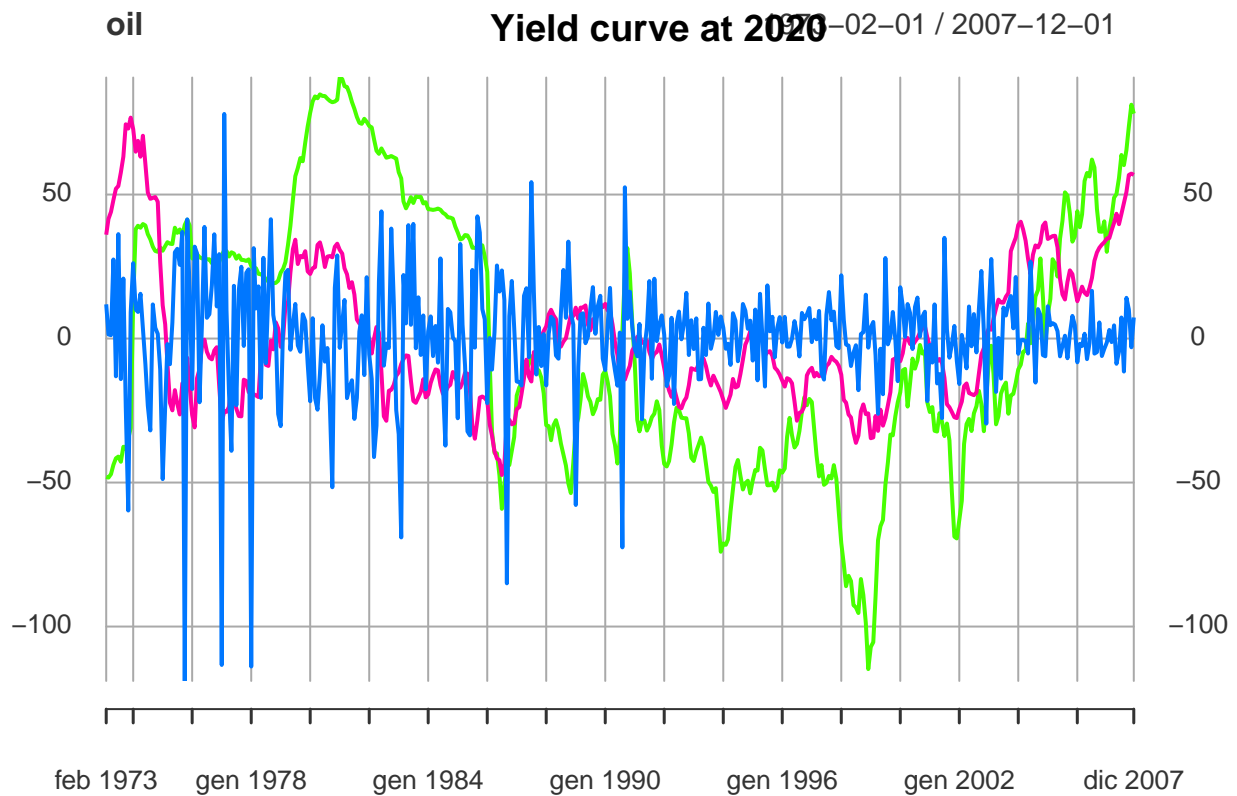# Assignement

Point 1

The time series below represents the monthly time series of: 1. % change in global crude oil production 2. the real price of oil 3. the real economy activity From 1973:1 to 2007:12.


As we can see the acf its clear signaling the presence of an autcorrelation process. In order to test if the *rea* is an $I(1)$, we will use an ADF test with lag =1. We will perform the test specifing four different type of the process: 1. No consant, no trend 2. Constant 3. Constant with trend 4. No costant with trend First, we print the first times series graph. We perform the different type of the test with a maximun lag order of 12:

$$rea_t = \alpha + \sigma_1 reat_(t-1) + ... + \sigma_1 2\delta reat_(t-13)$$

We take the model with constant, otherwise the model will be too restricive, and without time trend, selectin
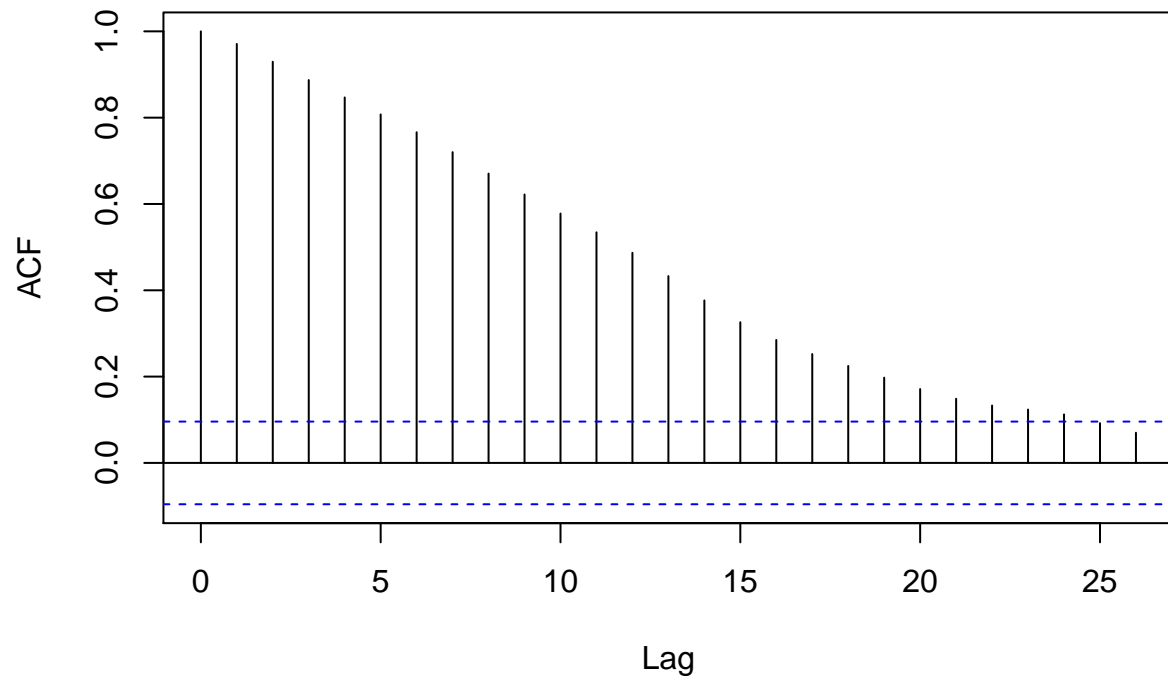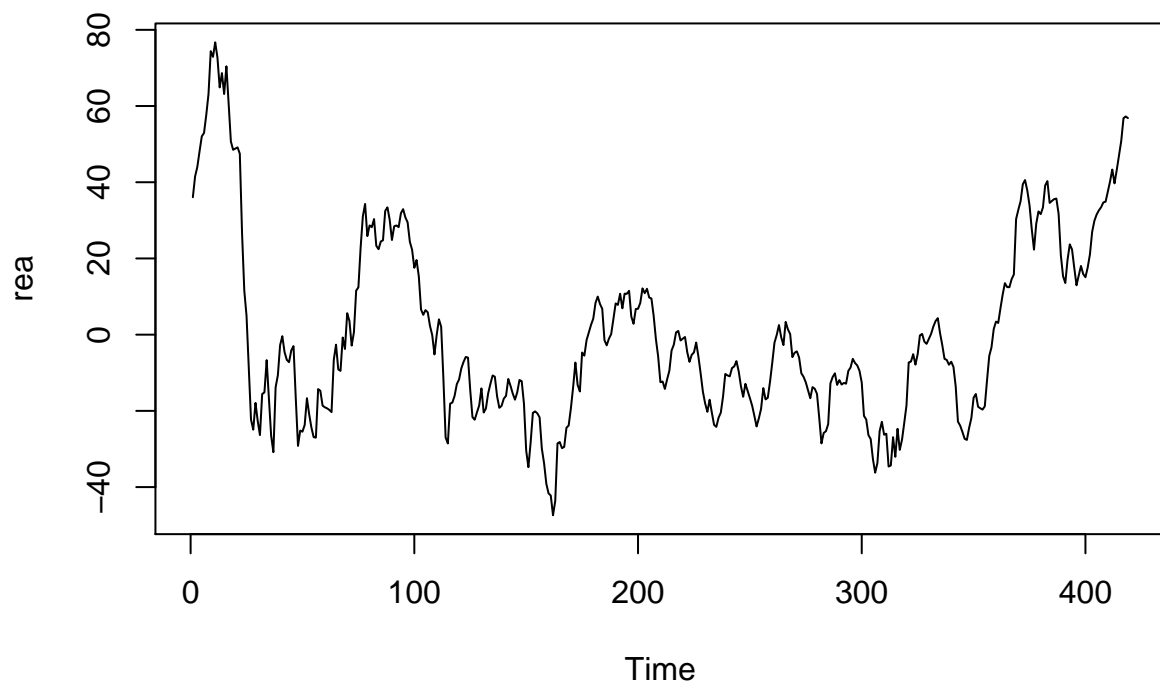
1

