Package ‘splm’

December 20, 2023

Title Econometric Models for Spatial Panel Data
Version 1.6-5
Date 2023-12-11
Description
ML and GM estimation and diagnostic testing of econometric models for spatial panel data.
Depends R (>= 2.12.0)
Imports plm, maxLik, MASS, bdsmatrix, nlme, Matrix, spam, methods,
spatialreg (>= 1.2-1), spdep (>= 1.2-1), stringr
License GPL-2
LazyLoad yes
 NeedsCompilation no

Author Giovanni Millo [aut, cre],
Gianfranco Piras [aut],
Roger Bivand [ctb] (<https://orcid.org/0000-0003-2392-6140>)

Maintainer Giovanni Millo <giovanni.millo@deams.units.it>

Repository CRAN

Date/Publication 2023-12-20 16:20:05 UTC

R topics documented:

bsjktest .................................................. 2
bsktest .................................................. 3
effects.splm .............................................. 4
Insurance ................................................ 5
itaww ...................................................... 6
listw2dgCMatrix ........................................ 7
print.splm ............................................... 7
RiceFarms .............................................. 8
riceww ................................................... 9
rwtest .................................................. 10
slag ..................................................... 12
slmtest ................................................ 13
bsjktest

Baltagi, Song, Jung and Koh LM test for spatial panels

Description

Baltagi, Song, Jung and Koh joint or conditional LM test for spatial error correlation or serial correlation sub spatial, serial correlation and random effects in panel models

Usage

bsjktest(x,...)

## S3 method for class 'formula'
bsjktest(x, data, index=NULL, listw, test=c("C.1","C.2","C.3","J"), ...)

Arguments

x an object of class formula
data a data.frame or pdata.frame containing the variables in the model
index either NULL (default) or a character vector to identify the indexes among the columns of the data.frame
listw either a matrix or a listw representing the spatial structure
test one of c("C.1","C.2","C.3","J"), the test to be performed.
... additional arguments to be passed

Value

an object of class htest

Author(s)

Giovanni Millo

References

bsktest

See Also
bsktest

Examples
```
data(Produc, package="plm")
data(usaww)
fm <- log(gsp)~log(pcap)+log(pc)+log(emp)+unemp
bsjktest(fm, data=Produc, listw = usaww, test="C.1")
```

bsktest

Baltagi, Song and Koh LM test for spatial panels

Description
Baltagi, Song and Koh marginal or conditional LM test for spatial error correlation or random effects in panel models

Usage
```
bsktest(x,...)
## S3 method for class 'formula'
bsktest(x, data, index=NULL, listw, test=c("LMH","LM1","LM2","CLMlambda","CLMmu"),
standardize=FALSE, method = "eigen", ...)
```

Arguments

- **x** a formula
- **data** a data.frame or pdata.frame containing the variables in the model
- **index** either NULL (default) or a character vector to identify the indexes among the columns of the data.frame
- **listw** a listw representing the spatial structure
- **test** one of c("LMH","LM1","LM2","CLMlambda","CLMmu"), the test to be performed
- **standardize** whether to standardize the test statistic or not (applies only to LM1 and LM2)
- **method** select a method for ML in "CLMmu". the default is "eigen"
- **...** additional arguments to be passed

Value
an object of class htest

Author(s)
Gianfranco Piras
References


See Also

sphtest

Examples

data(Produc, package="plm")
data(usaww)
fm <- log(gsp)-log(pcap)+log(pc)+log(emp)+unemp
bsktest(fm, data=Produc, listw = spdep::mat2listw(usaww),
        test="LM1")

effects.splm

method for extracting fixed effects

Description

Methods used for extracting fixed effects from objects of class splm where type is one of "fixed effects lag" or "fixed effects error"

Usage

## S3 method for class 'splm'
effects(object,...)

Arguments

object an object of class 'splm'

... additional arguments to be passed over

Details

If the argument object is not of class splm the function will terminate with an error.

If the argument object is of class splm but type is not one of "fixed effects lag" or "fixed effects error", the function will terminate with an error.

Value

An object of class effects.splm

res a list whose elements are various type of fixed effects and the intercept (when present)
Insurance

Author(s)
Gianfranco Piras

References

See Also
spml summary.effects.splm

Examples
```r
data(Produc, package = "plm")
data(usaww)
fm <- log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp
err <- splm(fm, data = Produc, listw = spdep::mat2listw(usaww), model="within")
summary(err)
eff <- effects(err)
print(eff)
```

Insurance

*Insurance consumption across Italian provinces, 1998-2002*

Description
A panel of 103 observations
- number of observations : 515
- observation : provinces
- country : Italy

Usage
data(Insurance)

Format
A dataframe containing :
- **code** the province code according to Istat
- **year** the year of observation
- **ppcd** real per capita premiums in 2000 euros, non-life insurance excluding mandatory motor third-party liability
**rgdp** real per-capita GDP

