Package ‘tvReg’

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Type Package
Title Time-Varying Coefficient for Single and Multi-Equation Regressions
Version 0.5.4
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Description Fitting time-varying coefficient models for single and multi-equation regressions, using kernel smoothing techniques.
License GPL (>= 3)
LazyData yes
Depends R (>= 3.6), Matrix, graphics, stats (>= 2.14.0), methods
Imports systemfit (>= 1.1-20), MASS, vars, bvarsv, plm
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R topics documented:

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Description

Calculate bandwidth(s) by cross-validation for functions tvSURE, tvVAR and tvLM.

Usage

bw(x, ...)  

## Default S3 method:  
bw(  
x,  
y,  
z = NULL,  
cv.block = 0,  
est = c("lc", "ll"),  
tkernel = c("Triweight", "Epa", "Gaussian"),  
singular.ok = TRUE,  
...  
)
## Arguments

- `x` An object used to select a method.
- `...` Other parameters passed to specific methods.
- `y` A matrix or vector with the dependent variable(s).
- `z` A vector with the variable over which coefficients are smooth over.
**cv.block**  
A positive scalar with the size of the block in leave-one block-out cross-validation. By default `cv.block=0` meaning leave-one-out cross-validation.

**est**  
The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.

**tkernel**  
A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

**singular.ok**  
Logical. If FALSE, a singular model is an error.

**method**  
A character with the choice of panel model/estimation method: If method = tvPOLS (default) then the data is pooled estimated with time-varying OLS. No individual or time effects are estimated If method = tvFE then individual effects which might be correlated with the regressors are estimated. If method = tvRE then individual effects are considered random and independent of the regressors.

**Value**

bw returns a vector or a scalar with the bandwith to estimate the mean or the covariance residuals, fitted values.

A scalar or a vector of scalars.

A scalar.

**Examples**

```r
##Generate data
tau <- seq(1:200)/200
beta <- data.frame(beta1 = sin(2*pi*tau), beta2 = 2*tau)
X <- data.frame(X1 = rnorm(200), X2 = rchisq(200, df = 4))
error <- rt(200, df = 10)
y <- apply(X*beta, 1, sum) + error

##Select bandwidth by cross-validation
bw <- bw(X, y, est = "ll", tkernel = "Gaussian")
data( Kmenta, package = "systemfit" )

## x is a list of matrices containing the regressors, one matrix for each equation
x <- list()
x[[1]] <- Kmenta[, c("price", "income")]
x[[2]] <- Kmenta[, c("price", "farmPrice", "trend")]

## 'y' is a matrix with one column for each equation
y <- cbind(Kmenta$consump, Kmenta$consump)

## Select bandwidth by cross-validation
bw <- bw(x = x, y = y)

##One bandwidth per equation
print(bw)
```
bwCov

Covariance Bandwidth Calculation by Cross-Validation bwCov calculates a single bandwidth to estimate the time-varying variance-covariance matrix.

Description

Covariance Bandwidth Calculation by Cross-Validation bwCov calculates a single bandwidth to estimate the time-varying variance-covariance matrix.

Usage

bwCov(
  x,
  cv.block = 0,
  est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian")
)

Arguments

x A matrix or a data frame.

cv.block A positive scalar with the size of the block in leave-one block-out cross-validation. By default 'cv.block=0' meaning leave-one-out cross-validation.

est The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.

tkernel A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

Value

A scalar.

Examples

data(CEES)
## Using a shorter set for a quick example. Variable "Date" is removed.
mydata <- tail (CEES[, -1], 50)
bw.cov <- bwCov(mydata)
Sigma.hat <- tvCov(mydata, bw = bw.cov)
**CEES**

*Standarised rates from a currency portfolio.*

**Description**

Aslanidis and Casas (2013) consider a portfolio of daily US dollar exchange rates of the Australian dollar (AUS), Swiss franc (CHF), euro (EUR), British pound (GBP), South African rand (RAND), Brazilian real (REALB), and Japanese yen (YEN) over the period from January 1, 1999 until May 7, 2010 (T = 2856 observations). This dataset contains the standardised rates after "devolatilisation", i.e. standardising the rates using a GARCH(1,1) estimate of the volatility.

**Format**

A data frame with 2855 rows and 8 variables. Below the standardised rates of daily US dollar exchange rates of

**Date** Daily data from Jan 6, 1999 until May 7, 2010 - without weekends and days off

**AUS** Australian dollar

**CHF** Swiss franc

**EUR** Euro

**GBP** British pound

**RAND** South African rand

**REALB** Brazilian real

**YEN** Japanese yen

**References**


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**confint.tvlm**

*Confidence Intervals for Objects in tvReg*

**Description**

confint is used to estimate the bootstrap confidence intervals for objects with class attribute tvlm, tvar, tvirf, tvsure and tvplm.
Usage

```r
## S3 method for class 'tvlm'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)
```

```r
## S3 method for class 'tvar'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)
```

```r
## S3 method for class 'tvsure'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)
```

```r
## S3 method for class 'tvvar'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)
```

```r
## S3 method for class 'tvirf'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)
```
## S3 method for class 'tvplm'
confint(
  object,
  parm,
  level = 0.95,
  runs = 100,
  tboot = c("wild", "wild2"),
  ...
)

### Arguments
- **object**: An object used to select a method.
- **parm**: A specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
- **level**: Numeric, the confidence level required (between 0 and 1).
- **runs**: (optional) Number of bootstrap replications.
- **tboot**: Type of wild bootstrap, choices 'wild' (default), 'wild2'. Option 'wild' uses the distribution suggested by Mammen (1993) in the wild resampling, while 'wild2' uses the standard normal.
- **...**: Other parameters passed to specific methods.

### Value
an object of class tvsure with BOOT, Lower and Upper different from NULL.

### References

### See Also
tvLM, tvAR, tvVAR, tvSURE

### Examples
```r
## Not run:
##Calculation of confidence intervals for a TVLM model
##Generation of time-varying coefficients linear model
```
```r
set.seed(42)
tau <- seq(1:200)/200
beta <- data.frame(beta1 = sin(2*pi*tau), beta2= 2*tau)
X1 <- rnorm(200)
X2 <- rchisq(200, df = 4)
error <- rt(200, df = 10)
y <- apply(cbind(X1, X2)*beta, 1, sum) + error
data <- data.frame(y = y, X1 = X1, X2 = X2)

##Fitting the model and confidence interval calculation
model.tvlm <- tvLM(y ~ 0 + X1 + X2, data = data, bw = 0.29)
tvci <- confint(model.tvlm, level = 0.95, runs = 20)

##If a second confidence interval on the "same" object is calculated,
##for example with a different level, the calculation is faster
tvci.80 <- confint(tvci, level = 0.8)

## End(Not run)
```

**Description**

A dataset containing the returns of four portfolios ordered by size and book-to-market. The four portfolios are SMALL/LoBM, SMALL/HiBM, BIG/LoBM and BIG/HiBM in four international markets: North America (NA), Japan (JP), Asia Pacific (AP) and Europe (EU). It also contains the Fama/French 5 factors for each of the markets.

**Format**

A data frame with 314 rows and 41 variables.