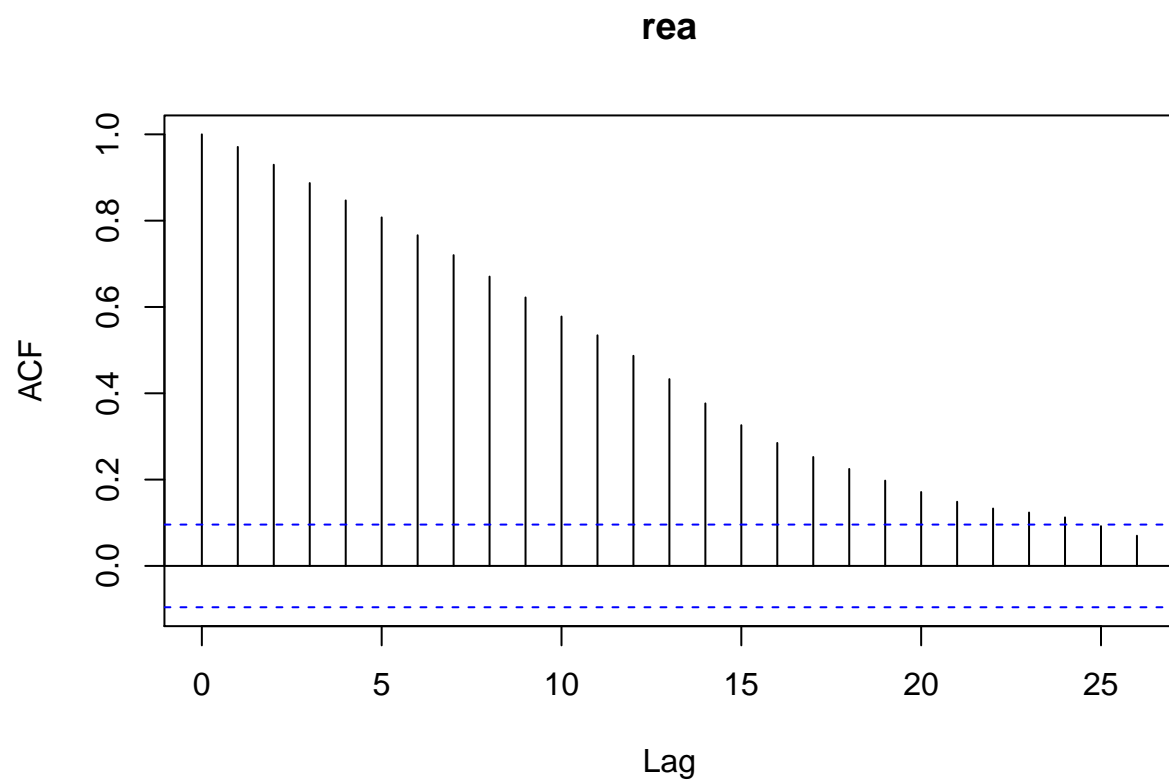**oil$rea**   1973–02–01 / 2007–12–01
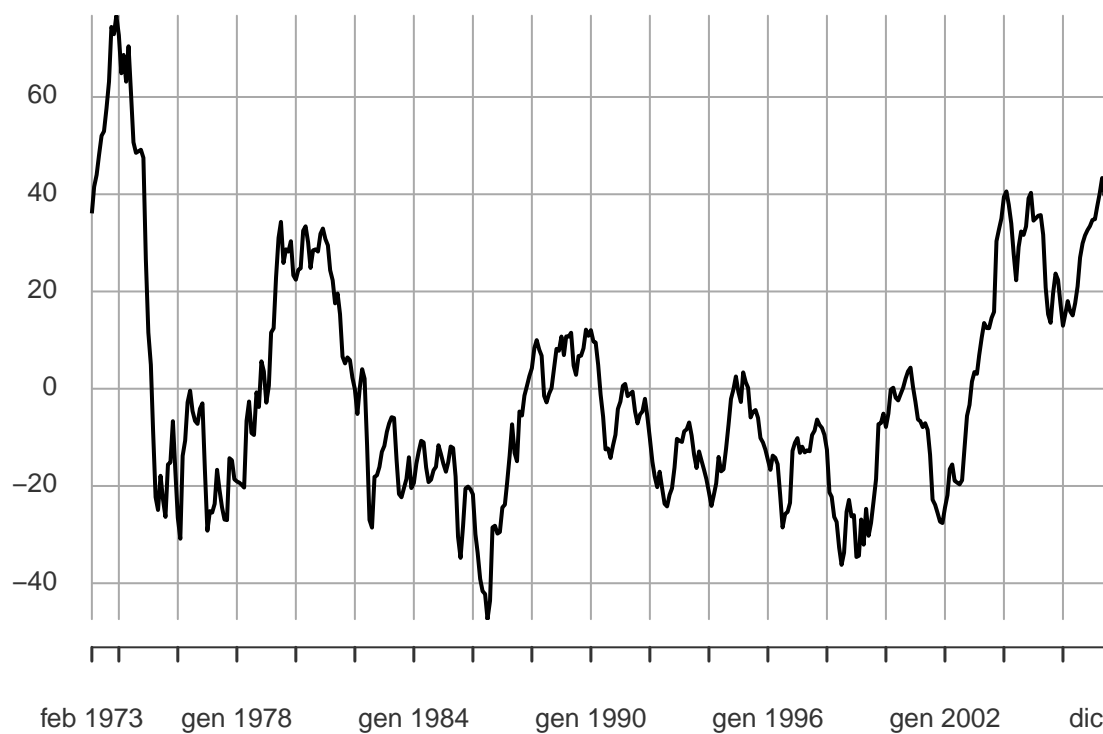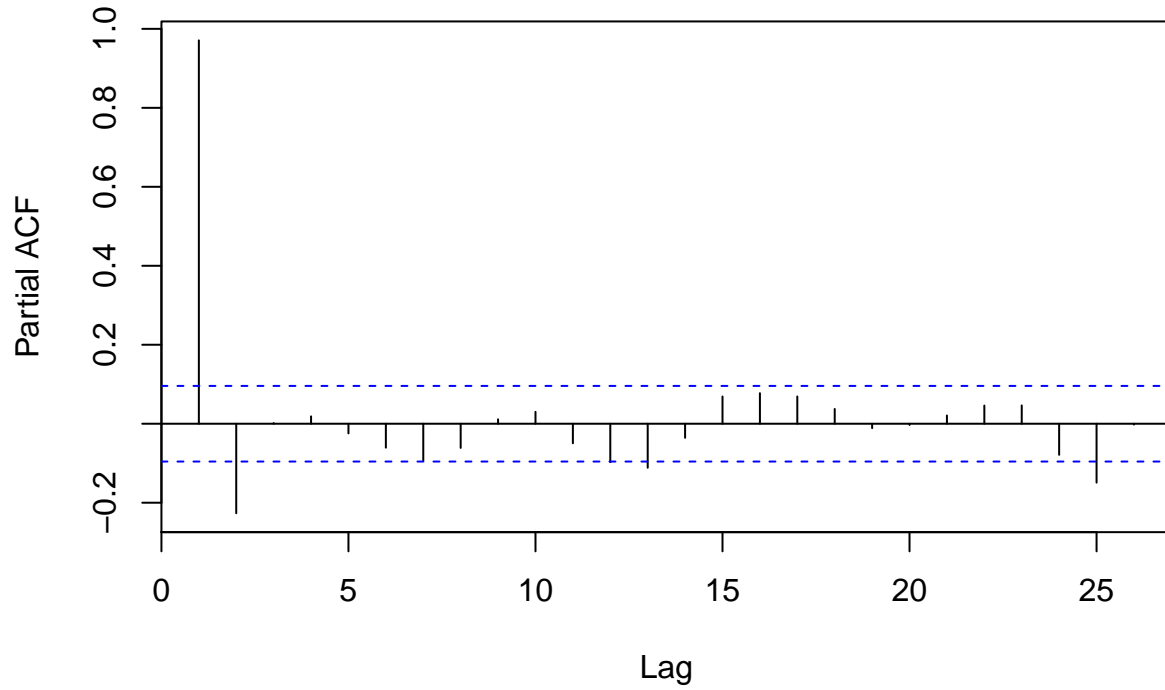

the one which as lower BIC:

