

# Package ‘cif’

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**Title** Cointegrated ICU Forecasting

**Description** Set of forecasting tools to predict ICU beds using a Vector Error Correction model with a single cointegrating vector. Method described in Berta, P. Lovaglio, P.G. Paruolo, P. Verzillo, S., 2020. "Real Time Forecasting of Covid-19 Intensive Care Units demand" Health, Econometrics and Data Group (HEDG) Working Papers 20/16, HEDG, Department of Economics, University of York, <<https://www.york.ac.uk/media/economics/documents/hedg/workingpapers/2020/2016.pdf>>.

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**License** GPL-3

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crossing	<i>computes at which observation a vector y crosses ref for the first time</i>
----------	--

---

### Description

Computes at which observation vector yfor crosses yref for the first time if it is not crossed, then 0 is returned

### Usage

```
crossing(yfor, ref = 0)
```

### Arguments

yfor	yfor is either a vector and a matrix
ref	ref is the refence value

### Value

whensign, a matrix with observation number at which there is crossing

### Author(s)

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

diffe	<i>appends NA at beginning of diff(y)</i>
-------	---

---

**Description**

appends NA at beginning of diff(y) and creates column names accordingly when y is either a vector and a matrix

**Usage**

```
diffe(y)
```

**Arguments**

y                    either a vector and a matrix

**Value**

Dy contains the differences of y, with NA appended at the start

**Author(s)**

P. Paruolo

**References**

Berta et al. 2020

---

ec.companion	<i>computes companion matrix of the VAR</i>
--------------	---

---

**Description**

builds the companion matrix of the VAR

**Usage**

```
ec.companion(est, p = 2, nlag = 4)
```

**Arguments**

est                    is the output of ec.EG1.R  
p                      (positive integer) is the dimension of the VAR  
nlag                   (positive integer) is the number of lags in the VAR

**Value**

mA companion matrix

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.datadet1                      *prepares deterministic  $D^{\wedge}(1)$*

---

**Description**

Prepares deterministic data

**Usage**

ec.datadet1(n, befpn, breaks)

**Arguments**

n                      is the number of obs in available data  
 befpn                is a vector with (begtrim,endtrim,nforecast,npred,nhstar)  
 breaks                is a vector of integers where the trend breaks should be

**Value**

matdet1 a matrix with the following columns (1\_vec, t\_vec) and (n+npred) rows

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.datadet2                    *prepares deterministic  $D^2$*

---

**Description**

Prepares deterministic dummies for de-meanded daily seasonal and difference point dummies

**Usage**

```
ec.datadet2(det1, booseas = NA, pntdates = NA)
```

**Arguments**

det1                    is the det term with constant and trend created by ec.datadet1.R  
booseas                is a boolean for daily seasonal dummies  
pntdates               is a vector of integers where the point dummies should be

**Value**

det2mat a matrix with the following columns (daily\_seas, point\_dummies) and n+npred rows

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.data1ag                    *prepares  $Dy$   $y_{-1}$   $Dy_{-1}$  ...  $Dy_{-nlag-1}$  for estimation*

---

**Description**

Prepares data for estimation

**Usage**

```
ec.data1ag(y, nlag = 4)
```

**Arguments**

y                        is the data matrix of variables in the VAR  
nlag                    is the number of lags in the VAR (min = 2)

**Value**

yamat contains the following columns Dy y\_1 Dy\_1 ... Dy\_nlag-1

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, P.G. Lovaglio

**References**

Berta et al. 2020

---

ec.EG1

*estimates the VECM with the 2-stage procedure of Engle & Granger*

---

**Description**

Estimates the EC with EG. Cointegration rank fixed at 1

**Usage**

ec.EG1(det1, det2, ymat, np1, befpn, ndet, drop1 = NA, drop2 = NA)

**Arguments**

det1	deterministic matrix of constant(s) and trend(s)
det2	deterministic matrix of seasonals and point dummies
ymat	matrix of lags
np1	n, p, nlag
befpn	begtrim, endtrim, nforecast, npred
ndet	order of the model d(i,j)
drop1	selection of det1 regressors in first stage to drop
drop2	selection of det1 regressors in second stage to drop

**Value**

out a list with estimates

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, P.G. Lovaglio

**References**

Berta et al. 2020

---

ec.gfd *plots forecasts of difference with confidence bars*

---

**Description**

plots forecasts of difference with confidence bars

**Usage**

```
ec.gfd(obj, whichseries = 1, nsigma = 3, xvec, yvec, cal, lar = 0.025, ...)
```

**Arguments**

obj	output of ec.main
whichseries	series number
nsigma	how many standard deviations in confidence bars
xvec	vector of dates to place on x axis
yvec	vector of exp(y) values to display on y axis
cal	calendar vector
lar	length of arrows in error bars
...	other plot parameters