- **Date**  Date, months from July 1990 until August 2016
- **NA.SMALL.LoBM**  Monthly returns of portfolio SMALL/LoBM in North American market
- **NA.SMALL.HiBM**  Monthly returns of portfolio SMALL/HiBM in North American market
- **NA.BIG.LoBM**  Monthly returns of portfolio BIG/LoBM in North American market
- **NA.BIG.HiBM**  Monthly returns of portfolio BIG/HiBM in North American market
- **NA.Mkt.RF**  North American market excess returns, i.e. return of the market - market risk free rate
- **NA.SMB**  SMB (Small Minus Big) for the North American market
- **NA.HML**  HML (High Minus Low) for the North American market
- **NA.RMW**  RMW (Robust Minus Weak) for the North American market
- **NA.CMA**  CMA (Conservative Minus Aggressive) for the North American market
- **NA.RF**  North American risk free rate
JP.SMALL.LoBM  Monthly returns of portfolio SMALL/LoBM in Japanese market
JP.SMALL.HiBM  Monthly returns of portfolio SMALL/HiBM in Japanese market
JP.BIG.LoBM    Monthly returns of portfolio BIG/LoBM in Japanese market
JP.BIG.HiBM    Monthly returns of portfolio BIG/HiBM in Japanese market
JP.Mkt.RF      Japanese market excess returns, i.e return of the market - market risk free rate
JP.SMB         SMB (Small Minus Big) for the Japanese market
JP.HML         HML (High Minus Low) for the Japanese market
JP.RMW         RMW (Robust Minus Weak) for the Japanese market
JP.CMA         CMA (Conservative Minus Aggressive) for the Japanese market
JP.RF          Japanese risk free rate
AP.SMALL.LoBM  Monthly returns of portfolio SMALL/LoBM in Asia Pacific market
AP.SMALL.HiBM  Monthly returns of portfolio SMALL/HiBM in Asia Pacific market
AP.BIG.LoBM    Monthly returns of portfolio BIG/LoBM in Asia Pacific market
AP.BIG.HiBM    Monthly returns of portfolio BIG/HiBM in Asia Pacific market
AP.Mkt.RF      Asia Pacific market excess returns, i.e return of the market - market risk free rate
AP.SMB         SMB (Small Minus Big) for the Asia Pacific market
AP.HML         HML (High Minus Low) for the Asia Pacific market
AP.RMW         RMW (Robust Minus Weak) for the Asia Pacific market
AP.CMA         CMA (Conservative Minus Aggressive) for the Asia Pacific market
AP.RF          Asia Pacific risk free rate
EU.SMALL.LoBM  Excess return of portfolio SMALL/LoBM in European market
EU.SMALL.HiBM  Excess return of portfolio SMALL/HiBM in European market
EU.BIG.LoBM    Excess return of portfolio BIG/LoBM in European market
EU.BIG.HiBM    Excess return of portfolio BIG/HiBM in European market
EU.Mkt.RF      European market excess returns, i.e returns of the market - market risk free rate
EU.SMB         SMB (Small Minus Big) for the European market
EU.HML         HML (High Minus Low) for the European market
EU.RMW         RMW (Robust Minus Weak) for the European market
EU.CMA         CMA (Conservative Minus Aggressive) for the European market
EU.RF          European risk free rate

Source
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

References
Description

`forecast` calculates the forecast for objects with class attribute `tvlm`, `tvar`, `tvvar`, `tvirf`, `tvsure` and `tvplm`. If the smoothing variable (z) in the model is non-NULL and it is a random variable then use function `predict` with parameter `newz`.

Usage

```r
forecast(object, ...)  
## S3 method for class 'tvlm'
forecast(object, newdata, n.ahead = 1, winsize = 0, ...)

## S3 method for class 'tvar'
forecast(object, n.ahead = 1, newz = NULL, newexogen = NULL, winsize = 0, ...)

## S3 method for class 'tvvar'
forecast(object, n.ahead = 1, newz = NULL, newexogen = NULL, winsize = 0, ...)

## S3 method for class 'tvsure'
forecast(object, newdata, n.ahead = 1, winsize = 0, ...)

## S3 method for class 'tvplm'
forecast(object, newdata, n.ahead = 1, winsize = 0, ...)
```

Arguments

- `object` An object used to select a method.
- `...` Other parameters passed to specific methods.
- `newdata` A matrix or data.frame with the values of the regressors to use for forecasting.
- `n.ahead` A scalar with the forecast horizon, value 1 by default.
- `winsize` A scalar. If 0 then an 'increase window' forecasting is performed. Otherwise a 'rolling window' forecasting is performed with window size given by 'winsize'.
- `newz` A vector with the new values of the smoothing variable.
- `newexogen` A matrix or vector with the new values of the exogenous variables. Only for predictions of *tvar* and *tvvar* objects.

Value

An object of class matrix or vector with the same dimensions than the dependent variable of object.
See Also

predict.

Examples

data("RV")
RV2 <- head(RV, 2001)
TVHAR <- tvLM (RV ~ RV_lag + RV_week + RV_month, data = RV2, bw = 20)
newdata <- cbind(RV$RV_lag[2002:2004], RV$RV_week[2002:2004],
RV$RV_month[2002:2004])
forecast(TVHAR, newdata, n.ahead = 3)

exogen = RV2[, c("RV_week", "RV_month")]
TVHAR2 <- tvAR(RV2$RV_lag, p = 1, exogen = exogen, bw = 20)
newexogen <- newdata[, -1]
forecast(TVHAR2, n.ahead = 3, newexogen = newexogen)

data(usmacro, package = "bvarsv")
model.tvVAR <- tvVAR(usmacro, p = 6, type = "const", bw = c(1.8, 20, 20))
forecast(model.tvVAR, n.ahead = 10)

data("Kmenta", package = "systemfit")
eqDemand <- consump ~ price + income
eqSupply <- consump ~ price + farmPrice
system <- list(demand = eqDemand, supply = eqSupply)
tvOLS.fit <- tvSURE(system, data = Kmenta, est = "ll", bw = c(1.5, 1.5))
newdata <- data.frame(price = c(90, 100, 103), farmPrice = c(70, 95, 103),
income = c(82, 94, 115))
forecast(tvOLS.fit, newdata = newdata, n.ahead = 3)
data(OECD)
tvpols <- tvPLM(lhe~lgdp+pop65+pop14+public, index = c("country", "year"),
data = OECD, method = "pooling", bw = 8.9)
newdata <- OECD[7:9, 4:7]
forecast(tvpols, newdata = newdata, n.ahead = 2)

OECDOECD

Variables related to the problem of healthcare spending.

Description

Variables related to the problem of healthcare spending.

Format

A data frame with 680 rows and 7 columns.

country
year
lhe  Log of country’s healthcare spending
lgdp  log of country’s gdp  
pop65  Country’s ratio of population greater than 65 years old  
pop14  Country’s ratio of population younger than 15 years old  
public  Country’s ratio of healthcare funding coming from the government  

References  

plot.tvsure  

Description  
Plot methods for objects with class attribute tvlm, tvar, tvvar, tvirf, tvsure or tvplm.  

Usage  
```r  
## S3 method for class 'tvsure'  
plot(x, eqs = NULL, vars = NULL, plot.type = c("multiple", "single"), ...)  
## S3 method for class 'tvlm'  
plot(x, ...)  
## S3 method for class 'tvar'  
plot(x, ...)  
## S3 method for class 'tvvar'  
plot(x, ...)  
## S3 method for class 'tvplm'  
plot(x, ...)  
## S3 method for class 'tvirf'  
plot(  
  x,  
  obs.index = NULL,  
  impulse = NULL,  
  response = NULL,  
  plot.type = c("multiple", "single"),  
  ...  
)  
```
Arguments

- **x**: An object used to select the method.
- **eqs**: A vector of integers. Equation(s) number(s) of the coefficients to be plotted.
- **vars**: A vector of integers. Variable number(s) of the coefficients to be plotted.
- **plot.type**: Character, if multiple all plots are drawn in a single device, otherwise the plots are shown consecutively.
- **...**: Other parameters passed to specific methods.
- **obs.index**: Scalar (optional), the time at which the impulse response is plotted. If left NULL, the mean over the whole period is plotted (this values should be similar to the estimation using a non time-varying VAR method).
- **impulse**: Character vector (optional) of the impulses, default is all variables.
- **response**: Character vector (optional) of the responses, default is all variables.