Series oil$rea

rea

Series timeseries

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	1	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	1	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	1	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	2	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	2	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	2	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	2	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	2	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	2	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	3	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	3	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	3	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	3	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	3	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	3	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	3	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	3	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	3	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	4	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	4	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	4	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	4	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	4	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	4	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	4	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	4	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	4	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	4	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	4	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	4	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	5	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	5	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	5	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	5	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	5	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	5	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	5	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	5	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	5	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	5	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	5	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	5	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	5	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	5	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	5	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	6	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	6	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	6	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	6	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	6	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	6	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	6	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	6	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	6	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	6	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	6	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	6	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	6	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	6	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	6	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	6	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	6	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	6	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	7	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	7	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	7	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	7	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	7	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	7	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	7	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	7	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	7	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	7	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	7	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	7	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	7	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	7	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	7	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	7	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	7	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	7	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	7	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	7	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	7	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	8	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	8	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	8	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	8	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	8	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	8	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	8	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	8	no drift no trend	8	-3.3318	0.01	Stat	Stat
rw	8	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	8	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	8	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	8	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	8	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	8	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	8	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	8	with drift no trend	8	-3.3321	0.0154	Stat	No Stat.
rw	8	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	8	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	8	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	8	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	8	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	8	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	8	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	8	with drift and trend	8	-3.3119	0.0686	No Stat.	No Stat.
rw	9	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	9	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	9	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	9	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	9	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	9	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	9	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	9	no drift no trend	8	-3.3318	0.01	Stat	Stat
rw	9	no drift no trend	9	-3.4479	0.01	Stat	Stat
rw	9	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	9	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	9	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	9	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	9	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	9	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	9	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	9	with drift no trend	8	-3.3321	0.0154	Stat	No Stat.

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	9	with drift no trend	9	-3.454	0.01	Stat	Stat
rw	9	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	9	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	9	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	9	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	9	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	9	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	9	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	9	with drift and trend	8	-3.3119	0.0686	No Stat.	No Stat.
rw	9	with drift and trend	9	-3.4427	0.0478	Stat	No Stat.
rw	10	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	10	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	10	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	10	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	10	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	10	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	10	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	10	no drift no trend	8	-3.3318	0.01	Stat	Stat
rw	10	no drift no trend	9	-3.4479	0.01	Stat	Stat
rw	10	no drift no trend	10	-3.2258	0.01	Stat	Stat
rw	10	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	10	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	10	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	10	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	10	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	10	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	10	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	10	with drift no trend	8	-3.3321	0.0154	Stat	No Stat.
rw	10	with drift no trend	9	-3.454	0.01	Stat	Stat
rw	10	with drift no trend	10	-3.2318	0.0202	Stat	No Stat.
rw	10	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	10	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	10	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	10	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	10	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	10	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	10	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	10	with drift and trend	8	-3.3119	0.0686	No Stat.	No Stat.
rw	10	with drift and trend	9	-3.4427	0.0478	Stat	No Stat.
rw	10	with drift and trend	10	-3.2348	0.0819	No Stat.	No Stat.
rw	11	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	11	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	11	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	11	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	11	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	11	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	11	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	11	no drift no trend	8	-3.3318	0.01	Stat	Stat
rw	11	no drift no trend	9	-3.4479	0.01	Stat	Stat
rw	11	no drift no trend	10	-3.2258	0.01	Stat	Stat
rw	11	no drift no trend	11	-3.5172	0.01	Stat	Stat

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	11	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	11	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	11	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	11	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	11	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	11	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	11	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	11	with drift no trend	8	-3.3321	0.0154	Stat	No Stat.
rw	11	with drift no trend	9	-3.454	0.01	Stat	Stat
rw	11	with drift no trend	10	-3.2318	0.0202	Stat	No Stat.
rw	11	with drift no trend	11	-3.529	0.01	Stat	Stat
rw	11	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	11	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	11	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	11	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	11	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.
rw	11	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	11	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	11	with drift and trend	8	-3.3119	0.0686	No Stat.	No Stat.
rw	11	with drift and trend	9	-3.4427	0.0478	Stat	No Stat.
rw	11	with drift and trend	10	-3.2348	0.0819	No Stat.	No Stat.
rw	11	with drift and trend	11	-3.5484	0.0375	Stat	No Stat.
rw	12	no drift no trend	1	-1.6457	0.0961	No Stat.	No Stat.
rw	12	no drift no trend	2	-2.5702	0.0104	Stat	No Stat.
rw	12	no drift no trend	3	-2.4271	0.0166	Stat	No Stat.
rw	12	no drift no trend	4	-2.4375	0.0162	Stat	No Stat.
rw	12	no drift no trend	5	-2.5514	0.0112	Stat	No Stat.
rw	12	no drift no trend	6	-2.801	0.01	Stat	Stat
rw	12	no drift no trend	7	-3.2152	0.01	Stat	Stat
rw	12	no drift no trend	8	-3.3318	0.01	Stat	Stat
rw	12	no drift no trend	9	-3.4479	0.01	Stat	Stat
rw	12	no drift no trend	10	-3.2258	0.01	Stat	Stat
rw	12	no drift no trend	11	-3.5172	0.01	Stat	Stat
rw	12	no drift no trend	12	-3.8179	0.01	Stat	Stat
rw	12	with drift no trend	1	-1.6443	0.4692	No Stat.	No Stat.
rw	12	with drift no trend	2	-2.5669	0.1025	No Stat.	No Stat.
rw	12	with drift no trend	3	-2.4235	0.1595	No Stat.	No Stat.
rw	12	with drift no trend	4	-2.4339	0.1554	No Stat.	No Stat.
rw	12	with drift no trend	5	-2.5482	0.11	No Stat.	No Stat.
rw	12	with drift no trend	6	-2.7977	0.0626	No Stat.	No Stat.
rw	12	with drift no trend	7	-3.2132	0.0211	Stat	No Stat.
rw	12	with drift no trend	8	-3.3321	0.0154	Stat	No Stat.
rw	12	with drift no trend	9	-3.454	0.01	Stat	Stat
rw	12	with drift no trend	10	-3.2318	0.0202	Stat	No Stat.
rw	12	with drift no trend	11	-3.529	0.01	Stat	Stat
rw	12	with drift no trend	12	-3.8297	0.01	Stat	Stat
rw	12	with drift and trend	1	-1.6235	0.736	No Stat.	No Stat.
rw	12	with drift and trend	2	-2.5446	0.3465	No Stat.	No Stat.
rw	12	with drift and trend	3	-2.3969	0.4087	No Stat.	No Stat.
rw	12	with drift and trend	4	-2.4043	0.4055	No Stat.	No Stat.
rw	12	with drift and trend	5	-2.5178	0.3578	No Stat.	No Stat.

