y, 1)	-0.46108	0.19994	-2.306	0.0290 *
L(y, 2)	-0.01601	0.12908	-0.124	0.9022
L(y, 3)	-0.03563	0.12999	-0.274	0.7861
L(y, 4)	-0.02875	0.13862	-0.207	0.8373
L(x, 1)	0.05842	0.02549	2.292	0.0300 *
L(x, 0)	0.09517	0.01852	5.138	2.1e-05 ***
L(r, 1)	-0.38373	0.16855	-2.277	0.0309 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 40.94 on 27 degrees of freedom
Multiple R-squared: 0.5683, Adjusted R-squared: 0.4564
F-statistic: 5.078 on 7 and 27 DF, p-value: 9e-04

```
> #
> r_ecm1 <- ecm1$residuals
> summary(ur.df(r_ecm1)) #
```

```
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####
```

Test regression none

Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:

	Min	1Q	Median	3Q	Max
	-84.623	-17.207	6.866	18.222	144.776

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
z.lag.1	-1.1622	0.2746	-4.232	0.000191 ***
z.diff.lag	0.1081	0.1870	0.578	0.567543

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 37.52 on 31 degrees of freedom
Multiple R-squared: 0.5034, Adjusted R-squared: 0.4713
F-statistic: 15.71 on 2 and 31 DF, p-value: 1.943e-05

Value of test-statistic is: -4.2323

Critical values for test statistics:

	1pct	5pct	10pct
tau1	-2.62	-1.95	-1.61

```
> summary(ur.kpss(r_ecm1)) #
```

```
#####
# KPSS Unit Root Test #
#####
```

Test is of type: mu with 3 lags.

Value of test-statistic is: 0.1962

Critical value for a significance level of:

	10pct	5pct	2.5pct	1pct
critical values	0.347	0.463	0.574	0.739

```
> summary(ur.pp(r_ecm1)) #
```

```
#####  
# Phillips-Perron Unit Root Test #  
#####
```

Test regression with intercept

Call:

```
lm(formula = y ~ y.l1)
```

Residuals:

Min	1Q	Median	3Q	Max
-87.857	-20.380	0.744	17.349	142.331

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.96851	6.38695	0.152	0.880
y.l1	-0.03837	0.18416	-0.208	0.836

Residual standard error: 37.18 on 32 degrees of freedom

Multiple R-squared: 0.001354, Adjusted R-squared: -0.02985

F-statistic: 0.0434 on 1 and 32 DF, p-value: 0.8363

Value of test-statistic, type: Z-alpha is: -33.1763

	aux. Z statistics
Z-tau-mu	0.1525

>

>