**bank** real per-capita bank deposits

**den** population density per square Km

**rir** real interest rate on lending to families and small enterprises

**agen** density of insurance agencies per 1000 inhabitants

**school** share of people with second grade schooling or more

**vaagr** share of value added, agriculture

**fam** average number of family members

**in** judicial inefficiency index: average years to settle first degree of civil case

**trust** survey result to the question "do you trust others?"

**dXX** year dummies

**NorthWest** macroregional dummy

**NorthEast** macroregional dummy

**Centre** macroregional dummy

**South** macroregional dummy

**Islands** macroregional dummy (Sicily and Sardinia)

**Author(s)**

Giovanni Millo

**Source**


---

**itaww**

*Spatial weights matrix - Italian provinces*

**Description**


**Usage**

`data(itaww)`

**Format**

A matrix with elements different from zero if province i and j are neighbors. Weights are row-standardized. Messina and Reggio Calabria, divided by the Messina Strait, are considered neighbours.

**Author(s)**

Giovanni Millo
listw2dgCMatrix

**Description**

Interface between Matrix class objects and weights list

**Usage**

`listw2dgCMatrix(listw, zero.policy = NULL)`

**Arguments**

- `listw`: a `listw` object created for example by `spdep::nb2listw`
- `zero.policy`: See `lagsarlm` for details

**Value**

Matrix class object: a sparse Matrix

**Author(s)**

Gianfranco Piras

**Examples**

```r
data(columbus, package="spdep")
listw<-spdep::nb2listw(col.gal.nb)
spW<-listw2dgCMatrix(listw)
```

---

print.splm

**Description**

Method to print objects of class `summary.splm` and `splm`

**Usage**

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

**Arguments**

- `x`: an object of class `splm`
- `digits`: minimal number of significant digits, see `print.default`
- `...`: additional arguments to be passed
Details

The summary function \texttt{summary.splm} returns an objects of class 'splm' organized in a coefficient matrix.
Also a matrix for the error components, or the spatial coefficients will be generated depending on the estimated model.

Author(s)

Giovanni Millo, Gianfranco Piras

See Also

\texttt{spml, spgm}

Examples

\begin{verbatim}
data(Produc, package = "plm")
data(usaww)
spremod<-spml(log(gsp)~log(pcap)+log(pc)+log(emp)+unemp, data=Produc,
listw = spdep::mat2listw(usaww), model="random", lag=TRUE, spatial.error="none")
summary(spremod)
\end{verbatim}

Description

yearly observations of 171 farms

\textit{number of observations} : 1026
\textit{country} : Indonesia
\textit{economic topic} : producer behavior
\textit{econometrics topic} : error component

Usage

\begin{verbatim}
data(RiceFarms)
\end{verbatim}

Format

A dataframe containing :

\textbf{id} the farm identifier
\textbf{time} the growing season
\textbf{size} the total area cultivated with rice, measured in hectares
\textbf{status} land status, on of 'owner' (non sharecroppers, owner operators or leaseholders or both), 'share' (sharecroppers), 'mixed' (mixed of the two previous status)
**Varieties** one of 'trad' (traditional varieties), 'high' (high yielding varieties) and 'mixed' (mixed varieties)

**Bimas** bIMAS is an intensification program; one of 'no' (non-bimas farmer), 'yes' (bimas farmer) or 'mixed' (part but not all of farmer's land was registered to be in the bimas program)

**Seed** seed in kilogram

**Urea** urea in kilogram

**Phosphate** phosphate in kilogram

**Pesticide** pesticide cost in Rupiah

**Pseed** price of seed in Rupiah per kg

**Purea** price of urea in Rupiah per kg

**Pphosph** price of phosphate in Rupiah per kg

**Hiredlabor** hired labor in hours

**Famlabor** family labor in hours

**Totalabor** total labor (excluding harvest labor)

**Wage** labor wage in Rupiah per hour

**Output** gross output of rice in kg

**Noutput** net output, gross output minus harvesting cost (paid in terms of rice)

**Price** price of rough rice in Rupiah per Kg

**Region** one of 'wargabinangun', 'langan', 'gunungwangi', 'malausma', 'sukaambit', 'ciwangi'

**Source**

Journal of Applied Econometrics Data Archive.

**References**


**Description**

Spatial weights matrix of the 171 farms in the Indonesian Rice Farming example. Farms in the same village (out of six) are considered contiguous.

**Usage**

data(riceww)
Format

A matrix with elements different from zero if farms i and j are neighbors. Farms are considered neighbors if in the same village. Weights are row-standardized.