	N of lags	Type	lag	ADF	p.value	Stationary at 5%	Stationary at 10%
rw	12	with drift and trend	6	-2.7702	0.2515	No Stat.	No Stat.
rw	12	with drift and trend	7	-3.1891	0.0898	No Stat.	No Stat.
rw	12	with drift and trend	8	-3.3119	0.0686	No Stat.	No Stat.
rw	12	with drift and trend	9	-3.4427	0.0478	Stat	No Stat.
rw	12	with drift and trend	10	-3.2348	0.0819	No Stat.	No Stat.
rw	12	with drift and trend	11	-3.5484	0.0375	Stat	No Stat.
rw	12	with drift and trend	12	-3.863	0.0156	Stat	No Stat.

```
## $`ADF Statistic using BIC`
## [1] -4.252854

##              N of lags                  Type                  lag
##                   "12" "with drift and trend"                 "12"
##                    ADF               p.value     Stationary at 5%
##               "-3.863"              "0.0156"                "Stat"
##       Stationary at 10%
##              "No Stat."
```

As we can see from the table above which report the result of the ADF tests, it is clear that the process is not stationary with a $alpha < 10$, so there are no suffcent empirical evidence to reject the null. Thus the *rea* time series is not a covariance-stationary process with a minium lag of order 1.

Point 2

We take the first difference of the timeseries *rea* and check if it is stationary with an adf test. Before that we print the time series of the first differences, the acf, and the pacf to understat the correct specification for the ADF test.

timeseries   1973–03–01 / 2007–12–01
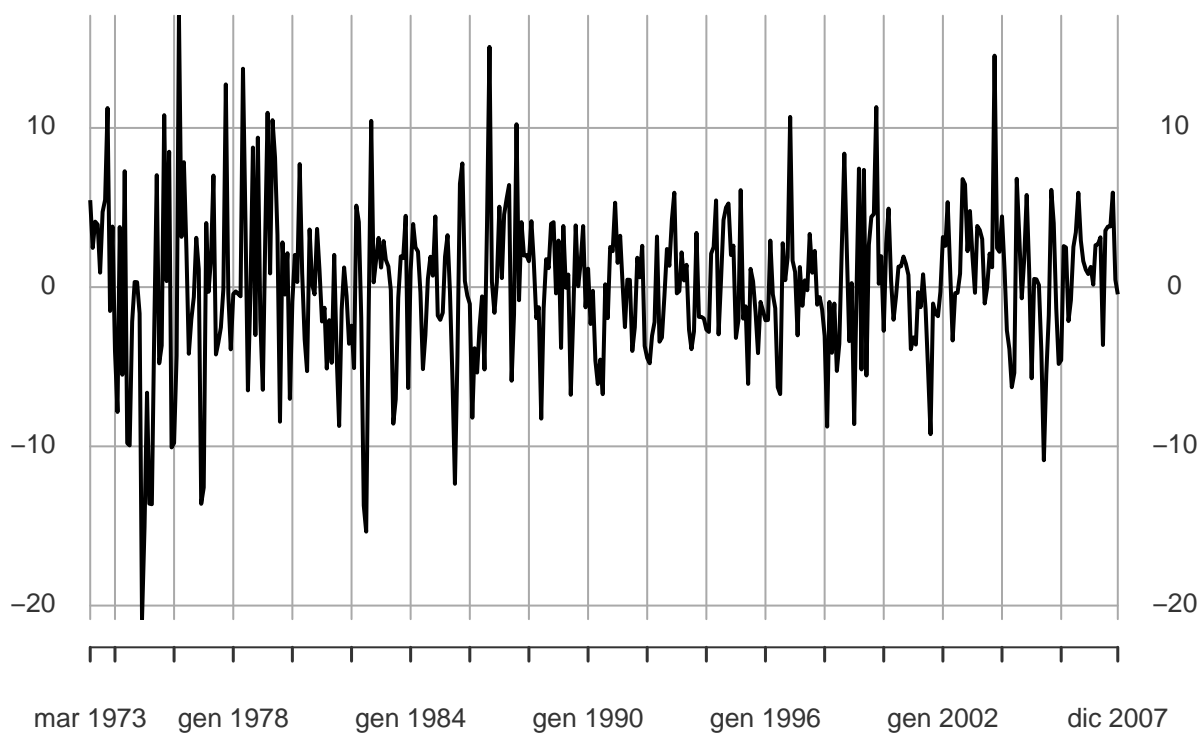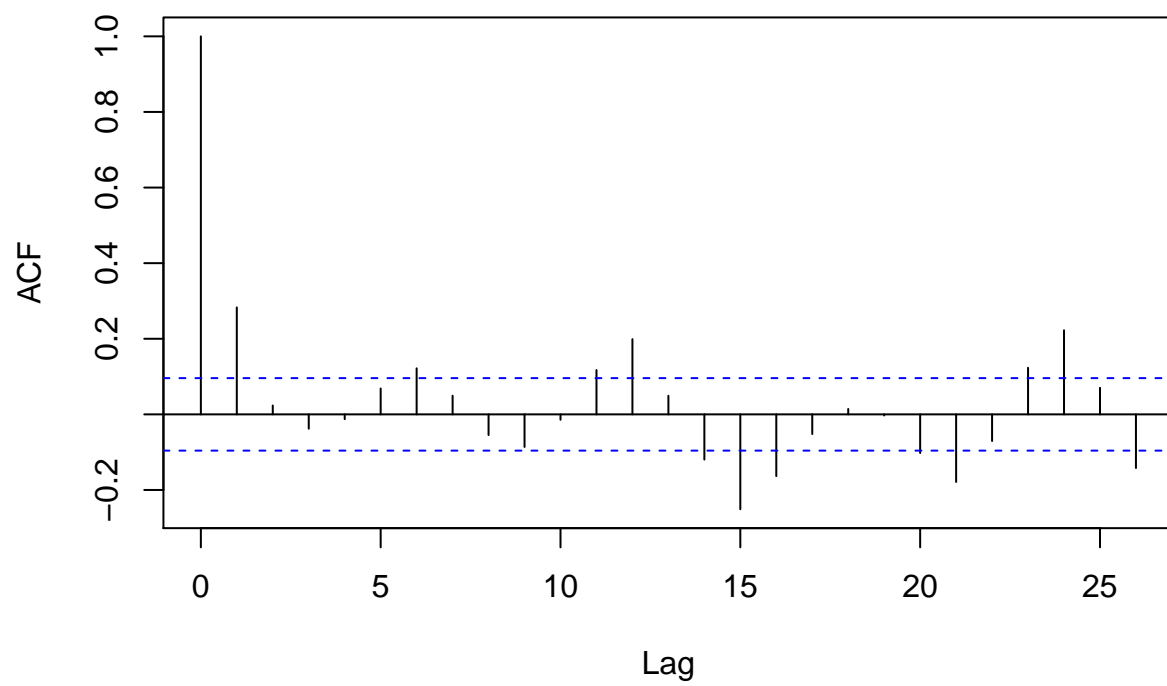
Series timeseries
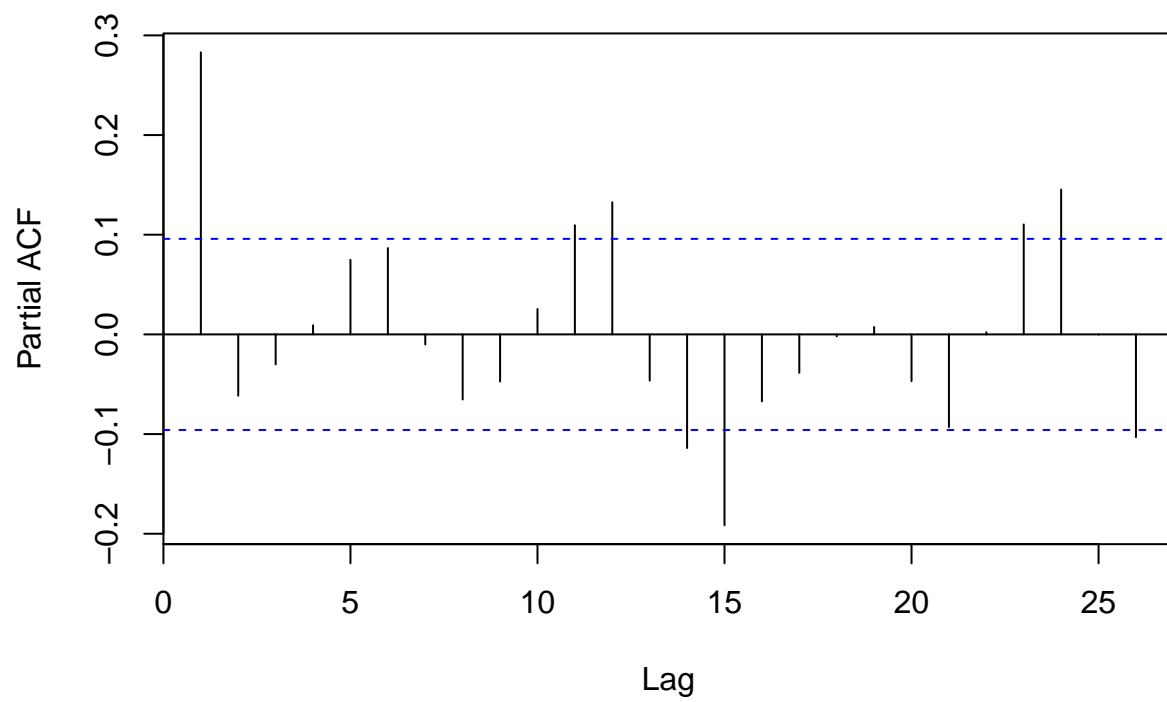
Series timeseries