See Also

tvlM, tvAR, tvVAR, tvSURE, tvPLM

predict.tvlm

Predict Methods for Objects in tvReg.

Description

Predict methods for objects with class attribute tvlm, tvar, tvvar, tvirf, tvsure and tvplm. This function needs new values of variables y (response), x (regressors), exogen (exogenous variables, when used), and z (smoothing variable).

Usage

```r
## S3 method for class 'tvlm'
predict(object, newdata, newz, ...)

## S3 method for class 'tvar'
predict(object, newdata, newz, newexogen = NULL, ...)

## S3 method for class 'tvvar'
predict(object, newdata, newz, newexogen = NULL, ...)

## S3 method for class 'tvsure'
predict(object, newdata, newz, ...)

## S3 method for class 'tvplm'
predict(object, newdata, newz, ...)
```
**predict.tvlm**

### Arguments

- **object**
  An object used to select a method.

- **newdata**
  A `pdata.frame` with new values of all regressors, with the same name and order as they appear in argument ‘data’ from the ‘tvplm’ object.

- **newz**
  A vector with new values of the smoothing variable.

- **...**
  Other arguments passed to specific methods.

- **newexogen**
  A matrix or vector with the new value of the exogenous variables. Only for predictions of ‘tvar’ and ‘tvvar’ objects.

### Value

An object of class matrix or vector with the prediction.

### See Also

`forecast`.

### Examples

```r
## Example of TVLM prediction with coefficients as
## functions of the realized quarticity

data("RV")
RV2 <- head(RV, 2001)
z <- RV2$RQ_lag_sqrt
TVHARQ <- tvLM(RV ~ RV_lag + RV_week + RV_month,
               z = z, data = RV2, bw = 0.0062)
newdata <- cbind(RV$RV_lag[2002:2004], RV$RV_week[2002:2004],
                 RV$RV_month[2002:2004])
newz <- RV$RQ_lag_sqrt[2002:2004]
predict(TVHARQ, newdata, newz)

## Example of TVAR prediction with coefficients as
## functions of the realized quarticity

exogen = RV2[, c("RV_week", "RV_month")]
TVHARQ2 <- tvAR(RV$RV, p = 1, exogen = exogen,
                z = RV2[, "RQ_lag_sqrt"], bw = 0.0062)
newylag <- RV$RV[2002:2004]
newz <- RV$RQ_lag_sqrt[2002:2004]
newexogen <- RV[2002:2004, c("RV_week", "RV_month")]
predict(TVHARQ2, newylag, newz, newexogen = newexogen)

## Example of TVVAR prediction with coefficients as
## functions of a random ARMA (2,2) process

data(usmacro, package = "bvarsv")
smoothing <- arima.sim(n = NROW(usmacro) + 3,
                       list(ar = c(0.8897, -0.4858), ma = c(-0.2279, 0.2488)),
                       sd = sqrt(0.1796))
smoothing <- as.numeric(smoothing)
```
TVVAR.z <- tvVAR(usmacro, p = 6, type = "const", 
  z = smoothing[1:NROW(usmacro)], bw = c(16.3, 16.3, 16.3))
newdata <- data.frame(inf = c(2, 1, 6), une = c(5, 4, 9), tbi = c(1, 2.5, 3))
newz <- c(0, 1.2, -0.2)
predict(TVVAR.z, newdata = newdata, newz = newz)

## Example of TVSURE prediction with coefficients as 
## functions of an ARMA(2,2) process 
data("Kmenta", package = "systemfit")
nobs <- NROW(Kmenta)
eqDemand <- consump ~ price + income
eqSupply <- consump ~ price + farmPrice
system <- list(demand = eqDemand, supply = eqSupply)
smoothing <- arima.sim(n = nobs + 3,
  list(ar = c(0.8897, -0.4858), ma = c(-0.2279, 0.2488)),
  sd = sqrt(0.1796))
smoothing <- as.numeric(smoothing)
TVOLS.z <- tvSURE(system, data = Kmenta,
  z = smoothing[1:nobs], bw = c(7, 1.8),
  est = "ll")
newdata <- data.frame(consump = c(95, 100, 102), price = c(90, 100, 103),
  farmPrice = c(70, 95, 103), income = c(82, 94, 115))
newz <- tail(smoothing, 3)
predict(TVOLS.z, newdata = newdata, newz = newz)
data(OECD)
z <- runif(length(levels(OECD$year)), 10, 15)
TVPOLS <- tvPLM(lhe~lgdp+pop65+pop14+public, z = z,
  index = c("country", "year"), data = OECD, method ="pooling", bw = 2)
newdata <- cbind(lgdp = c(10, 13), pop65 = c(9, 12),
  pop14 = c(17, 30), public = c(13, 20))
newz <- runif(2, 10, 15)
predict(TVPOLS, newdata = newdata, newz = newz)

---

Print results of functions in tvReg

Description
Print some results for objects with class attribute tvlm, tvar, tvvar, tvirf, tvsure and tvplm.

Usage
## S3 method for class 'tvlm'
print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvar'
print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvplm'
RV

print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvsure'
print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvvar'
print(x, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvirf'
print(x, digits = max(3, getOption("digits") - 3), ...)

Arguments

x An object used to select a method.
digits An integer, indicating the minimal number of significant digits.
... Other parameters passed to specific methods.

Details

These functions print a few results from the time-varying estimated coefficients

See Also

plot.tvlm, plot.tvar, plot.tvvar, plot.tvirf, plot.tvsure, plot.tvplm

<table>
<thead>
<tr>
<th>RV</th>
<th>Daily realized variance</th>
</tr>
</thead>
</table>

Description

A dataset containing the daily realized variance, and some of its lags, obtained from 1-minute close prices of the S&P 500. Similar data has been used in the HAR model in Corsi (2009), the HARQ and SHARQ models in Bollerslev et al (2016) and the TVHARQ and TVSHARQ models in Casas et al (2018). The time period runs from Jan 1990 until Dec 2007 as in Bollerslev et al (2009).

Format

A data frame with 4529 rows and 6 variables.

Date Daily data from Jan 3, 1990 until Dec 19, 2007 - without weekends and days off
RV Daily realized variance at time t
RV_lag Daily realized variance at time t-1
RV_week Weekly average realized variance at time t-1
RV_month Monthly average realized variance at time t-1
RQ_lag_sqrt Daily squared root of the realized quarticity at time t-1
References


---

**summary.tvlm**

Print results of functions in tvReg

---

**Description**

Print some results for objects with class attribute tvlm, tvar, tvvar, tvirf, tvsure and tvplm.

**Usage**

```r
## S3 method for class 'tvlm'
summary(object, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvar'
summary(object, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvplm'
summary(object, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvsure'
summary(object, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvvar'
summary(object, digits = max(3, getOption("digits") - 3), ...)

## S3 method for class 'tvirf'
summary(object, digits = max(3, getOption("digits") - 3), ...)
```

**Arguments**

- `object` An object used to select a method.
- `digits` Integer, indicating the minimal number of significant digits.
- `...` Other parameters passed to specific methods.