Author(s)

Giovanni Millo, data provided by Yves Croissant

rctest

Randomization-based test of spatial dependence for panel models

Description

Randomization-based test of spatial dependence for panel models, robust to global dependence induced by common factors and to persistence (serial correlation) in the data

Usage

rctest(x, ...)  
## S3 method for class 'formula'

rctest(x, data, w, index = NULL, model = NULL,  
replications = 99, seed=NULL, order=1,  
mc=1, test = c("rho", "cd", "sclm"),  
alternative=c("twosided", "onesided", "symmetric"), ...)

## S3 method for class 'panelmodel'

rctest(x, w, replications = 99, seed=NULL,  
order=1, mc=1,  
test = c("rho", "cd", "sclm"),  
alternative=c("twosided", "onesided", "symmetric"), ...)

## S3 method for class 'pseries'

rctest(x, w, replications = 99, seed=NULL,  
order=1, mc=1,  
test = c("rho", "cd", "sclm"),  
alternative=c("twosided", "onesided", "symmetric"), ...)

Arguments

x an object of class formula, panelmodel, or pseries (depending on the respective interface) describing the model to be tested.

data a data.frame
\(w\) a \(n \times n\) matrix describing proximity between individuals, with \(w_{ij} = a\) where \(a\) is any number such that \(\text{as.logical}(a) = \text{TRUE}\). If \(i, j\) are neighbours, 0 or any number \(b\) such that \(\text{as.logical}(b) = \text{FALSE}\) elsewhere. Only the lower triangular part (without diagonal) of \(w\) after coercing by \(\text{as.logical()}\) is evaluated for neighbouring information (but \(w\) can be symmetric). See also Details and Examples.

index an optional numerical index, in case data has to be formatted by \texttt{plm.data}

model an optional character string indicating which type of model to estimate; if left to NULL, the original heterogeneous specification of Pesaran is used

replications the number of Monte Carlo randomizations of the neighbourhood matrix (default: 99),

seed the optional random seed,

order the order of neighbourhood to test for,

mc the number of parallel threads to execute; defaults to 1 (serial execution); is limited to the number of execution cores actually available, and depends on operating system support.

test the type of test statistic to be returned. One of
- "rho" for the average correlation coefficient,
- "cd" for Pesaran's CD statistic, or
- "sclm" for the scaled version of Breusch and Pagan's LM statistic,

alternative the alternative hypothesis for the test, defaulting to (asymmetric) twosided,

... further arguments to be passed on to \texttt{plm}, such as e.g. \texttt{effect} or \texttt{random.method}

Details

This test is meant as a generalization of Pesaran’s spatial dependence test "CD(p)" for robustness against global dependence (perhaps of the factor type) and persistence in the data, both of which the original test does not tolerate.

The procedure can be applied to model residuals as well as to individual \texttt{pseries}. See the comments in \texttt{pcdtest} as for the different methods.

Space is defined supplying a proximity matrix (elements coercible to \texttt{logical}) with argument \(w\) which provides information on whether any pair of individuals are neighbours or not. If \(\text{order}=1\), only first-order neighbouring pairs will be used in computing the test; else, \(w\) will be transformed in the neighbourhood matrix of the appropriate order. The matrix need not be binary, so commonly used “row–standardized” matrices can be employed as well. \texttt{nb} objects from \texttt{spdep} must instead be transformed into matrices by \texttt{spdep}'s function \texttt{nb2mat} before using.

Notice that the "rho" and "cd" tests are permutationally equivalent.

The test is suitable also for unbalanced panels.

The test on a \texttt{pseries} is the same as a test on a pooled regression model of that variable on a constant, i.e. \texttt{rwtest(some_pseries)} is equivalent to \texttt{rwtest(plm(some_var ~ 1, data = some_pdata.frame, model = "pooling"))} and also equivalent to \texttt{rwtest(some_var ~ 1, data = some_data)}, where \texttt{some_var} is the variable name in the data which corresponds to \texttt{some_pseries}. 

Value
An object of class "htest".

Author(s)
Giovanni Millo

References

Examples
data(Produc, package = "plm")
data(usaww)
fm <- log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp
## test on heterogeneous model (separate time series regressions)
rwtest(fm, data = Produc, w=usaww, index = c("state", "year"))

## test on two-way fixed effects homogeneous model
rwtest(fm, data = Produc, w=usaww, index = c("state", "year"),
       model = "within", effect = "twoways")

## test on panelmodel object
library(plm)
g <- plm(fm, data = Produc)
rwtest(g, w=usaww)

## test on pseries, higher-order neighbourhood
pprod <- pdata.frame(Produc)
rwtest(pprod$gsp, w=usaww, order=3)

slag Spatial lag operator

Description
Spatial lagging method for vectors or pseries objects.