timeseries   1973–03–01 / 2007–12–01
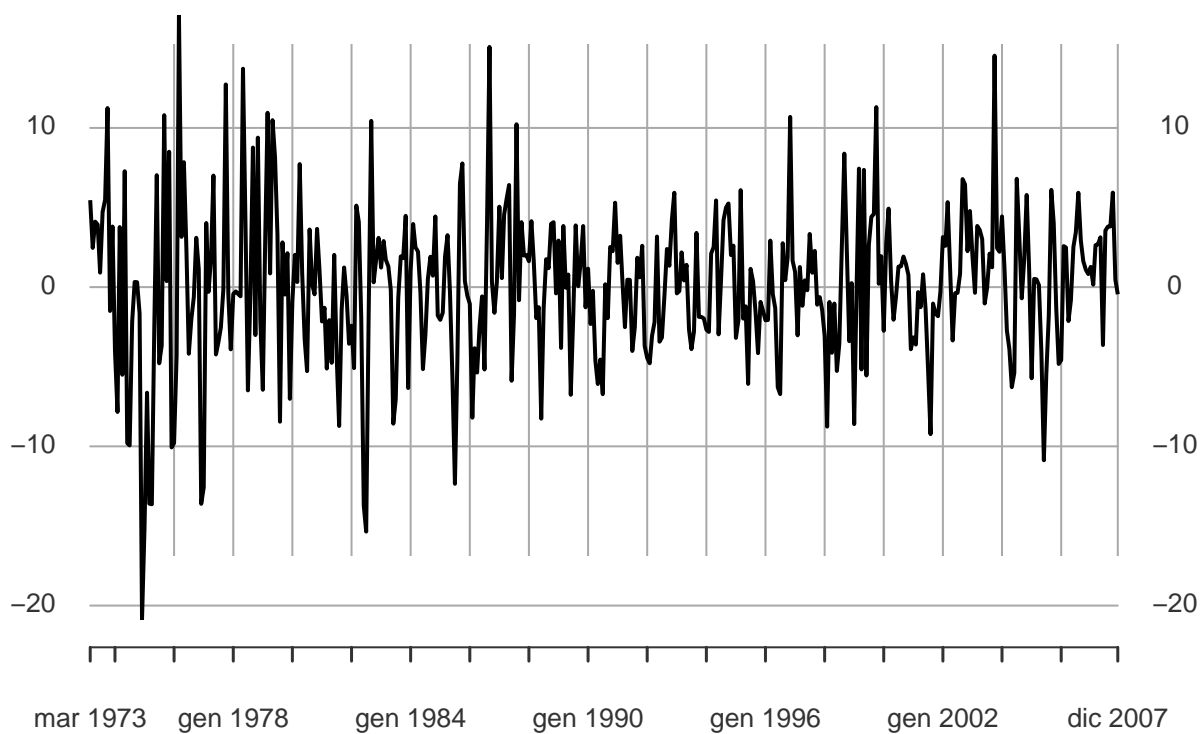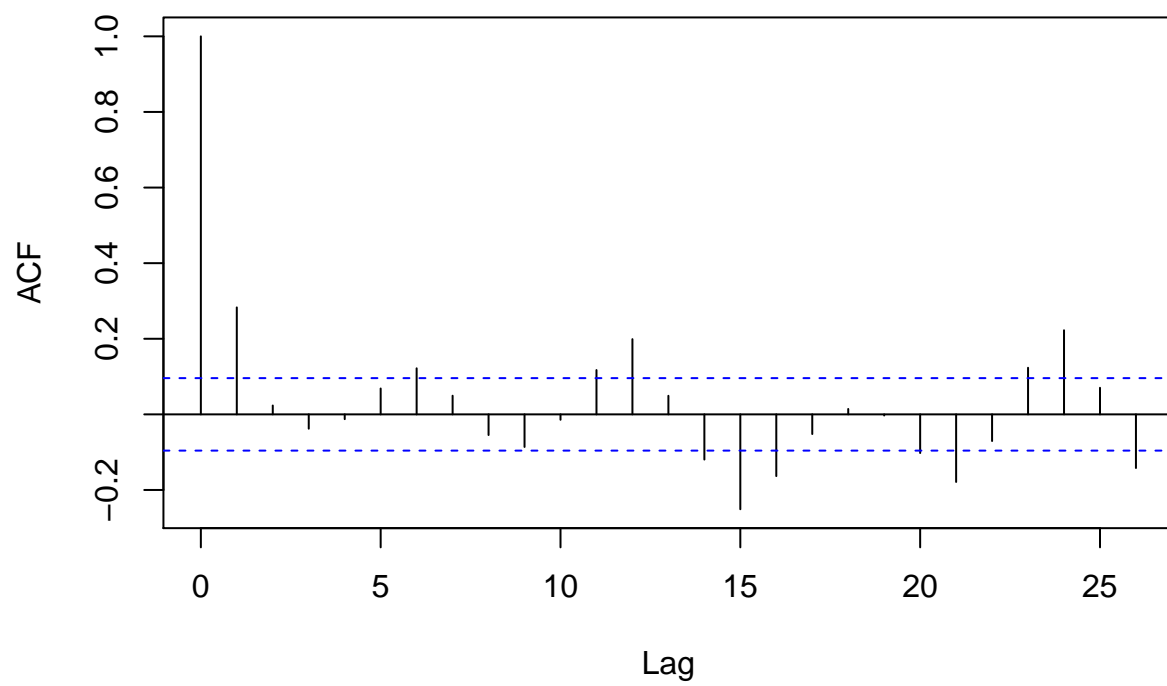
Series timeseries

