

Package ‘nowcasting’

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Type Package

Title Predicting Economic Variables using Dynamic Factor Models

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Description It contains the tools to implement dynamic factor models to forecast economic variables. The user will be able to construct pseudo real time vintages, use information criteria for determining the number of factors and shocks, estimate the model, and visualize results among other things.

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BugReports <https://github.com/nmecsyst/nmecsyst/nowcasting/issues>

URL <https://github.com/nmecsyst/nmecsyst/nowcasting>

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

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Suggests knitr, rmarkdown

Imports corpcor, httr, lubridate, matlab, RCurl, xts, zoo, DBI, magic, RMySQL, Matrix, vars, stats

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base_extraction	<i>Create a real time data base</i>
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Description

Create a time series matrix `mts` extracting information from Bacen (Banco Central do Brasil) API.

Usage

```
base_extraction(series_code)
```

Arguments

<code>series_code</code>	Vector with the series encoding following the Bacen (Banco Central do Brasil) standards.
--------------------------	--

References

Central Bank of Brazil

Examples

```
# Extracting GDP serie at real-time from Central Bank of Brasil data base
## Not run:
gdp<-base_extraction(22099)
# Industrial production (21859) serie at real-time from Central Bank of Brasil data base
ind_prod<-base_extraction(21859)

# Creating real time data base with the series:
# Vehicles production (1373);
```

```

# Industrial production, general index (21859).
mybase<-base_extraction(c(1373,21859))

# Creating real time data base with the series:
# Exchange rate - Free - United States dollar (1);
# Interest rate - CDI (12).
mybase<-base_extraction(c(1,12))

# Creating real time data base with the series:
# Vehicles production (1373);
# Credit Sales Index (1453);
# Retail sales (1455);
# Industrial production, general index (21859).
mybase<-base_extraction(c(1373,1453,1455,21859))
## End(Not run)

```

Bpanel

Balanced panel

Description

This function transforms the original monthly time series to its stationary representation following the user specification. The time series with more than 1/3 missing, i.e. NAs, are deleted and the remaining are modified such that the missings and outliers are replaced by an approximated value.

The missings and outliers are “corrected” following the same method available in the replication files of Giannone et al. 2008. Outliers are defined as observations that lie more than 4 IQR from the median. All missings and outliers are replaced by the median. A centered moving average of degree *k* is calculated, forming a new panel. Then the missings and outliers are replaced by their equivalent observations on this new panel. We’ve made an important modification on the outlier_correction function found in the above mentioned files: Here the median of an even-sized sample is calculated by the mean of the two most central values, rather than using the largest of those numbers. Because of this modification the results obtained with the original replication files in (USGDP) are slightly different from those found here.

Usage

```

Bpanel(base = NULL, trans = NULL, aggregate = F, k.ma = 3,
       na.prop = 1/3, h = 12)

```

Arguments

- | | |
|-------|---|
| base | A mts with the series to be transformed. |
| trans | A vector where each coordinate is a code for the transformation of the correspondent coordinate in the base argument. The transformation is specified by codes, as follows: <ul style="list-style-type: none"> trans = 0: the original serie is preserved; |

- trans = 1: monthly rate of change

$$\frac{x_{i,t} - x_{i,t-1}}{x_{i,t-1}}$$

- trans = 2: monthly difference

$$x_{i,t} - x_{i,t-1}$$

- trans = 3: monthly difference in year-over-year rate of change

$$\frac{x_{i,t} - x_{i,t-12}}{x_{i,t-12}} - \frac{x_{i,t-1} - x_{i,t-13}}{x_{i,t-13}}$$

- trans = 4: monthly difference in year difference

$$(x_{i,t} - x_{i,t-12}) - (x_{i,t-1} - x_{i,t-13})$$

- trans = 5: yearly difference

$$(x_{i,t} - x_{i,t-12})$$

- trans = 6: yearly rate of change

$$\frac{x_{i,t} - x_{i,t-12}}{x_{i,t-12}}$$

aggregate	A boolean representing if you want aggregate the monthly variables to represent quarterly quantities. If TRUE the aggregation is made following the approximation of <i>Mariano and Murasawsa 2003</i> .
k.ma	A numeric representing the degree of the moving average correction.
na.prop	A numeric representing the proportion of NA allowed. Default is 1/3.
h	A numeric representing the number of steps ahead to forecasting. Default is 12.