Usage
## S3 method for class 'pseries'
slag(x, listw, maxlag, ...)
## Default S3 method:
slag(x, listw, maxlag, index, ...)
Arguments

- **x**: an object of class `pseries`
- **listw**: an object of class `listw`
- **maxlag**: the spatial lag order (including lower)
- **index**: the default method needs a well-specified index
- **...**: additional arguments to be passed

Value

A `pseries`

Author(s)

Giovanni Millo

Examples

```r
data(Produc, package="plm")
data(usaww)
usalw <- spdep::mat2listw(usaww)
fm <- log(gsp)~log(pcap)+log(pc)+log(emp)+unemp+slag(log(pcap),
  listw=usalw)
slxmod <- spreml(fm, data=Produc, w = usaww,
  model="pooling", lag=FALSE, errors="ols")
```

Description

Locally robust panel Lagrange Multiplier tests for spatial dependence

Usage

```r
slmtest(x,...)
```

## S3 method for class 'formula'

```r
slmtest(formula, data, listw, model="pooling",
  test=c("lme","lml","rlme","rlml"), index=NULL, ...)
```

## S3 method for class 'plm'

```r
slmtest(x, listw,
  test=c("lme","lml","rlme","rlml"), ...)
```
Arguments

- **formula**: an object of class `formula`
- **data**: a data.frame or pdata.frame containing the variables in the model
- **x**: an object of class `plm`
- **listw**: either a matrix or a listw representing the spatial structure
- **model**: a character value specifying the transformation to be applied to the data.
- **test**: one of `c("lme","lml","rlme","rlml")`, the test to be performed.
- **index**: either NULL (default) or a character vector to identify the indexes among the columns of the data.frame
- **...**: additional arguments to be passed

Details

This tests are panel versions of the locally robust LM tests of Anselin et al. (1996), based on a pooling assumption: i.e., they do not allow for any kind of individual effect. Therefore it is advisable to employ a within transformation whenever individual effects cannot be ruled out.

It must be kept in mind that these locally robust procedures have been designed for situations in which the "other" effect is not of substantial magnitude, and can behave suboptimally otherwise.

Four tests are available to be chosen through the test argument: "lml" for "LM lag" and, respectively, "lme" for "LM error" are the standard, non-robust versions, obtained simply pooling the cross-sectional versions; "rlml" and "rlme" are, respectively, the locally robust test for lag, allowing for a spatial error; and for error, allowing for a spatial lag.

The model argument, specified according to the standards of `plm`, is passed on internally and employed to determine the panel data transformation to be applied before calculating the test. Defaults to "pooling" (no transformation).

Value

an object of class `htest`

Author(s)

Giovanni Millo

References


Examples

data(Produc, package="plm")
data(usaww)
fm <- log(gsp)+log(pcap)+log(pc)+log(emp)+unemp
## robust LM test for spatial error sub spatial lag
## model on original data, pooling hypothesis
```
slmtest(fm, data=Produc, listw = usaww, test="rlme")
```
## model on within-transformed (time-demeaned) data, eliminates individual effects
```
slmtest(fm, data=Produc, listw = usaww, test="rlme",
    model="within")
```

---

### Description

GM estimation of panel data models with spatially correlated errors components of the form:

\[
y_N(t) = \lambda W y + X_N(t)\beta + u_N(t)
\]

\[
    u_N(t) = \rho W_N u_N(t) + \epsilon(t)
\]

\[
    \epsilon_N = (\epsilon_T \otimes I_N)\mu_N + \nu_N
\]

where \(\rho\), and the variance components \(\sigma^2_\mu\) and \(\sigma^2_\nu\) are estimated by GM, and the model coefficients by a Feasible GLS estimator. The model can also include additional (other than the spatial lag) endogenous variables.

### Usage

```
spgm(formula, data=list(), index=NULL, listw = NULL, listw2 = NULL, Durbin = FALSE,
    model = c("within", "random"), lag = FALSE, spatial.error = TRUE,
    moments = c("initial", "weights", "fullweights"), endog = NULL,
    instruments = NULL, lag.instruments = FALSE, verbose = FALSE,
    method = c("w2sls", "b2sls", "g2sls", "ec2sls"), control = list(),
    optim.method = "nlminb", pars = NULL)
```

### Arguments

- `formula` a description of the model to be fit. The details of model specification are given for `lm`
- `data` an object of class `data.frame` or `pdata.frame`. An optional data frame containing the variables in the model. When the object is a `data.frame`, the first two columns may contain the indexes. See `index`
- `index` if not NULL (default), a character vector to identify the indexes among the columns of the data.frame
- `listw` an object of class `listw`, `matrix`, or `Matrix`

---
listw2: an object of class listw, matrix, or Matrix. Only if both lag and spatial.error are both TRUE.