Series timeseries
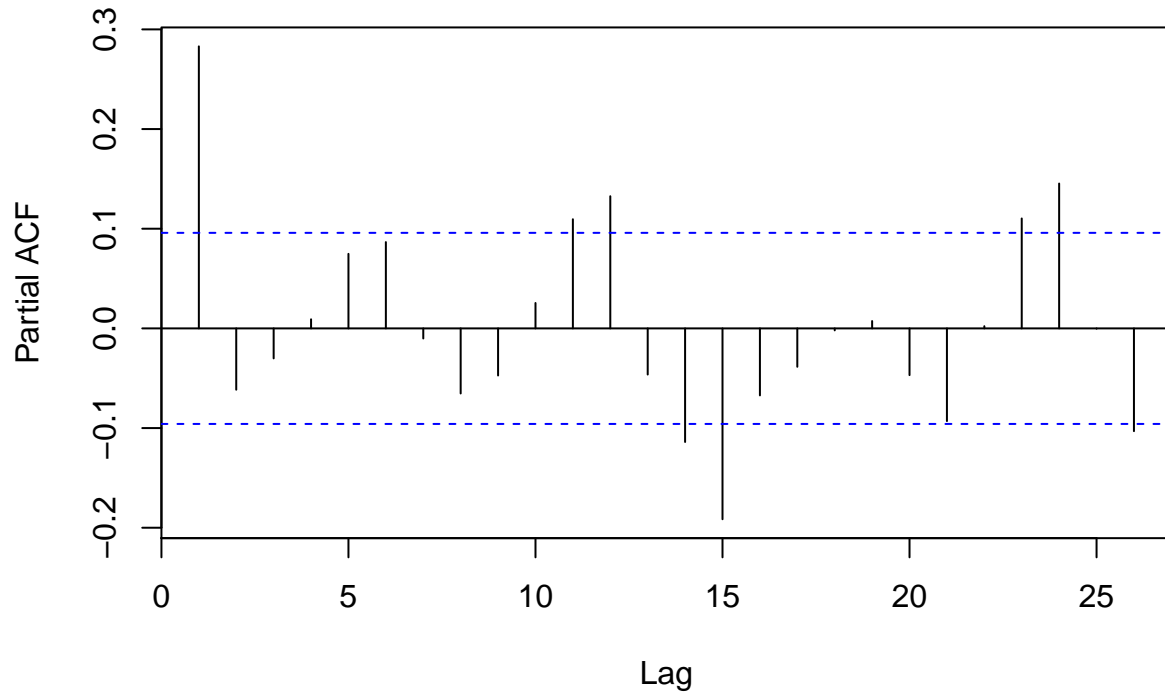
The above graphs clearly underline stationarity of the process, indeed the acf for the $lag > 2$ the partial autcorrelation is not statisticaly different from 0. As for the partial autcorrelation that is statistically different only for some lag>10. From the plot of the time series we can see a mean reverting process, and so I will opt for the specification without time trend and constant. so the test will have the following specification:

$$\delta rea_t = \sigma_1 \delta reat_(t-1) + ... + \sigma_1 2 \delta reat_(t-13)$$

The test will be performed with all passible four specification, and will be selected the specification with lower adf value.

```
##          N of lags                Type              lag
##              "1" "with drift no trend"              "1"
##              ADF             p.value  Stationary at 5%
##           "15.19"              "0.99"       "No Stat."
##    Stationary at 10%
##          "No Stat."
```

Point 3

Series out$residuals
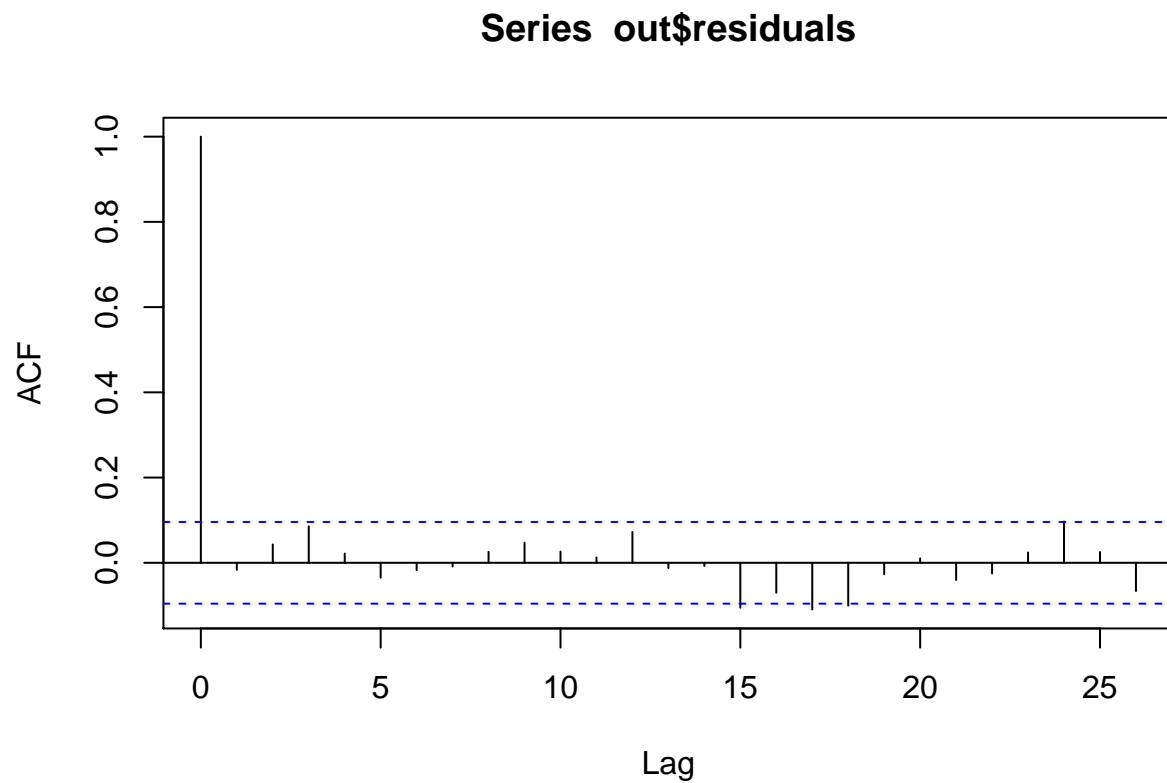

```
## p q
## 3 2
```