References

- Giannone, D., Reichlin, L., & Small, D. (2008). Nowcasting: The real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4), 665-676.<doi:10.1016/j.jmoneco.2008.05.010>
- Mariano, R. S., & Murasawa, Y. (2003). A new coincident index of business cycles based on monthly and quarterly series. *Journal of applied Econometrics*, 18(4), 427-443.<doi:10.1002/jae.695>

Examples

```
# Example from database BRGDP:
data(BRGDP)
Bpanel(BRGDP$base, rep(3, ncol(BRGDP$base)))
```

BRGDP

*Real Time Database of 100 economic variables from 12/11/2018***Description**

a list containing the database, a vector of transformation for the function Bpanel, a vector of delays for the function PRTDB, and the GDP time series.

Usage

BRGDP

Format

The format is: List of 4 \$ base : Time-Series [1:227, 1:100] from 2000 to 2019: NA NA NA NA NA NA NA NA NA NA NA- attr(*, "dimnames")=List of 2\$: NULL\$: chr [1:100] "DIVIDA_6" "IBC_BR" "PMC_TOTAL" "PIM_BCONSND" ... \$ trans: num [1:100] 5 3 3 3 3 3 3 3 3 3 ... \$ delay: num [1:100] 14 42 42 42 42 42 35 35 35 35 ... \$ GDP : Time-Series [1:75] from 2000 to 2018: 106 110 114 114 110 ...

ICfactors

*Information criteria for determining the number of factors in a factors model***Description**

Minimizes the selected information criterion to determine the number of factors to be used in an approximate factor model.

Usage

ICfactors(x, rmax = NULL, type = 2)

Arguments

x	a dataset;
rmax	a positive integer corresponding to the maximum number of factors for which the information criterion should be tested;
type	a positive integer corresponding to the chosen information criterion (1,2,3). The default is 2.

Value

A list containing two elements:

r_star	The number of factors minimizing the information criterion;
IC	A vector of values of the information criterion for the number of factors within the selected range.

References

Bai, J., Ng, S. (2002). Determining the Number of Factors in Approximate Factor Models. *Econometrica*, 70(1), 191-221. <doi:10.1111/1468-0262.00273>

ICshocks	<i>Information criterion for determining the number of shocks in a factor model</i>
----------	---

Description

The function gives the number of shocks that minimizes the information criterion.

Usage

```
ICshocks(x, delta = 0.1, m = 1, r = NULL, p = NULL)
```

Arguments

x	a dataset;
delta	a real number within the range (0,1/2) for the sensitivity of the tolerance level to the size of the dataset;
m	a finite positive real number defining the tolerance level;
r	a positive integer corresponding to the number of factors;
p	a positive integer corresponding to the number of lags to be considered within the model.

Value

A list containing two elements:

q_star	The number of shocks minimizing the information criterion;
p	The number of lags used.

References

Bai, J., Ng, S. (2007). Determining the Number of Primitive Shocks in Factor Models. *Journal of Business & Economic Statistics*, 25(1), 52-60. <https://doi.org/10.1198/073500106000000413>

month2qtr	<i>Monthly to quarterly transformation</i>
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Description

It transforms a monthly time series in a quarterly one, selecting the last month of the quarter to represent the value of the quarter.

Usage

```
month2qtr(x, reference_month = 3)
```

Arguments

`x` a ts or mts in monthly frequency
`reference_month` a vector to define the reference month that will represent the quarter. Default is 3. The options are 1, 2, 3 or 'mean'.