**Details**

These functions print a few results from the time-varying estimated coefficients.
### tvAcoef

**Time-Varying Coefficient Arrays of the Lagged Endogenous Variables of a TVVAR (no intercept).**

#### Description

Returns the estimated coefficients of the lagged endogenous variables as an array. Given an estimated time varying VAR of the form:

\[
\hat{y}_t = \hat{A}_{1t} y_{t-1} + \ldots + \hat{A}_{pt} y_{t-p} + \hat{C}_t D_t
\]

the function returns a list for each equation with \(\hat{A}_{1t}, \ldots, \hat{A}_{pt}, \hat{C}_t\) set of arrays.

#### Usage

```r
tvAcoef(x)
```

#### Arguments

- `x`: An object of class `tvvar` generated by `tvVAR`.

#### Value

A list object with coefficient arrays for the lagged endogenous variables.

#### Examples

```r
data(Canada, package="vars")
var.2p <- vars::VAR(Canada, p = 2, type = "const")
tvvar.2p <- tvVAR(Canada, p = 2, type = "const")
A <- vars::Acoef(var.2p)
tvA <- tvAcoef(tvvar.2p)
```
**tvAR**  
*Time-Varying Autoregressive Model*

**Description**

`tvAR` is used to fit an autoregressive model with time varying coefficients.

**Usage**

```r
tvAR(
  y,  
  p = 1,  
  z = NULL,  
  ez = NULL,  
  bw = NULL,  
  cv.block = 0,  
  type = c("const", "none"),  
  exogen = NULL,  
  fixed = NULL,  
  est = c("lc", "ll"),  
  tkernel = c("Triweight", "Epa", "Gaussian"),  
  singular.ok = TRUE
)
```

**Arguments**

- `y` A vector with the dependent variable.
- `p` A scalar indicating the number of lags in the model.
- `z` A vector with the smoothing variable.
- `ez` (optional) A scalar or vector with the smoothing estimation values. If values are included then the vector `z` is used.
- `bw` An optional scalar or vector of length the number of equations. It represents the bandwidth in the estimation of coefficients. If NULL, it is selected by cross validation.
- `cv.block` A positive scalar with the size of the block in leave one block out cross-validation. By default `cv.block=0` meaning leave one out cross-validation.
- `type` A character 'const' if the model contains an intercept and 'none' otherwise.
- `exogen` A matrix or data.frame with the exogenous variables (optional)
- `fixed` (optional) numeric vector of the same length as the total number of parameters. The order of the parameters is intercept (if type = "const"), lags in ascending order and exogenous variables. If supplied, only NA entries in fixed will be estimated.
- `est` The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.
- `tkernel` A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.
- `singular.ok` Logical. If FALSE, a singular model is an error.
Details

It is a special case of linear model in which the regressors are lags of the dependent variable. If any variable is included in the \textit{xreg} term, these are added to the regressors matrix. A time-varying coefficients linear regression (with an intercept if \textit{type} = "const") is fitted.

Value

An object of class \texttt{tvar} with the following components:

- \texttt{coefficients}: A vector of dimension \texttt{obs} (\texttt{obs} = number of observations - number lags), with the time-varying coefficients estimates.
- \texttt{fitted}: The fitted values.
- \texttt{residuals}: Estimation residuals.
- \texttt{x}: A matrix of model data, with lagged \texttt{y} and exogenous variables.
- \texttt{y}: A vector with the dependent data used in the model.
- \texttt{z}: A vector with the smoothing variable in the model.
- \texttt{ez}: A vector with the smoothing estimation values.
- \texttt{y.orig}: A vector with the original variable \texttt{y}.
- \texttt{bw}: Bandwidth of mean estimation.
- \texttt{type}: Whether the model has a constant or not.
- \texttt{exogen}: A matrix or data.frame with other exogenous variables.
- \texttt{p}: Number of lags
- \texttt{obs}: Number of observations in estimation.
- \texttt{totobs}: Number of observations in the original set.
- \texttt{level}: Confidence interval range.
- \texttt{runs}: Number of bootstrap replications.
- \texttt{tboot}: Type of bootstrap.
- \texttt{BOOT}: List with all bootstrap replications of \texttt{coefficients}, if done.

References


See Also

\texttt{bw}, \texttt{tvLM}, \texttt{confint}, \texttt{plot}, \texttt{print} and \texttt{summary}
Examples

```r
## Estimate coefficients of different realized variance models
data("RV")
RV2 <- head(RV, 2000)
RV <- RV2$RV
RV_week <- RV2$RV_week
RV_month <- RV2$RV_month
RQ <- RV2$RQ_lag_sqrt
##Corsi (2009) HAR model
HAR <- arima(RV, order = c(1, 0, 0), xreg = cbind (RV_week, RV_month))
print(HAR)
##Chen et al (2017) TVCHAR model
TVCHAR <- tvAR (RV, p = 1, exogen = cbind (RV_week, RV_month), bw = 20)
print(TVCHAR)
##Casas et al (2018) TVHARQ model
TVHARQ <- tvAR (RV, p = 1, exogen = cbind (RV_week, RV_month), z=RQ, bw = 0.0062)
print(TVHARQ)
```

---

tvBcoef  

**Coefficient Array of an Estimated tvVAR**

**Description**

Returns the system estimated coefficients as an array.

**Usage**

```r
tvBcoef(x)
```

**Arguments**

- `x`: An object of class `tvvar`, generated by `tvVAR`.

**Details**

Given an estimated time varying VAR of the form:

\[
\hat{y}_t = \hat{A}_1 y_{t-1} + \ldots + \hat{A}_p y_{t-p} + \hat{C}_t D_t
\]

the function returns a list for each equation with \((\hat{A}_1|\ldots|\hat{A}_p|\hat{C}_t)\) set of arrays.

**Value**

A list object with coefficient arrays for the lagged endogenous variables without including the intercept.
**Examples**

```r
data(Canada, package="vars")
var.2p <- vars::VAR(Canada, p = 2, type = "const")
tvvar.2p <- tvVAR(Canada, p=2, type= "const")
B <- vars::Bcoef(var.2p)
tvB <- tvBcoef(tvvar.2p)
```

---

**tvCov**

*Time-varying Variance-Covariance Estimation*

**Description**

Estimation of a time-varying variance-covariance matrix using the local constant or the local linear kernel smoothing methodologies.

**Usage**

```r
tvCov(
  x, bw = NULL, cv.block = 0, est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian")
)
```

**Arguments**

- **x**
  - A matrix.
- **bw**
  - A scalar.
- **cv.block**
  - A positive scalar with the size of the block in leave-one block-out cross-validation. By default `cv.block=0` meaning leave-one-out cross-validation.
- **est**
  - A character, either "lc" or "ll" for local constant or local linear.
- **tkernel**
  - A character, either "Triweight", "Epa" or "Gaussian" kernel functions.

**Value**

A matrix of dimension obs x neq x neq.