**Value**

does not return output, just creates a graph

**Author(s)**

P. Paruolo,

---

ec.gfl *plots level forecasts with confidence bars*

---

**Description**

plots level forecasts with confidence bars

**Usage**

```
ec.gfl(obj, whichseries = 1, nsigma = 3, xvec, yvec, cal, lar = 0.025, ...)
```

**Arguments**

obj	output of ec.main
whichseries	series number
nsigma	how many standard deviations in confidence bars
xvec	vector of dates to place on x axis
yvec	vector of exp(y) values to display on y axis
cal	calendar vector
lar	length of arrows in error bars
...	other plot parameters

**Value**

does not return output, just creates a graph

**Author(s)**

P. Paruolo

---

ec.gfld

*ec.gfld plots forecasts of levels and difference with confidence bars*

---

**Description**

plots forecasts of levels and difference with confidence bars

**Usage**

```
ec.gfld(  
  obj,  
  whichseries = 1,  
  nsigma = 3,  
  jointboo = TRUE,  
  epsboo = TRUE,  
  filename = "whatever",  
  xvec,  
  yvec,  
  cal,  
  lar = 0.025,  
  ...  
)
```



**Arguments**

obj	output of ec.main
whichseries	series number
nsigma	how many standard deviations in confidence bars
jointboo	boolean: TRUE if 1x2 graph, FALSE otherwise
epsboo	boolean: TRUE eps graph, FALSE pdf graph
filename	string, name of the file (no extension)
xvec	vector of dates to place on x axis
yvec	vector of exp(y) values to display on y axis
cal	calendar vector
lar	length of arrows in error bars
...	other plot parameters

**Value**

does not return output, just creates a double graph

**Author(s)**

P. Paruolo

---

ec.ifp

*Computes Indices of Forecast Performance*

---

**Description**

indices of forecast performance

**Usage**

```
ec.ifp(afdlin, rwsigma, rwabsmean, kval = 1.959964)
```

**Arguments**

afdlin	actual + forecast values + fcse
rwsigma	standard deviation of Random Walk in sample
rwabsmean	mean absolute deviation of Random Walk in sample
kval	how many se to use, default kval = 1.959964

**Value**

list of indices of forecast performance 1: index for model forecast 0: index for Random Walk forecast

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.main

*Forecast with Vector Error Correction Model*

---

**Description**

This function estimate VECM model. Selects begtrim and entrim period, define lag and run.

**Usage**

```
ec.main(
  y,
  ndet = c(2, 1),
  nlag,
  befpn,
  breaks = NA,
  booseas = NA,
  pntdates = NA,
  drop1 = NA,
  drop2 = NA,
  cal,
  kval = 1.959964
)
```

**Arguments**

y	matrix with time across rows and variables in columns
ndet	vector of length 3, (i,j,q): i for EG1-st stage, j for EG-2nd stage, q number of breaks i,j=0 no deterministic i,j=1 constant i,j=2 constant and trend
nlag	number of lags in the VAR
befpn	begtrim, endtrim, nforecast, npred
breaks	vector with observation numbers for T1,T2,...
booseas	boolean =T if seasonal dummies, =F otherwise
pntdates	vector with observation numbers for point dummies
drop1	selection of det1 regressors in first stage to drop
drop2	selection of det1 regressors in second stage to drop
cal	calendar for the y matrix
kval	how many se to use, default kval=1.959964

**Value**

results Output contains the a set of estimates and forecasting results.

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.plotfor	<i>plots forecasts</i>
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---

**Description**

plot actual and forecast intervals

**Usage**

```
ec.plotfor(
  y,
  x = NA,
  lcolact = NA,
  lcolfor = NA,
  ltypefor = NA,
  polycol = NA,
  myylim = NA,
  ...
)
```

**Arguments**

y	actual values and forecasts (point forecast, lower bound, upper bound)
x	time calendar
lcolact	color actual (scalar)
lcolfor	color forecasts
ltypefor	type forecasts
polycol	color polygons if one wishes to have different lcolfor,ltypefor,polycol by week > make linecol, linetype, polycol vectors, indexed by week
myylim	vector with min and max for y axis
...	other plot parameters

**Value**

does not return output, just creates a graph

**Author(s)**

P. Paruolo

**References**

Berta et al. 2020

---

ec.plotroots

*Companion matrix of the VAR*

---

**Description**

plots roots and the unit circle

**Usage**

```
ec.plotroots(roots)
```

**Arguments**

roots are the roots of the companion matrix, see ec.companion.R

**Value**

does not return output, just creates a graph

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

ec.predict                      *produces predictions for the VECM via its VAR companion form*

---

### Description

Predicts both in-sample (1 step ahead) and out-of-sample (1 step ahead and dynamic forecasts)