Value

The correspondent quarterly transformation.

Examples

```
## Not run:  
# Selecting only the last month of time series IPCA:  
month2qtr(BRGDP$base[,"IPCA"], reference_month = 3)  
  
# Selecting only the first month of time series IPCA:  
month2qtr(BRGDP$base[,"IPCA"], reference_month = 1)  
  
## End(Not run)
```

nowcast	<i>Nowcasting of a quarterly time series using a dynamic factor model.</i>
---------	--

Description

Estimate nowcasting and forecasting for a quarterly series. For more details read the Vignettes.

Usage

```
nowcast(y, x, q = NULL, r = NULL, p = NULL, method = "2sq",  
        blocks = NULL, oldFactorsParam = NULL, oldRegParam = NULL)
```

Arguments

y	Stationary quarterly time series.
x	A monthly time series matrix (mts) representing regressors variables. The series must be stationary.
q	Dynamic rank. Number of error terms.
r	number of common factors.
p	AR order of factor model.
method	There are three options: "2sq": "Two stages: quarterly factors" as in Giannone et al. 2008; "2sm": "Two stages: monthly factors" as in Bańbura and Rünstler 2011; "EM": Expected Maximization as in Bańbura et al. 2011.
blocks	a binary matrix Nx3 that characterizes the regressors variables in global (1st column), nominal (2nd column) and real (3rd column). If NULL, the matrix assume 1 for all cells.
oldFactorsParam	a list containing estimated factors parameters from nowcast function.
oldRegParam	a list containing estimated regression parameters from nowcast function.

Value

A list containing two elements:

yfcst	the original y series and its in-sample and out-of-sample estimations.
reg	regression model between y and the estimated factors. Not available for EM method.
factors	the estimated factors and DFM model coefficients.
xfcst	the original regressors and their out-of-sample estimations.
month_y	the monthly measure for quarterly y variable. Only available for EM method.

References

- Giannone, D., Reichlin, L., & Small, D. (2008). Nowcasting: The real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4), 665-676.<doi:10.1016/j.jmoneco.2008.05.010>
- Bańbura, M., & Rünstler, G. (2011). A look into the factor model black box: publication lags and the role of hard and soft data in forecasting GDP. *International Journal of Forecasting*, 27(2), 333-346. <doi:10.1016/j.ijforecast.2010.01.011>
- Bańbura M., Giannone, D. & Reichlin, L. (2011). Nowcasting, in Michael P. Clements and David F. Hendry, editors, *Oxford Handbook on Economic Forecasting*, pages 193-224, January 2011. <doi:10.1093/oxfordhb/9780195398649.001.0001>

See Also

[base_extraction](#)