Point 4

```
## Augmented Dickey-Fuller Test
## alternative: stationary
##
## Type 1: no drift no trend
##      lag  ADF p.value
## [1,]   0 22.3    0.99
## [2,]   1 32.7    0.99
## [3,]   2 41.8    0.99
## [4,]   3 50.3    0.99
## [5,]   4 59.7    0.99
## [6,]   5 66.9    0.99
## Type 2: with drift no trend
##      lag  ADF p.value
## [1,]   0 22.3    0.99
## [2,]   1 32.7    0.99
## [3,]   2 41.9    0.99
## [4,]   3 50.5    0.99
```
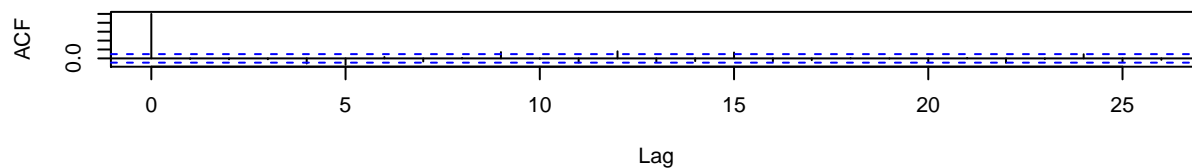
```
## [5,]   4 60.1    0.99
## [6,]   5 67.4    0.99
## Type 3: with drift and trend
##      lag  ADF p.value
## [1,]   0 22.3    0.99
## [2,]   1 32.7    0.99
## [3,]   2 41.9    0.99
## [4,]   3 50.5    0.99
## [5,]   4 60.1    0.99
## [6,]   5 67.5    0.99
## ----
## Note: in fact, p.value = 0.01 means p.value <= 0.01


## Augmented Dickey-Fuller Test
## alternative: stationary
##
## Type 1: no drift no trend
##      lag  ADF p.value
## [1,]   0 2.47   0.990
## [2,]   1 1.42   0.960
## [3,]   2 1.60   0.973
## [4,]   3 1.63   0.975
## [5,]   4 1.56   0.970
## [6,]   5 1.35   0.955
## Type 2: with drift no trend
##      lag  ADF p.value
## [1,]   0 2.46    0.99
## [2,]   1 1.41    0.99
## [3,]   2 1.60    0.99
## [4,]   3 1.63    0.99
## [5,]   4 1.56    0.99
## [6,]   5 1.35    0.99
## Type 3: with drift and trend
##      lag ADF p.value
## [1,]   0 2.47    0.99
## [2,]   1 1.42    0.99
## [3,]   2 1.61    0.99
## [4,]   3 1.64    0.99
## [5,]   4 1.57    0.99
## [6,]   5 1.36    0.99
## ----
## Note: in fact, p.value = 0.01 means p.value <= 0.01


## Augmented Dickey-Fuller Test
## alternative: stationary
##
## Type 1: no drift no trend
##      lag   ADF p.value
## [1,]   0 1.852   0.984
## [2,]   1 0.579   0.811
## [3,]   2 0.886   0.899
## [4,]   3 0.933   0.906
## [5,]   4 1.072   0.923
## [6,]   5 1.081   0.924
```
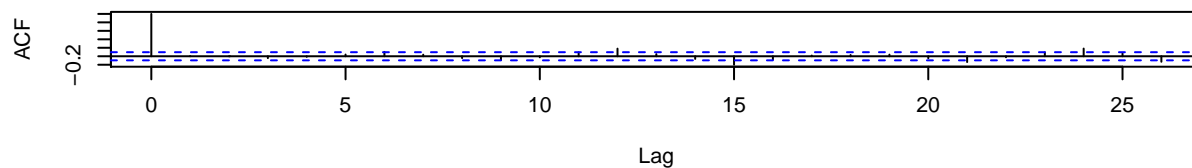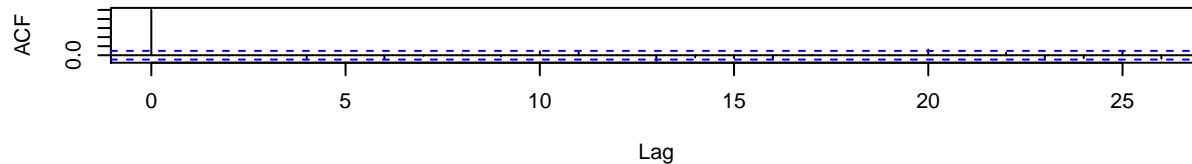
```
## Type 2: with drift no trend
##      lag   ADF  p.value
## [1,]   0 1.847   0.990
## [2,]   1 0.579   0.989
## [3,]   2 0.886   0.990
## [4,]   3 0.933   0.990
## [5,]   4 1.071   0.990
## [6,]   5 1.081   0.990
## Type 3: with drift and trend
##      lag   ADF  p.value
## [1,]   0 2.137    0.99
## [2,]   1 0.714    0.99
## [3,]   2 1.070    0.99
## [4,]   3 1.145    0.99
## [5,]   4 1.313    0.99
## [6,]   5 1.332    0.99
## ----
## Note: in fact, p.value = 0.01 means p.value <= 0.01


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

Series res[, 1]

Series res[, 2]

Series res[, 3]

Series res[, 1]

Partial ACF / Lag

Series res[, 2]

Partial ACF / Lag

Series res[, 3]

Partial ACF / Lag
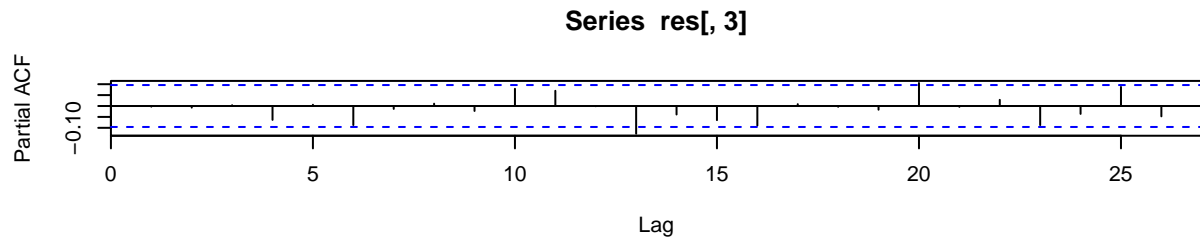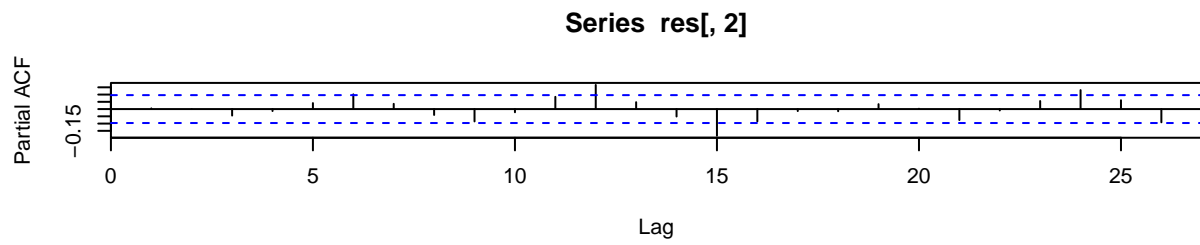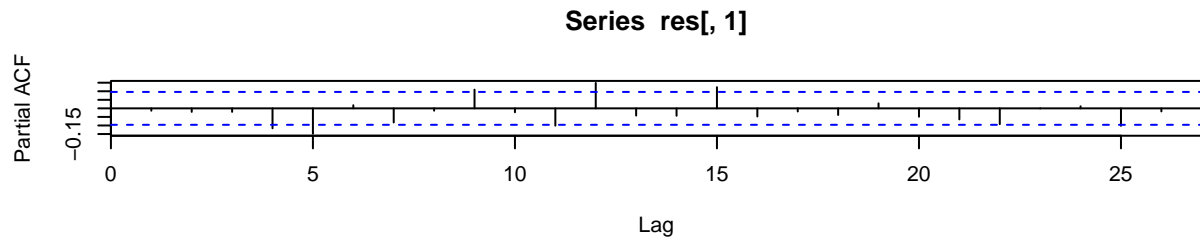
```
##             Dprod       rea       rpo
## Dprod 416.145308  7.824951 -4.099590
## rea     7.824951 20.483391  1.765876
## rpo    -4.099590  1.765876 38.132342
```

```
##             Dprod        rea         rpo
## Dprod  1.00000000 0.08475361 -0.03254402
## rea    0.08475361 1.00000000  0.06318480
## rpo   -0.03254402 0.06318480  1.00000000
```