**References**


**See Also**

`bwCov`
Examples

```r
# Generate two independent (uncorrelated series)
y <- cbind(rnorm(100, sd = 4), rnorm(100, sd = 1))

# Estimation variance-variance matrix. If the bandwidth is unknown, it can
calculated with function bwCov()
Sigma.hat <- tvCov(y, bw = 1.4)

# The first time estimate
print(Sigma.hat[,1])
# The mean over time of all estimates
print(apply(Sigma.hat, 1:2, mean))

# Generate two dependent variables
y <- MASS::mvrnorm(n = 100, mu = c(0,0), Sigma = cbind(c(1, -0.5), c(-0.5, 4)))

# Estimation variance-variance matrix
Sigma.hat <- tvCov(y, bw = 3.2)
# The first time estimate
print(Sigma.hat[,1])
```

---

**tvFE**

*Time-Varying Fixed Effects Estimation*

**Description**

tvFE estimate time-varying coefficient of fixed effects panel data models using kernel smoothing.

**Usage**

tvFE(x, ...)

```r
## S3 method for class 'matrix'
tvFE(
  x,
  y,
  z = NULL,
  ez = NULL,
  bw,
  neq,
  obs,
  est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian"),
  ...
)
```

```r
## S3 method for class 'tvplm'
tvFE(x, ...)
```
tvGLS

Arguments

x  An object used to select a method.

...  Other arguments passed to specific methods.

y  A vector with dependent variable.

z  A vector with the variable over which coefficients are smooth over.

ez  (optional) A scalar or vector with the smoothing values. If values are included then the vector z is used.

bw  A numeric vector.

neq  A scalar with the number of equations

obs  A scalar with the number of time observations

est  The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.

tkernel  A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

Value
tvFE returns a list containing:

coefficients  A vector of length obs, number of observations with the time-varying estimates.

fitted  A vector of length obs with the fitted values from the estimation.

residuals  A vector of length obs with the residuals from the estimation.

alpha  A vector of length neq with the fixed effects.

Description
tvGLS estimates time-varying coefficients of SURE using the kernel smoothing GLS.
tvGLS is used to estimate time-varying coefficients SURE using the kernel smoothing generalised least square.

Usage
tvGLS(x, ...)

## S3 method for class 'list'
tvGLS(
  x,
  y,
  z = NULL,
  ez = NULL,
  bw,
)
Sigma = NULL,
R = NULL,
r = NULL,
est = c("lc", "ll"),
tkernel = c("Triweight", "Epa", "Gaussian"),
...
)

## S3 method for class 'matrix'
tvGLS(
x,
y,
z = NULL,
ez = NULL,
bw,
Sigma = NULL,
R = NULL,
r = NULL,
est = c("lc", "ll"),
tkernel = c("Triweight", "Epa", "Gaussian"),
...
)

## S3 method for class 'tvsure'
tvGLS(x, ...)

Arguments

x An object used to select a method.
...
Other arguments passed to specific methods.
y A matrix.
z A vector with the smoothing variable.
ez (optional) A scalar or vector with the smoothing values. If values are included
then the vector z is used.
bw A numeric vector.
Sigma An array.
R A matrix.
r A numeric vector.
est The nonparametric estimation method, one of "lc" (default) for linear constant
or "ll" for local linear.
tkernel A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

Details

The classical GLS estimator must be modified to generate a set of coefficients changing over time.
The tvGLS finds a GLS estimate at a given point in time \( t \) using the data near by. The size of the
data window used is given by the bandwidth. The closest a point is to \( t \), the larger is its effect on the estimation which is given by the kernel. In this programme, the three possible kernels are the Triweight, Epanechnikov and Gaussian. As in the classical GLS, the covariance matrix is involved in the estimation formula. If this matrix is NULL or the identity, then the program returns the OLS estimates for time-varying coefficients.

Note, that unless with the tvSURE, the tvGLS may run with one common bandwidth for all equations or with a different bandwidths for each equation.

### Value

tvGLS returns a list containing:

- **coefficients**: An array of dimension \( \text{obs} \times \text{nvar} \times \text{neq} \) (\( \text{obs} = \) number of observations, \( \text{nvar} = \) number of variables in each equation, \( \text{neq} = \) number of equations in the system) with the time-varying coefficients estimates.
- **fitted**: A matrix of dimension \( \text{obs} \times \text{neq} \) with the fitted values from the estimation.
- **residuals**: A matrix of dimension \( \text{obs} \times \text{neq} \) with the residuals from the estimation.

### Examples

data(FF5F)
x <- list()
## SMALL/LoBM porfolios time-varying three factor model
x[[1]] <- cbind(rep (1, 314), FF5F[, c("NA.Mkt.RF", "NA.SMB", "NA.HML", "NA.RMW", "NA.CMA")])
x[[2]] <- cbind(rep (1, 314), FF5F[, c("JP.Mkt.RF", "JP.SMB", "JP.HML", "JP.RMW", "JP.CMA")])
x[[3]] <- cbind(rep (1, 314), FF5F[, c("AP.Mkt.RF", "AP.SMB", "AP.HML", "AP.RMW", "AP.CMA")])
x[[4]] <- cbind(rep (1, 314), FF5F[, c("EU.Mkt.RF", "EU.SMB", "EU.HML", "EU.RMW", "EU.CMA")])
##Returns
y <- cbind(FF5F$NA.SMALL.LoBM, FF5F$JP.SMALL.LoBM, FF5F$AP.SMALL.LoBM, 
FF5F$EU.SMALL.LoBM)
##Excess returns
y <- y - cbind(FF5F$NA.RF, FF5F$JP.RF, FF5F$AP.RF, FF5F$EU.RF)
#I fit the data with one bandwidth for each equation
FF5F.fit <- tvGLS(x = x, y = y, bw = c(1.03, 0.44, 0.69, 0.31))

---

### tvIRF

**Time-Varying Impulse Response Function**

**Description**

Computes the time-varying impulse response coefficients of an object of class tvvar, obtained with function tvVAR for \( n \) ahead steps.
Usage

```r
tvIRF(
  x,
  impulse = NULL,
  response = NULL,
  n.ahead = 10,
  ortho = TRUE,
  ortho.cov = c("tv", "const"),
  bw.cov = NULL,
  cumulative = FALSE,
  ...
)
```

Arguments

- **x**: An object of class `tvvar`.
- **impulse**: A character vector of the impulses, default is all variables.
- **response**: A character vector of the responses, default is all variables.
- **n.ahead**: Integer specifying the steps.
- **ortho**: Logical, if TRUE (the default) the orthogonalised IRF is computed.
- **ortho.cov**: A character indicating if the covariance matrix for the orthogonal tvIRF should be estimated as a constant or time varying. Either 'const' or 'tv' (default). This parameter is used only when ortho = TRUE.
- **bw.cov**: A scalar (optional) with the bandwidth to estimate the errors variance-covariance matrix. If left NULL, it is estimated.
- **cumulative**: Logical, if TRUE the cumulated impulse response coefficients are computed. Default is FALSE.
- **...**: Other parameters passed to specific methods.

Value

`tvIRF` returns and object of class `tvirf` with the following components:

- **irf**: A list of length the number of impulse variable(s). Each element of the list is an array of dim = c(obs x number of response variables x n.ahead).
- **Lower**: A list of length the number of impulse variable(s), containing the lower confidence line, if calculated.
- **Upper**: A list of length the number of impulse variable(s), containing the upper confidence line, if calculated.
- **response**: A character, a number of a vector with the names or positions of the response(s) variable(s).
- **impulse**: A character, a number of a vector with the names or positions of the impulse(s) variable(s).
- **x**: A object of class `tvvar`
tvLM

Description

tvLM is used to fit a time-varying coefficients linear model

Usage

tvLM(
  formula,
  z = NULL,
  ez = NULL,
  data,
  bw = NULL,
cv.block = 0,
est = c("lc", "ll"),
tkernel = c("Triweight", "Epa", "Gaussian"),
singular.ok = TRUE
)

Arguments

formula An object of class formula.
z A vector with the smoothing variable.
ez (optional) A scalar or vector with the smoothing estimation values. If values are included then the vector \( z \) is used.
data An optional data frame or matrix.
bw An opcional scalar. It represents the bandwidth in the estimation of trend coefficients. If NULL, it is selected by cross validation.
cv.block A positive scalar with the size of the block in leave one block out cross-validation. By default 'cv.block=0' meaning leave one out cross-validation.
est The nonparametric estimation method, one of 'lc' (default) for linear constant or 'll' for local linear.
tkernel A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.
singular.ok Logical. If FALSE, a singular model is an error.