Durbin: default FALSE. If TRUE all the regressors are also spatially lagged. If it is a formula (Durbin = ~ x1 + x2), only the variables specified in the formula are lagged.

model: One of "within" or "random". The assumption made on the individual effects

lag: if TRUE a spatial lag of the dependent variable is added to the regression equation

spatial.error: a logic vector. If TRUE the spatial autoregressive error term is added to the model and an estimate for $\rho$ is produced

moments: "initial" (default) defines the set of GM estimator to be used. Alternatives are "weights" and "fullweights" (See Details)

endog: additional endogenous variables. Default NULL. If not NULL should be specified as a formula with no dependent variable (endog = ~ x1 + x2). Note the ~ before the expression.

instruments: external instruments. Default NULL. If not NULL should be specified as a formula with no dependent variable (instruments = ~ x1 + x2). Note the ~ before the expression.

lag.instruments: should the external instruments be spatially lagged?

verbose: default FALSE. If TRUE reports function values during optimization

method: One of "w2sls", "b2sls", "g2sls", "ec2sls". (See Details)

control: a list of control parameters for the optimization

optim.method: default set to "nlminb". or optionally a method passed to optim to use an alternative optimizer.

pars: initial values of the parameter rho and sigmav. The default for rho is to start from a regression of the spatially lagged residuals on the residuals (depending on the model). for sigmav the starting value is the variance of the residuals (again this depends on the model).

**Details**

The function is a very general interface to estimate various nested specifications of the general model including additional endogenous variables described above. When both spatial.error and lag are FALSE the model reduces to a panel data model with an additional endogeneous variable. The function then uses ivsplm to perform the Instrumental Variables and two-stage least squares for panel data model. method = "w2sls" corresponds to the fixed effects estimator, method = "b2sls" to the between effects model, method = "g2sls" to the GLS random effects model, and method = "ec2sls" to the Baltagi’s EC2SLS.

When spatial.error is TRUE and lag is FALSE the model is one with spatially autocorrelated error components. If effects is "random", the Kapoor et al. (2007) GM estimator is performed and the residuals in the first step come from an OLS regression. When moments is "initial", the initial estimator is calculated. This first set of GM estimators is based only on a subset of the moments conditions and assigns equal weights to each of them. When moments is "fullweights", the second set of GM estimators is calculated. This estimator is based on the full set of moments.
conditions. It also involves the expression for the variance covariance matrix of the sample moments calculated under the assumption of normally distributed innovations. The calculation of the trace terms in the expression of the variance covariance matrix of the sample moments uses codes from the Matrix package. When moments is "weights", the third set of GM estimator is used. This is motivated by computational issues. The procedure is analogous to the second one but uses a simplified expression for the variance covariance matrix of the sample moments. If effects is "fixed", the initial estimator is a within estimator and the moments conditions of Kapoor et al. (2007) are modified accordingly.

Finally, when both spatial.error and lag are TRUE the complete model is estimated (with or without additional endogenous variables). OLS residuals are no longer consistent because of the spatially lagged dependent variable. If effects is "random", two initial estimators are computed: a within two-stage least squares and a between two stage least squares. The two sets of corresponding residuals are used in the spatial generalized moments estimator (GM) where the moments conditions of Kapoor et al. (2007) are again modified accordingly. If effects is "fixed", the initial estimator is a within two stage least squares estimator and the moments conditions of Kapoor et al. (2007) are modified accordingly.

Note that for the random effects models, \( \sigma^2_\mu \) is not reported. \( \sigma^2_1 \) is reported instead. However, a value for \( \sigma^2_\mu \) can easily be obtained from:

\[
\sigma^2_1 = \sigma^2_\nu + T \sigma^2_\mu
\]

The function also produces an estimate for \( \theta \) which is a function of the variance components.

**Value**

An object of class "splm".

- coefficients: GLS coefficients estimate of the model parameters
- vcov: the variance covariance matrix of the estimated coefficients
- residuals: the GLS residuals
- fitted.values: difference between response variable and residuals
- sigma2: GLS residuals variance
- type: 'a description of the model estimated'
- rho: a vector including the spatial parameter and the variance components (see Details)
- model: the matrix of the data used
- call: the call used to create the object