Examples

```

## Not run:
### Method 2sq (two stages: quarterly factors)
gdp <- month2qtr(x = USGDP$base[,"RGDPGR"])
gdp_position <- which(colnames(USGDP$base) == "RGDPGR")
base <- Bpanel(base = USGDP$base[,-gdp_position],
              trans = USGDP$legend$Transformation[-gdp_position],
              aggregate = TRUE)
now2sq <- nowcast(y = gdp, x = base, r = 2, p = 2, q = 2, method = '2sq')

### Method 2sm (two stages: monthly factors)
base <- Bpanel(base = USGDP$base[,-gdp_position],
              trans = USGDP$legend$Transformation[-gdp_position],
              aggregate = F)
now2sm <- nowcast(y = gdp, x = base, r = 2, p = 2, q = 2, method = '2sm')

### Method EM
# selecting and transforming y
gdp <- month2qtr(x = USGDPshort$base[,"GDPUS"])
gdp <- ts(c(gdp,NA,NA,NA,NA), start = start(gdp), frequency = 4)
gdp_stationary <- gdp/lag(gdp, k = -1) -1
gdp_position <- which(colnames(USGDPshort$base) == "GDPUS")

# selecting and transforming x
base <- USGDPshort$base[,-gdp_position]
trans <- USGDPshort$legend[-gdp_position,"transformation"]
stationaryBase <- cbind(base[,trans == 1]/lag(base[,trans == 1], k = -1) - 1,
                      diff(base[,trans == 2]))
colnames(stationaryBase) <- colnames(base)[c(which(trans == 1),which(trans == 2)) ]
stationaryBase <- stationaryBase[,colnames(base)]

# DFM estimation via EM
blocks <- matrix(c(1,0,1,1,0,1,1,1,0,1,1,0,1,1,0,1,1,0,1,1,0,1,1,0,1,1,
                  0,1,1,0,1,1,0,1,0,1,1,1,0,1,1,0,1,0,1,1,1,0,1,1,0,1,
                  1,0,1,0,1,1,0,1,1,0,1,1,0,1,1,1,0,1,1,0,1,1,1,0), byrow = T, ncol = 3)
nowEM <- nowcast(y = gdp_stationary, x = stationaryBase, r = 1, p = 1, q = 1,
                method = 'EM', blocks = blocks)

## End(Not run)

```

nowcast.plot

Plot for the nowcast output function

Description

Make plots to visualize the output of the nowcast function

Usage

```
nowcast.plot(out, type = "fcst")
```

Arguments

`out` output of the nowcast function.

`type` 'fcst', 'factors', 'eigenvalues', 'eigenvectors' or 'month_y'. The latter is only available for the EM method, while 'eigenvalues' and 'eigenvectors' are only available for the two stages methods.

Examples

```
## Not run:
gdp <- month2qtr(x = USGDP$base[, "RGDPGR"])
gdp_position <- which(colnames(USGDP$base) == "RGDPGR")
base <- Bpanel(base = USGDP$base[, -gdp_position],
              trans = USGDP$legend$Transformation[-gdp_position],
              aggregate = TRUE)
now2sq <- nowcast(y = gdp, x = base, r = 2, p = 2, q = 2, method = '2sq')

nowcast.plot(now2sq, type = "fcst")
nowcast.plot(now2sq, type = "factors")
nowcast.plot(now2sq, type = "eigenvalues")
nowcast.plot(now2sq, type = "eigenvectors")

base <- Bpanel(base = USGDP$base[, -gdp_position],
              trans = USGDP$legend$Transformation[-gdp_position],
              aggregate = FALSE)
now2sm <- nowcast(y = gdp, x = base, r = 2, p = 2, q = 2, method = '2sm')

nowcast.plot(now2sm, type = "fcst")
nowcast.plot(now2sm, type = "factors")
nowcast.plot(now2sm, type = "eigenvalues")
nowcast.plot(now2sm, type = "eigenvectors")

## End(Not run)
```

Description

This package is an initiative of the Center for Statistical and Computational Methods (NMEC) belonging to the Brazilian Institute of Economics (IBRE) of the Getulio Vargas Foundation (FGV).

The purpose of this package is to allow R users to implement dynamic factor models that have gained prominence in the nowcasting literature.

In this version of the package we present three methods, based on seminal articles in this literature: *Giannone et al. 2008*, *Bañbura et al. 2011* and *Bañbura and Rünstler 2011*. Some backend functions are adaptations and translations of these paper's *replication files* available in MATLAB. One can find these *replication files* in the following url: <https://www.newyorkfed.org/research/economists/giannone/pub>

Note

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References

- Giannone, D., Reichlin, L., & Small, D. (2008). Nowcasting: The real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4), 665-676.<doi:10.1016/j.jmoneco.2008.05.010>
- Bañbura, M., & Rünstler, G. (2011). A look into the factor model black box: publication lags and the role of hard and soft data in forecasting GDP. *International Journal of Forecasting*, 27(2), 333-346. <doi:10.1016/j.ijforecast.2010.01.011>
- Bañbura M., Giannone, D. & Reichlin, L. (2011). Nowcasting, in Michael P. Clements and David F. Hendry, editors, *Oxford Handbook on Economic Forecasting*, pages 193-224, January 2011. <doi:10.1093/oxfordhb/9780195398649.001.0001>

 PRTDB

Pseudo Real Time Data Base

Description

Create a pseudo real time data base based on data and delays of disclosure stipulated by the user.