Details

Models for \texttt{tvLM} are specified symbolically using the same formula format than function \texttt{lm}. A typical model has the form \texttt{response ~ terms} where response is the (numeric) response vector and terms is a series of terms which specifies a linear predictor for response. A terms specification of the form first + second indicates all the terms in first together with all the terms in second with duplicates removed. A specification of the form first:second indicates the set of terms obtained by taking the interactions of all terms in first with all terms in second. The specification first*second indicates the cross of first and second. This is the same as first + second + first:second.

A formula has an implied intercept term. To remove this use either \( y ~ x - 1 \) or \( y ~ 0 + x \).

Value

An object of class \texttt{tvlm} The object of class \texttt{tvlm} have the following components:

\begin{itemize}
\item \texttt{coefficients} A matrix of dimensions
\item \texttt{fitted} The fitted values.
\item \texttt{residuals} Estimation residuals.
\item \texttt{x} A matrix with the regressors data.
\item \texttt{y} A vector with the dependent variable data.
\item \texttt{z} A vector with the smoothing variable.
\item \texttt{ez} A vector with the smoothing estimation variable.
\item \texttt{bw} Bandwidth of mean estimation.
\end{itemize}
est  Nonparametric estimation methodology.
tkernel  Kernel used in estimation.
level  Confidence interval range.
runs  Number of bootstrap replications.
tboot  Type of bootstrap.
BOOT  List with all bootstrap replications of coefficients, if done.

References


See Also

bw, tvAR, confint, plot, print and summary

Examples

```r
## Simulate a linear process with time-varying coefficient
## as functions of scaled time.
set.seed(42)
tau <- seq(1:200)/200
beta <- data.frame(beta1 = sin(2*pi*tau), beta2= 2*tau)
X1 <- rnorm(200)
X2 <- rchisq(200, df = 4)
error <- rt(200, df = 10)
y <- apply(cbind(X1, X2)*beta, 1, sum) + error
data <- data.frame(y = y, X1 = X1, X2 = X2)
## Estimate coefficients with lm and tvLM for comparison
coef.lm <- stats::lm(y ~ 0 + X1 + X2, data = data)$coef
tvlm.fit <- tvLM(y ~ 0 + X1 + X2, data = data, bw = 0.29)
## Estimate coefficients of different realized variance models
data("AV")
RV2 <- head(RV, 2000)
##Bollerslev et al. (2016) HARQ model
HARQ <- with(RV2, lm(RV ~ RV_lag + I(RV_lag * RQ_lag_sqrt) + RV_week + RV_month))
#Casas et al. (2018) TVHARQ model
TVHARQ <- with(RV2, tvLM (RV ~ RV_lag + RV_week + RV_month, z = RQ_lag_sqrt, bw = 0.0061))
boxplot(data.frame(TVHARQ = TVHARQ$coefficients[,2] * RV2$RV_lag,
```
**tvOLS**  
*Time-Varying Ordinary Least Squares*

**Description**

`tvOLS` estimate time-varying coefficient of univariate linear models using the kernel smoothing OLS.

**Usage**

```r
tvOLS(x, ...) 
```

```r
## S3 method for class 'matrix'
tvOLS(
  x,
  y,
  z = NULL,
  ez = NULL,
  bw,
  est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian"),
  singular.ok = TRUE,
  ...
)
```

```r
## S3 method for class 'tvlm'
tvOLS(x, ...)
```

```r
## S3 method for class 'tvar'
tvOLS(x, ...)
```

```r
## S3 method for class 'tvvar'
tvOLS(x, ...)
```

**Arguments**

- `x`  
  An object used to select a method.

- `...`  
  Other arguments passed to specific methods.

- `y`  
  A vector with dependent variable.

- `z`  
  A vector with the variable over which coefficients are smooth over.

- `ez`  
  (optional) A scalar or vector with the smoothing values. If values are included then the vector `z` is used.

- `bw`  
  A numeric vector.

- `est`  
  The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.
tvPhi

A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

singular.ok Logical. If FALSE, a singular model is an error.

Value

tvOLS returns a list containing:

- coefficients: A vector of length obs, number of observations time observations.
- fitted: A vector of length obs with the fitted values from the estimation.
- residuals: A vector of length obs with the residuals from the estimation.

See Also

bw for bandwidth selection, tvLM and tvAR.

Examples

tau <- seq(1:500)/500
beta <- data.frame(beta1 = sin(2*pi*tau), beta2 = 2*tau)
X <- data.frame(X1 = rnorm(500), X2 = rchisq(500, df = 4))
error <- rt(500, df = 10)
y <- apply(X*beta, 1, sum) + error
coef.lm <- stats::lm(y~0+X1+X2, data = X)$coef
coef.tvlm <- tvOLS(x = as.matrix(X), y = y, bw = 0.1)$coefficients
plot(tau, beta[, 1], type="l", main="", ylab = expression(beta[1]), xlab = expression(tau),
ylim = range(beta[,1], coef.tvlm[, 1]))
abline(h = coef.lm[,1], col = 2)
lines(tau, coef.tvlm[, 1], col = 4)
legend("topright", c(expression(beta[1]), "lm", "tvlm"), col = c(1, 2, 4), bty="n", lty = 1)

---

tvPhi

Time-Varying Coefficient Arrays of the MA Representation

Description

Returns the estimated time-varying coefficient arrays of the moving average representation of a stable tvvar object obtained with function tvVAR.

Usage

tvPhi(x, nstep = 10, ...)

Arguments

- x: An object of class tvvar.
- nstep: An integer specifying the number of moving error coefficient matrices to be calculated.
- ...: Other parameters passed to specific methods.
tvPLM

**Time-Varying Coefficients Panel Data Models**

**Description**

Fits a balanced panel data model using the Time-Varying Pooled Ordinary Least Squares, the Time-Varying Random Effects and the Time-Varying Fixed Effects models.

**Usage**

```r
tvPLM(
  formula,
  z = NULL,
  ez = NULL,
  data,
  index = NULL,
  bw = NULL,
  bw.cov = NULL,
  cv.block = 0,
  method = c("pooling", "random", "within"),
  est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian"),
  control = tvreg.control(...),
  ...
)
```

**Arguments**

- `formula`: An object of class formula.
- `z`: A vector containing the smoothing variable.
- `ez`: (optional) A scalar or vector with the smoothing estimation values. If values are included then the vector `z` is used.
- `data`: An optional data frame or matrix.
- `index`: Indicates the individual and time indexes.
- `bw`: An optional scalar. It represents the bandwidth in the estimation of trend coefficients. If NULL, it is selected by cross validation.
- `bw.cov`: An optional scalar. It represents the bandwidth in the "lc" nonparametric estimation of the time-varying covariance matrix. If NULL, it is selected by cross validation for method "random".
- `cv.block`: A positive scalar with the size of the block in leave one block out cross-validation. By default `cv.block=0` meaning leave one out cross-validation.
- `method`: A character with the choice of panel model/estimation method: If `method = "pooling"` (default) then the data is pooled estimated with time-varying OLS. No individual or time effects are estimated. If `method = "random"` then individual effects are considered random and independent of the regressors. If `method = "within"` then individual effects are estimated using fixed effects.
= "within" then individual effects which might be correlated with the regressors are estimated.