**Author(s)**

Gianfranco Piras

**References**


**Examples**

```r
library(splm)
library(plm)
data(Produc)
data(usaww)

# no space no endog: error use plm
## Not run: GM_lag_b2sls <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc, 
# lag = FALSE, spatial.error = FALSE, method = "b2sls", 
# listw = usaww)
## End(Not run)

# no space but endog
GM_b2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc, 
lag = FALSE, spatial.error = FALSE, endog = ~ log(pcap), 
method = "b2sls", 
instruments = ~log(hwy), listw = usaww)
summary(GM_b2sls_e)
GM_g2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc, 
lag = FALSE, spatial.error = FALSE, endog = ~ log(pcap), 
method = "g2sls", 
instruments = ~log(hwy), listw = usaww)
summary(GM_g2sls_e)
GM_ec2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc, 
lag = FALSE, spatial.error = FALSE, endog = ~ log(pcap), 
method = "ec2sls", 
instruments = ~log(hwy), listw = usaww)
summary(GM_ec2sls_e)
GM_w2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc, 
lag = FALSE, spatial.error = FALSE, endog = ~ log(pcap), 
method = "w2sls", 
instruments = ~log(hwy), listw = usaww)
summary(GM_w2sls_e)

# SPATIAL LAG MODEL

GM_lag_b2sls <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc, 
lag = TRUE, spatial.error = FALSE, method = "b2sls", 
listw = usaww)
summary(GM_lag_b2sls)
GM_lag_g2sls <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc, 
lag = TRUE, spatial.error = FALSE, method = "g2sls", 
listw = usaww)
```

spgm

summary(GM_lag_g2sls)
GM_lag_ec2sls <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = TRUE, spatial.error = FALSE, method = "ec2sls",
   listw = usaww)
summary(GM_lag_ec2sls)
GM_lag_w2sls <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = TRUE, spatial.error = FALSE,
   listw = usaww, method = "w2sls")
summary(GM_lag_w2sls)
#endogenous
GM_lag_b2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
   lag = TRUE,
   spatial.error = FALSE, endog = ~ log(pcap),
   method = "b2sls",
   instruments = -log(hwy), listw = usaww)
summary(GM_lag_b2sls_e)
GM_lag_g2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
   lag = TRUE,
   spatial.error = FALSE, endog = ~ log(pcap),
   method = "g2sls",
   instruments = -log(hwy), listw = usaww)
summary(GM_lag_g2sls_e)
GM_lag_ec2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
   lag = TRUE,
   spatial.error = FALSE, endog = ~ log(pcap),
   method = "ec2sls",
   instruments = -log(hwy), listw = usaww)
summary(GM_lag_ec2sls_e)
GM_lag_w2sls_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
   lag = TRUE,
   spatial.error = FALSE, endog = ~ log(pcap),
   method = "w2sls",
   instruments = -log(hwy), listw = usaww)
summary(GM_lag_w2sls_e)

############SPATIAL ERROR MODEL######
GM_error_within <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = FALSE, spatial.error = TRUE, model = "within",
   listw = usaww)
summary(GM_error_within)
GM_error_random <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = FALSE, spatial.error = TRUE, model = "random",
   listw = usaww)
summary(GM_error_random)
GM_error_within_fw <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = FALSE, spatial.error = TRUE, model = "within",
   listw = usaww, moments = "fullweights")
summary(GM_error_within_fw)
GM_error_random_w <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
   lag = FALSE, spatial.error = TRUE, model = "random",
   listw = usaww, moments = "fullweights")
summary(GM_error_random_w)
#endogenous
GM_error_within_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
    lag = FALSE,
    spatial.error = TRUE, endog = ~ log(pcap),
    model = "within",
    instruments = ~log(hwy), listw = usaww)
summary(GM_error_within_e)

GM_error_random_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
    lag = FALSE,
    spatial.error = TRUE, endog = ~ log(pcap),
    model = "random",
    instruments = ~log(hwy), listw = usaww)
summary(GM_error_random_e)

############SARAR MODEL############
GM_sarar_within <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
    lag = TRUE, spatial.error = TRUE, model = "within",
    listw = usaww)
summary(GM_sarar_within)

GM_sarar_random <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
    lag = TRUE, spatial.error = TRUE, model = "random",
    listw = usaww)
summary(GM_sarar_random)

GM_sarar_within_fw <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
    lag = TRUE, spatial.error = TRUE, model = "within",
    listw = usaww, moments = "fullweights")
summary(GM_sarar_within_fw)

GM_sarar_random_fw <- spgm(log(gsp) ~ log(pcap) + log(pc) + unemp, data=Produc,
    lag = TRUE, spatial.error = TRUE, model = "random",
    listw = usaww, moments = "fullweights")
summary(GM_sarar_random_fw)
#endogenous

GM_sarar_within_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
    lag = TRUE,
    spatial.error = TRUE, endog = ~ log(pcap),
    model = "within",
    instruments = ~log(hwy), listw = usaww)
summary(GM_sarar_within_e)

GM_sarar_random_e <- spgm(log(gsp) ~ log(pc) + unemp, data=Produc,
    lag = TRUE,
    spatial.error = TRUE, endog = ~ log(pcap),
    model = "random",
    instruments = ~log(hwy), listw = usaww)
summary(GM_sarar_random_e)

---

sphtest  

Hausman test for spatial panel data models

Description

Hausman specification test for spatial panel data models
Usage

sphtest(x, ...)  
## S3 method for class 'formula'
sphtest(x, data, index = NULL, listw, 
    spatial.model = c("lag", "error", "sarar"), 
    method = c("ML", "GM"), errors = c("KKP", "BSK"),...)  
## S3 method for class 'splm'
sphtest(x, x2, ...)