Usage

```
PRTDB(mts, delay, vintage = Sys.Date())
```

Arguments

mts	A mts with the series data.
delay	A numeric vector with the delay in days the information is available after the reference month. Each element corresponds to the series in the respective column in mts.
vintage	The day when the data is supposed to be collected.

Value

A mts with the series transformed.

Examples

```
# Pseudo Real Time Data Base from data base BRGDP
PRTDB(mts = BRGDP$base, delay = BRGDP$delay, vintage = "2017-10-01")
```

<code>qtr2month</code>	<i>Quarterly to monthly transformation</i>
------------------------	--

Description

It transforms a quarterly time series in a monthly one. The values of the quarterly `ts` are set to the last month of the quarter.

Usage

```
qtr2month(x, reference_month = 3, interpolation = FALSE)
```

Arguments

<code>x</code>	a <code>ts</code> or <code>mts</code> in quarterly frequency
<code>reference_month</code>	a integer to define the position of a quarter value in a quarter. Default is 3. The options are 1, 2 or 3.
<code>interpolation</code>	logical. The NA values can be estimated by linear interpolation (approx function from stats package). Default is FALSE.

Value

The correspondent monthly transformation.

Examples

```
# Selecting the quarterly GDP variable in BRGDP
qtr2month(BRGDP$GDP)
```

<code>RTDB</code>	<i>Create Real Time Data Base</i>
-------------------	-----------------------------------

Description

Create a time series matrix `mts` replicating the information available in a given date.

Usage

```
RTDB(series_code = NULL, vintage = NULL)
```

Arguments

<code>series_code</code>	vector with the series encoding following the Bacen (Banco Central do Brasil) standards.
<code>vintage</code>	the vintage encoded by the day of the extraction

References

Central Bank of Brazil

Examples

```
## Not run:
# Show series available:
RTDB()

# Show vintages available for the series 1:
RTDB(series_code = 1)

# Show series 1 data at vintage 2017-04-04:
RTDB(series_code = 1, vintage = "2017-04-04")

## End(Not run)
```

USGDP

Example of replication files in Giannone et al. 2008

Description

Dataset available to replicate the results in *Giannone et al. 2008*.

Usage

USGDP

Format

A list with 2 elements:

- base is a mts with 193 series and 312 observations. There are missing values;
- legend is a data.frame with specifications of the series in USGDP\$base.

Source

This dataset is available as *replication files* of the seminal work *Giannone 2008*. One can find these *replication files* in the following url: <https://www.newyorkfed.org/research/economists/giannone/pub>

References

Giannone, D., Reichlin, L., & Small, D. (2008). Nowcasting: The real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4), 665-676.<doi:10.1016/j.jmoneco.2008.05.010>

USGDPshort

Example of replication files in Banbura et al. 2011

Description

Dataset available to replicate the results in *Banbura et al. 2011*.

Usage

USGDPshort

Format

A list with 2 elements:

- base is a mts with 26 series and 358 observations. There are missing values;
- legend is a data.frame with specifications of the series in USGDPshort\$base.

Source

This dataset is available as *replication files* of the seminal work *Banbura et al 2011*. One can find these *replication files* in the following url: <https://www.newyorkfed.org/research/economists/giannone/pub>

References

Banbura, M., Giannone, D. & Reichlin, L. (2011). Nowcasting. Oxford Handbook on Economic Forecasting, ed. by M. P. Clements, and D. F. Hendry, pp. 63-90. Oxford University Press.

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