\text{est} \quad \text{The nonparametric estimation method, one of "lc" (default) for linear constant}

\text{tkernel} \quad \text{A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.}

\text{control} \quad \text{list of control parameters. The default is constructed by the function \text{tvreg.control}.}
\quad \text{See the documentation of \text{tvreg.control} for details.}

\ldots \quad \text{Other parameters passed to specific methods.}

\section*{Details}

This function wraps up the kernel smoothing time-varying coefficient pooled, random effects and fixed effects estimators.

Bandwidth selection is of great importance in kernel smoothing methodologies and it is done automatically by cross-validation.

A panel data model consists of "neq" elements in the cross-sectional dimension and "obs" number of time observations for each cross-section. All variables are the same for each equation which have common coefficients.

\section*{Value}

\text{tvPLM} returns a list of the class \text{tvplm} containing the results of model, results of the estimation and confidence intervals if chosen. The object of class \text{tvplm} have the following components:

\text{coefficients} \quad \text{An array of dimension obs x nvar x neq (obs = number of observations, nvar = number of variables in each equation, neq = number of equations in the system) with the time-varying coefficients estimates.}

\text{Lower} \quad \text{If level non equal zero, an array of dimension obs x nvar x neq containing the confidence interval lower band.}

\text{Upper} \quad \text{If level non equal zero, an array of dimension obs x nvar x neq containing the confidence interval upper band.}

\text{fitted} \quad \text{The fitted values.}

\text{residuals} \quad \text{Estimation residuals.}

\text{x} \quad \text{A list with the regressors data.}

\text{y} \quad \text{A matrix with the dependent variable data.}

\text{z} \quad \text{A vector with the smoothing variable.}

\text{ez} \quad \text{A vector with the smoothing estimation values.}

\text{alpha} \quad \text{A vector with the individual fixed effects, if chosen.}

\text{bw} \quad \text{Bandwidth of mean estimation.}

\text{totobs} \quad \text{Integer specifying the total number of observations.}

\text{neq} \quad \text{Integer specifying the number of cross-section observations.}

\text{obs} \quad \text{Integer specifying the number of time observations per cross-section.}

\text{nvar} \quad \text{Number of variables.}

\text{method} \quad \text{Estimation method.}
tvPsi

Time-Varying Coefficient Arrays of the Orthogonalised MA Representation

Description

Returns the estimated orthogonalised time-varying coefficient arrays of the moving average representation of a stable tvvar object obtained with function tvVAR.

Usage

```
tvPsi(x, nstep = 10, ortho.cov = "const", bw.cov = NULL, ...)
```
Arguments

- **x**: An object of class `tvvar`, generated by `tvVAR()`.
- **nstep**: An integer specifying the number of orthogonalised moving error coefficient matrices to be calculated for each time `t`.
- **ortho.cov**: A character either 'const' if the error cov matrix must be estimated by a constant or 'tv' if it is estimated as a time-varying matrix. Default is 'const'.
- **bw.cov**: A scalar (optional) with the bandwidth to estimate the errors variance-covariance matrix.
- **...**: Other parameters passed to specific methods.

Value

A list with an array of dimensions (obs x neq x neq nstep + 1) holding the estimated time varying coefficients of the moving average representation, and the bandwidth used to estimate the covariance matrix (optional).

Description

tvRE estimate time-varying coefficient of a random effects panel data model using kernel smoothing.

Usage

tvRE(x, ...)

## S3 method for class 'matrix'
tvRE(
  x,
  y,  # Asymptotic variance-covariance matrix.
  Sigma = NULL,
  bw,
  ...)  

## S3 method for class 'tvplm'
tvRE(x, ...)
Arguments

x     An object used to select a method.

...  Other arguments passed to specific methods.

y     A vector with dependent variable.

z     A vector with the variable over which coefficients are smooth over.

ez    (optional) A scalar or vector with the smoothing values. If values are included
       then the vector z is used.

bw    A numeric vector with the bandwidth.

Sigma NULL (default) or a matrix of size obs x obs.

neq   A scalar with the number of equations

obs   A scalar with the number of time observations

est   The nonparametric estimation method, one of "lc" (default) for linear constant
       or "ll" for local linear.

tkernel A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

Value

tvRE returns a list containing:

coefficients A vector of length obs, number of observations with the time-varying estimates.

fitted        A vector of length obs with the fitted values from the estimation.

residuals     A vector of length obs with the residuals from the estimation.

alpha         A vector of length neq with the fixed effects.

---

**tvSURE**  
*Time-Varying Seemingly Unrelated Regression Equations Model*

Description

Fits a set of balanced linear structural equations using Time-varying Ordinary Least Squares (tvOLS), Time-varying Seemingly Unrelated Regression (tvGLS), when the error variance-covariance matrix is known, or Time-varying Feasible Seemingly Unrelated Regression (tvFGLS), when the error variance-covariance matrix is unknown.

Usage

tvSURE(
  formula,
  z = NULL,
  ez = NULL,
  bw = NULL,
  cv.block = 0,
  data,
method = c("tvOLS", "tvFGLS", "tvGLS"),
Sigma = NULL,
est = c("lc", "ll"),
tkernel = c("Triweight", "Epa", "Gaussian"),
bw.cov = NULL,
singular.ok = TRUE,
R = NULL,
r = NULL,
control = tvreg.control(...),
...
)

Arguments

formula A list of formulas, one for each equation.

z A vector containing the smoothing variable.

ez (optional) A scalar or vector with the smoothing estimation values. If values are included then the vector \( z \) is used.

bw An optional scalar or vector of length the number of equations. It represents the bandwidth in the estimation of trend coefficients. If NULL, it is selected by cross validation.

cv.block A positive scalar with the size of the block in leave one block out cross-validation. By default 'cv.block = 0' meaning leave one out cross-validation.

data A matrix or data frame containing variables in the formula.

method A character, a matrix of dimensions neq x neq or an array of dimensions obs x neq x neq, where obs is the number of observations and neq is the number of equations. If method = identity or tvOLS (default) then the method used is a time-varying OLS. If method is a matrix (constant over time) or an array, then the tvGLS is called. If method = tvFGLS, then the covariance matrix is estimated nonparametrically and the estimation of the system is done as a whole.

Sigma A matrix of dimensions neq x neq or an array of dimensions neq x neq x obs (neq = number of equations, obs = number of observations). It represents the covariance matrix of the error term. Only necessary for method tvGLS.

est The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.

tkernel A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

bw.cov An optional scalar. It represents the bandwidth in the "lc" nonparametric estimation of the time-varying covariance matrix. If NULL, it is selected by cross validation.

singular.ok Logical. If FALSE, a singular model is an error.

R An optional nrest x nvar x neq (nrest = number of restrictions, nvar = number of variables in each equation, neq = number of equations).

r An optional vector of length the number of restrictions. By default it contains zeros.
control list of control parameters. The default is constructed by the function `tvreg.control`. See the documentation of `tvreg.control` for details.