Arguments

x  
an object of class formula or splm

x2  
an object of class splm

data  
an object of class data.frame or pdata.frame. An optional data frame containing the variables in the model. When the object is a data.frame, the first two columns may contain the indexes. See index

index  
if not NULL (default), a character vector to identify the indexes among the columns of the data.frame

listw  
an object of class listw created for example by spdep::nb2listw

spatial.model  
one of c("lag","error","sarar"), the model to be estimated (only lag, only error, both lag and error dependence)

method  
one of c("ML","GM")

errors  
one of c("BSK","KPP"). When method is "ML" defines the specification of the innovations

...  
additional arguments to be passed

Value

an object of class htest

Author(s)

Gianfranco Piras

References


See Also

spgm
Examples

data(Produc, package="plm")
data(usaww)
fm <- log(gsp)~log(pcap)+log(pc)+log(emp)+unemp

```r
test1<-sphtest(fm, data=Produc, listw = spdep::mat2listw(usaww),
                 spatial.model = "error", method="GM")
test1

mod1<- spgm(fm, data=Produc, listw = usaww, model = "random",
            spatial.error = TRUE, moments="fullweights")
mod2<- spgm(fm, data=Produc, listw = usaww, model = "within",
            spatial.error = TRUE)

test2<-sphtest(mod1, mod2)
test2
```

spml

Spatial Panel Model by Maximum Likelihood

Description

Maximum likelihood (ML) estimation of spatial panel models, possibly with fixed or random effects.

Usage

```r
spml(formula, data, index=NULL, listw, listw2=listw, na.action,
      model=c("within","random","pooling"),
      effect=c("individual","time","twoways"),
      lag=FALSE, spatial.error=c("b","kkp","none"),
      ...)
```

```r
## S3 method for class 'splm_ML'
impacts(obj, listw = NULL,
         time = NULL, ...,
         tr = NULL, R = 200,
         type = "mult",
         empirical = FALSE, Q = NULL)
```

```r
## S3 method for class 'splm_GM'
impacts(obj, ..., tr=NULL,
         R=NULL, listw=NULL,
         type = "mult",
         time = NULL,
         evalues=NULL, tol=1e-6,
         empirical=FALSE, Q=NULL,
         KPformula = FALSE, prt = TRUE)
```

Arguments

- **formula**: a symbolic description of the model to be estimated
data  an object of class data.frame or pdata.frame. A data frame containing the variables in the model. When the object is a data.frame, the first two columns shall contain the indexes, unless otherwise specified. See index

index  if not NULL (default), a character vector to identify the indexes among the columns of the data.frame

listw  an object of class listw or a matrix. It represents the spatial weights to be used in estimation.

listw2  an object of class listw or a matrix. Second of set spatial weights for estimation, if different from the first (e.g., in a 'sarar' model).

na.action  see spdep for more details.

model  one of c("within", "random", "pooling").

effect  one of c("individual","time","twoways"); the effects introduced in the model.

lag  default=FALSE. If TRUE, a spatial lag of the dependent variable is added.

spatial.error  one of c("b", "kkp", "none"). The type of spatial error in the specification, if any. See details.

...  additional argument to pass over to other functions

obj  fitted model object

time  ?time??

tr  A vector of traces of powers of the spatial weights matrix created using 'trW', for approximate impact measures

R  If given, simulations are used to compute distributions for the impact measures, returned as 'mcmc' objects

type  Either "mult" (default) for powering a sparse matrix (with moderate or larger N, the matrix becomes dense, and may lead to swapping), or "MC" for Monte Carlo simulation of the traces (the first two simulated traces are replaced by their analytical equivalents), or "moments" to use the looping space saving algorithm proposed by Smirnov and Anselin (2009) - for "moments", 'W' must be symmetric, for row-standardised weights through a similarity transformation

empirical  Argument passed to 'mvrnorm' (default FALSE)

Q  default NULL, else an integer number of cumulative power series impacts to calculate if 'tr' is given

evalues  vector of eigenvalues of spatial weights matrix for impacts calculations

tol  Argument passed to 'mvrnorm'

KPformula  not yet implemented

prt  not yet implemented

Details

The models are estimated by two-step Maximum Likelihood. Further optional parameters to be passed on to the estimator may be: pvar: if TRUE the pvar function is called hess: if TRUE use numerical Hessian instead of GLS for the standard errors of the estimates quiet: if FALSE report
function and parameters values during optimization initval: one of c("zeros", "estimate"), the
initial values for the parameters. If "zeros" a vector of zeros is used. if "estimate" the initial
values are retrieved from the estimation of the nested specifications. Alternatively, a numeric vector
can be specified. x.tol: Tolerance. See \texttt{nlminb} for details. rel.tol: Relative tolerance. See \texttt{nlminb}
for details.