### Usage

```
ec.predict(est, det1, det2, ymat, npl, befpn, ndet, cal, kval = 1.959964)
```

### Arguments

est	output from estimation by ec.EG1.R
det1	deterministic matrix of constant(s) and trend(s)
det2	deterministic matrix of seasonals and point dummies
ymat	matrix of lags
npl	n, p, nlag
befpn	begtrim, endtrim, nforecast, npred, nhstar
ndet	order of the model d(i,j)
cal	calendar, should match the number of rows in ymat
kval	how many se to use, default kval= 1.959964

### Value

list with contains: afl (actual and 1 step ahead fitted levels) afd (actual and 1 step ahead fitted differences) fit (1 step ahead fit) dynpred (dynamic predictions) mAt mB (companion matrix and selection of it) Sigmah (Sigmah for dyn forecasts) forstartdate (starting date for dyn forecast) outcal (dates for the prediction) h1star (h1star) cspred (table with change in sign of pred for Dx\_1) indexfa (indices of forecast accuracy)

### Author(s)

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

### References

Berta et al. 2020

---

ec.searchbreaks      *search for breaks dates for given q (=1,2,3,4)*

---

### Description

Search for location of break points in 1st-stage of Engle-Granger

### Usage

```
ec.searchbreaks(qse, ymat, npl, befpn, ndet, gfillmin = 10, fixed = NA)
```

### Arguments

qse	q: number of (additional) breaks, s: start date for search, e: end date for search
ymat	matrix of lags
npl	n, p, nlag
befpn	begtrim, endtrim, nforecast, npred
ndet	order of the model d(i,j)
gfillmin	gfill value
fixed	vector of breaks to be taken as fixed (not between s=start and e=end)

### Value

out list with break dates and values of regression average sum of squares

### Author(s)

P. Paruolo

### References

Berta et al. 2020

---

iculomb      *Data from Italian Civil Protection*

---

### Description

Data from Italian Civil Protection

### Usage

```
data(iculomb)
```

**Format**

A dataset including 324 obs and 24 columns.

**Source**

<https://github.com/pcm-dpc/COVID-19/>

**References**

Italian Civil Protection

**Examples**

```
data(iculomb)
```

---

lagn	<i>lag j of matrix or vector y</i>
------	------------------------------------

---

**Description**

`lagn(y,j,fill=NA)` produces lag  $j$  of matrix or vector  $y$ , with fill in missing  $j$  cells REM: alternative to "lead-lag" dplyr which applies to vector  $y$

**Usage**

```
lagn(y, j, fill = NA)
```

**Arguments**

<code>y</code>	column vector or matrix
<code>j</code>	number of lags
<code>fill</code>	value to be used to fill the missing values at the beginning, default = NA

**Value**

$y$  lagged  $j$  cells, with fill in the missing  $j$  positions

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

listsize	<i>listsize number of terms in the search for 1,2,3,4 number of breaks</i>
----------	--

---

**Description**

computes length-4 vector with number of terms in the search for 1,2,3,4 number of breaks

**Usage**

```
listsize(myT, gfill, start)
```

**Arguments**

myT	sample size
gfill	number of gap periods
start	beginning

**Value**

a vector of 4 elements, with the number of candidate models for 1,2,3,4 breaks

**Author(s)**

P. Paruolo

---

mls	<i>Multivariate Least-Squares regression</i>
-----	--

---

**Description**

Multivariate Least-Squares regression  $y = x \beta + u$

**Usage**

```
mls(y, x, df_flag = FALSE)
```

**Arguments**

y	left hand side data matrix (one or more columns)
x	right hand side data matrix (one or more columns)
df_flag	flag = TRUE for degrees of freedom correction for the variance

**Value**

out regression coefficients and related statistics



**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

summary.cif	<i>summary function for cif</i>
-------------	---------------------------------

---

**Description**

Summary function for presize

**Usage**

```
## S3 method for class 'cif'  
summary(object, ..., digits = 4)
```

**Arguments**

object	is the name of the cif object created by cif
...	other parameters
digits	integer indicating the number of decimal places (round) or significant digits (signif) to be used.

**Value**

returns summary output from model estimation and forecasting

**Author(s)**

P. Berta, P. Paruolo, S. Verzillo, PG. Lovaglio

**References**

Berta et al. 2020

---

`Wald.mls`*Wald test for Multivariate Least-Squares regression*

---

**Description**

Wald test for multivariate Least-Squares regression

**Usage**

```
Wald.mls(mlsresults)
```

**Arguments**

```
mlsresults      output of mls, mlsresults<-mls(y, x, df_flag)
```

**Value**

wald table of Wald tests on significance of single regressors and pvalues based on chi square distribution

**Author(s)**

P. Paruolo

**References**

Berta et al. 2020

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