... Other parameters passed to specific methods.

Details

This function wraps up the kernel smoothing "tvOLS" and "tvGLS" estimators. The former is used when equations are considered independent while the later assumes that the error term is correlated amongst equations. This relation is given in matrix "Sigma" which is used in the estimation. When "Sigma" is known, the estimates are calculated via the "tvGLS", and via the "tvFGLS" when "Sigma" is unknown and must be estimated.

Bandwidth selection is of great importance in kernel smoothing methodologies and it is done automatically by cross-validation. One important aspect in the current packages is that the bandwidth is selected independently for each equation and then the average is taken to use the same bandwidth for each equation. It has been shown in Casas et al. (2017) that using different bandwidths for each equation is in general a bad practice, even for uncorrelated equations. Even though, the user may be able to use different bandwidths calling functions `bw` and `tvGLS` separately.

A system consists of "neq" number of equations with "obs" number of observations each and a number of variables not necessarily equal for all equations. The matrix notation is:

\[ Y_t = X_t \beta_t + u_t \]

where \( Y_t = (y_{1t}, y_{2t}, \ldots, y_{neqt})' \), \( X_t = diag(x_{1t}, x_{2t}, \ldots, x_{neqt}) \) and \( \beta_t = (\beta_{1t}', \ldots, \beta_{neqt}')' \) is a vector of order the total number of variables in the system. The error vector \( u_t = (u_{1t}, u_{2t}, \ldots, u_{neqt})' \) has zero mean and covariance matrix \( E(u_t u_t') = \Sigma_t \).

Value

tvSURE returns a list of the class `tvsure` containing the results of the whole system, results of the estimation and confidence intervals if chosen. The object of class `tvsure` have the following components:

- **coefficients**: An array of dimension obs x nvar x neq (obs = number of observations, nvar = number of variables in each equation, neq = number of equations in the system) with the time-varying coefficients estimates.
- **Lower**: If `level` non equal zero, an array of dimension obs x nvar x neq containing the confidence interval lower band.
- **Upper**: If `level` non equal zero, an array of dimension obs x nvar x neq containing the confidence interval upper band.
- **Sigma**: An array of dimension obs x neq x neq with the estimates of the errors covariance matrix.
- **fitted**: The fitted values.
- **residuals**: Estimation residuals.
- **x**: A list with the regressors data.
- **y**: A matrix with the dependent variable data.
- **z**: A vector with the smoothing variable.
ez
A vector with the smoothing estimation values.
bw
Bandwidth of mean estimation.
obs
Integer specifying the number of observations in each equation (balanced sample).
neq
Integer specifying the number of equations.
nvar
Vector of integers specifying the number of variables in each equation.
method
Estimation method.
est
Nonparametric estimation methodology.
tkernel
Kernel type.
bw.cov
Bandwidth of Sigma estimation.
level
Confidence interval range.
runs
Number of bootstrap replications.
tboot
Type of bootstrap.
BOOT
List with all bootstrap replications of coefficients, if done.
R
Restrictions matrix.
r
Restrictions vector.
formula
Initial formula.

References


See Also

bw, tvCov, tvVAR, confint, plot, print and summary

Examples

```r
## Not run:
data("Kmenta", package = "systemfit")
eqDemand <- consump ~ price + income
eqSupply <- consump ~ price + farmPrice + trend
system <- list(demand = eqDemand, supply = eqSupply)
eqSupply2 <- consump ~ price + farmPrice
```
system2 <- list(demand = eqDemand, supply = eqSupply2)

## OLS estimation of a system
OLS <- systemfit::systemfit(system, method = "OLS", data = Kmenta)

## tvOLS estimation of a system with the local linear estimator
## removing trend because it is included in the intercept changing over time
TVOLS <- tvSURE(system2, data = Kmenta, est = "ll")

## SUR/FGLS estimation
FGLS <- systemfit::systemfit(system, method = "SUR")

## tvSURE estimation
TFGLS <- tvSURE(system, method = "tvFGLS")

## End(Not run)

---

### tvVAR

**Time-varying Vector Autoregressive Models**

**Description**

Fits a time-varying coefficients vector autorregressive model with p lags.

**Usage**

```r
tvVAR(
  y,
  p = 1,
  z = NULL,
  ez = NULL,
  bw = NULL,
  cv.block = 0,
  type = c("const", "none"),
  exogen = NULL,
  est = c("lc", "ll"),
  tkernel = c("Triweight", "Epa", "Gaussian"),
  singular.ok = TRUE
)
```

**Arguments**

- `y` A matrix with dimention obs x neq (obs = number of observations and neq = number of equations)
- `p` A scalar indicating the number of lags in the model
- `z` A vector containing the smoothing variable.
- `ez` (optional) A scalar or vector with the smoothing estimation values. If values are included then the vector `z` is used.
bw
An optional scalar or vector of length the number of equations. It represents the bandwidth in the estimation of trend coefficients. If NULL, it is selected by cross validation.

cv.block
A positive scalar with the size of the block in leave one block out cross-validation. By default 'cv.block = 0' meaning leave one out cross-validation.

type
A character 'const' if the model contains an intercept and 'none' otherwise.

exogen
A matrix or data.frame with the exogenous variables (optional)

est
The nonparametric estimation method, one of "lc" (default) for linear constant or "ll" for local linear.

tkernel
A character, either "Triweight" (default), "Epa" or "Gaussian" kernel function.

singular.ok
Logical. If FALSE, a singular model is an error.

Value
An object of class 'tvvar' The object of class tvvar have the following components:

coefficients
An array of dimension obs x neq (obs = number of observations, neq = number of equations in the system) with the time-varying coefficients estimates.

fitted
The fitted values.

residuals
Estimation residuals.

x
A list with the regressors data and the dependent variable.

y
A matrix with the dependent variable data.

z
A vector with the smoothing variable.

ez
A vector with the smoothing estimation values.

bw
Bandwidth of mean estimation.

type
Whether the model has a constant or not.

exogen
A matrix or data.frame with other exogenous variables.

p
Number of lags

neq
Number of equations

obs
Number of observations in estimation.

totobs
Number of observations in the original set.

call
Matched call.

References


See Also
bw, tvIRF, plot, print and summary
## Inflation rate, unemployment rate and treasury bill interest rate for
## the US, as used in Primiceri (2005).

data(usmacro, package = "bvarsv")

VAR.fit <- vars::VAR(usmacro, p = 6, type = "const")
tvVAR.fit <- tvVAR(usmacro, p = 6, type = "const", bw = c(1.8, 20, 20))

plot(tvVAR.fit)

---

### Description

*Update and Re-fit the Models of package tvReg*

### Usage

#### S3 method for class 'tvlm'

```r
update(object, ...)
```

#### S3 method for class 'tvar'

```r
update(object, ...)
```

#### S3 method for class 'tvvar'

```r
update(object, ...)
```

#### S3 method for class 'tvsure'

```r
update(object, ...)
```

#### S3 method for class 'tvplm'

```r
update(object, ...)
```

### Arguments

- **object**
  
  An object of any class in package tvReg.

- **...**
  
  Other parameters passed to specific methods.

### Value

An object of the same class than the argument *object*. 

---

### Examples

#### S3 method for class 'tvlm'

```r
update.tvlm
```

#### S3 method for class 'tvar'

```r
tvar
```

#### S3 method for class 'tvvar'

```r
tvvar
```

#### S3 method for class 'tvsure'

```r
tvsure
```

#### S3 method for class 'tvplm'

```r
tvplm
```
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