```
## [1] 0.9701644 0.9701644 0.4696721 0.4634054 0.4634054 0.4593787 0.4593787
## [8] 0.2924893 0.2924893
```

Orthogonal Impulse Response from Dprod
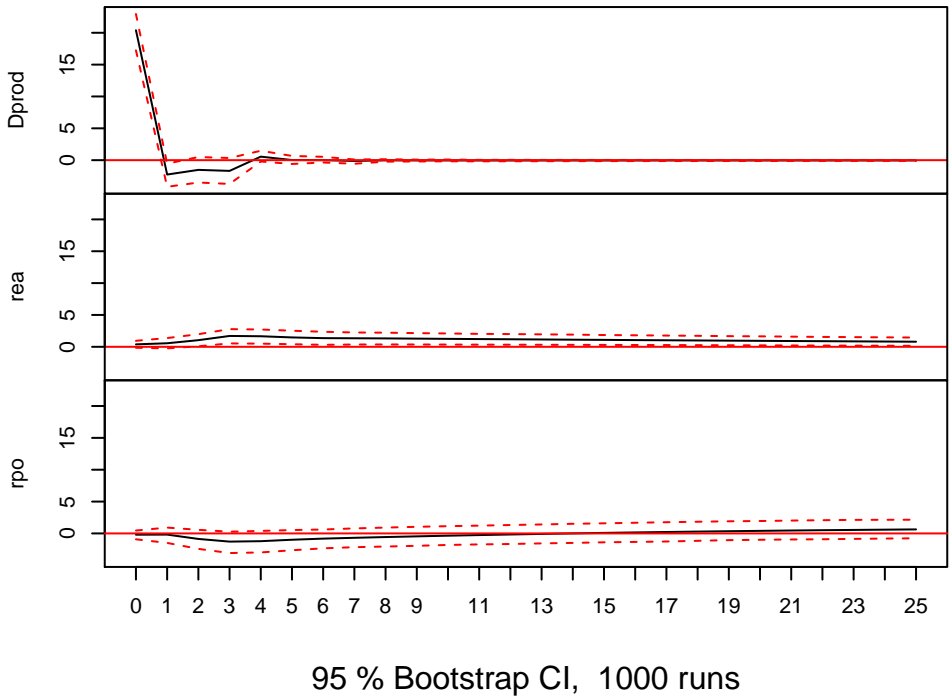
95 % Bootstrap CI, 1000 runs

Orthogonal Impulse Response from rea
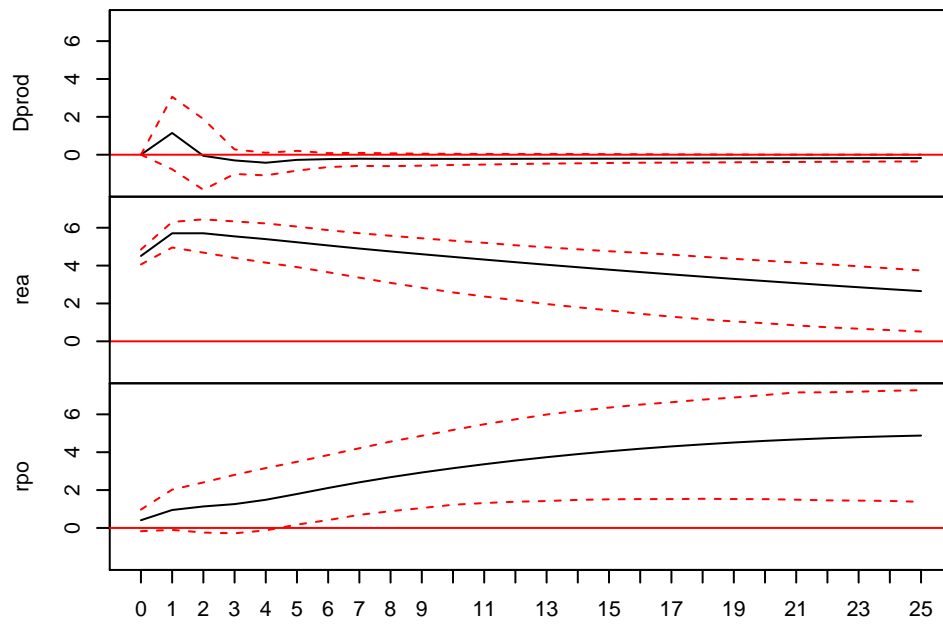
95 % Bootstrap CI, 1000 runs

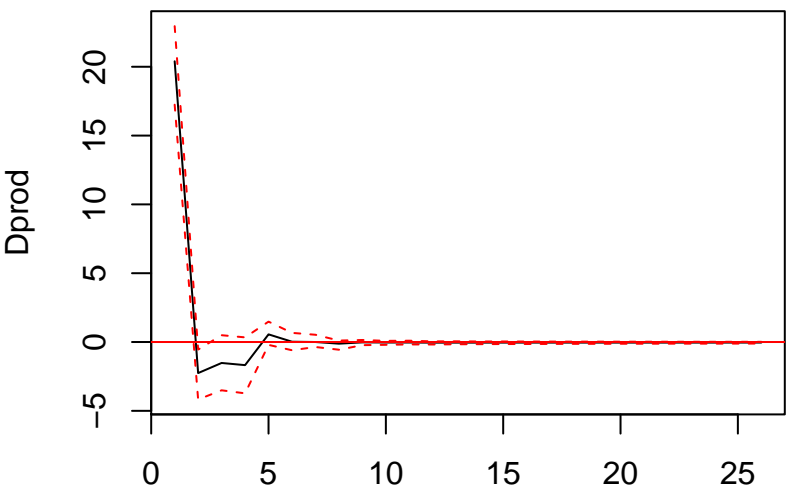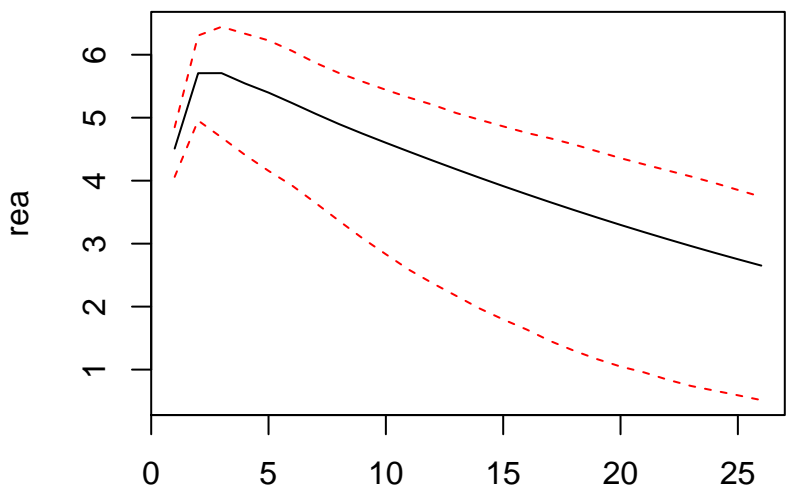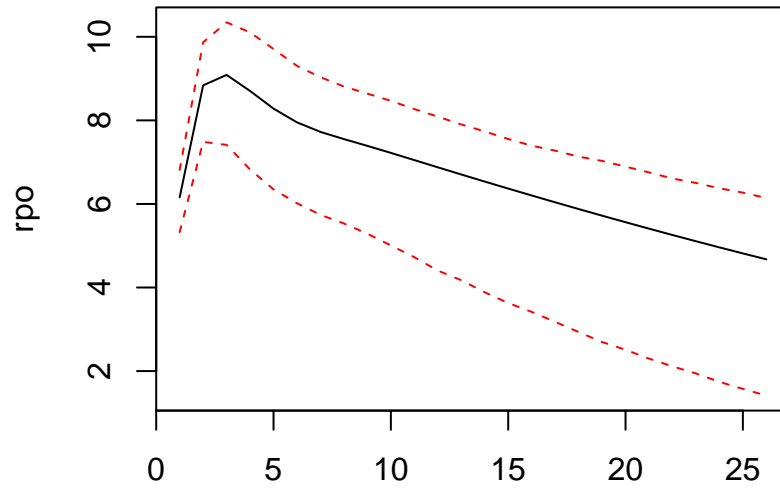# Orthogonal Impulse Response from rpo
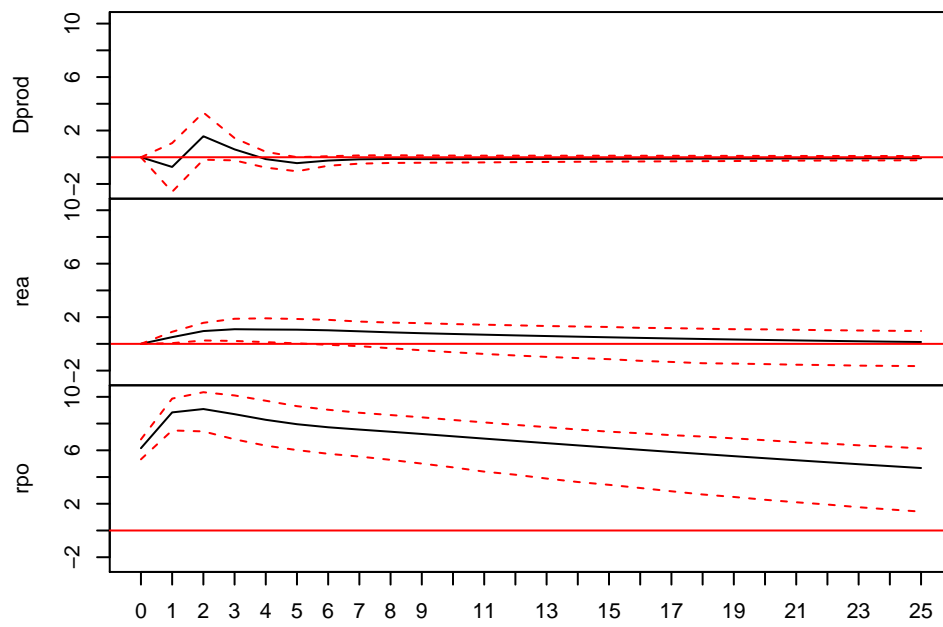
95 % Bootstrap CI, 1000 runs

Point 5

Orthogonal Impulse Response from Dprod

95 % Bootstrap CI, 1000 runs

Orthogonal Impulse Response from rea

95 % Bootstrap CI, 1000 runs

Orthogonal Impulse Response from rpo

95 % Bootstrap CI, 1000 runs