\textbf{Value}

An object of class "splm".

coefficients coefficients estimate of the model parameters
arcoef the coefficient for the spatial lag on y
errcomp the estimates of the error variance components
vcov the asymptotic variance covariance matrix of the estimated coefficients
vcov.arcoef the asymptotic variance of the estimated spatial lag parameter
vcov.errcomp the asymptotic variance covariance matrix of the estimated error covariance pa-
rameters
type 'random effects ML'
residuals the model residuals
fitted.values the fitted values, calculated as $\hat{y} = X\hat{\beta}$
sigma2 GLS residuals variance
model the matrix of the data used
call the call used to create the object
logLik the value of the log likelihood function at the optimum
errors the value of the \texttt{errors} argument

\textbf{Author(s)}

Giovanni Millo

\textbf{References}


\textbf{47}(1), 1–38. URL http://www.jstatsoft.org/v47/i01/.

\textbf{See Also}

spgm
Examples

data(Produc, package = "plm")
data(usaww)
fm <- log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp
## the two standard specifications (SEM and SAR) one with FE
## and the other with RE:
## fixed effects panel with spatial errors
fespaterr <- spml(fm, data = Produc, listw = spdep::mat2listw(usaww),
model="within", spatial.error="b", Hess = FALSE)
summary(fespaterr)
## random effects panel with spatial lag
respatlag <- spml(fm, data = Produc, listw = spdep::mat2listw(usaww),
model="random", spatial.error="none", lag=TRUE)
summary(respatlag)
## calculate impact measures
#impac1 <- impacts.splm(respatlag, listw = spdep::mat2listw(usaww, #style = "W"), time = 17)
#summary(impac1, zstats=TRUE, short=TRUE)

---

spreml

**Spatial Panel Model with Random Effects by Maximum Likelihood**

Description

Maximum likelihood (ML) estimation of spatial panel models with random effects and serial error correlation.

Usage

```
spreml(formula, data, index = NULL, w, w2=w, lag = FALSE,
errors = c("semsrre", "semsr", "srre", "semre",
"re", "sr", "sem", "ols", "sem2srre",
"sem2re", "semgre"),
pvar = FALSE, hess = FALSE, quiet = TRUE,
initval = c("zeros", "estimate"),
x.tol = 1.5e-18, rel.tol = 1e-15, ...)
```

Arguments

- `formula`: a symbolic description of the model to be estimated
- `data`: an object of class `data.frame` or `pdata.frame`. A data frame containing the variables in the model. When the object is a `data.frame`, the first two columns shall contain the indexes, unless otherwise specified. See `index`
- `index`: if not `NULL` (default), a character vector to identify the indexes among the columns of the `data.frame`
- `w`: an object of class `listw` or a matrix. It represents the spatial weights to be used in estimation.
spreml

w2 an object of class listw or a matrix. Second set of spatial weights for estimation, if different from the first (e.g., in a 'sarar' model).

lag default=FALSE. If TRUE, a spatial lag of the dependent variable is added.

errors Specifies the error covariance structure. See details.

pvar legacy parameter here only for compatibility.

hess default=FALSE. If TRUE estimate the covariance for beta_hat by numerical Hessian instead of GLS at optimal values.

quiet default=TRUE. If FALSE, report function and parameters values during optimization.

initval one of c("zeros", "estimate"), the initial values for the parameters. If "zeros" a vector of zeros is used. if "estimate" the initial values are retrieved from the estimation of the nested specifications. Alternatively, a numeric vector can be specified.

x.tol control parameter for tolerance. See nlmnb for details.

rel.tol control parameter for relative tolerance. See nlmnb for details.

... additional arguments to pass over to other functions, e.g. method.

Details

Second-level wrapper for estimation of random effects models with serial and spatial correlation. The specifications without serial correlation (no "sr" in errors) can be called through spml, the extended ones only through spreml. The models are estimated by two-step Maximum Likelihood. Abbreviations in errors correspond to: "sem" Anselin-Baltagi type spatial autoregressive error: if present, random effects are not spatially correlated; "sem2" Kapoor, Kelejian and Prucha-type spatial autoregressive error model with spatially correlated random effects; "sr" serially correlated remainder errors; "re" random effects; "ols" spherical errors (usually combined with lag=T). The optimization method can be passed on as optional parameter. Default is "nlminb"; all constrained optimization methods from maxLik are allowed ("BFGS", "NM", "SANN") but the latter two are still experimental.

Value

An object of class "splm".

coefficients coefficients estimate of the model parameters

arcoef the coefficient for the spatial lag on y

errcomp the estimates of the error variance components

vcov the asymptotic variance covariance matrix of the estimated coefficients

vcov.arcoef the asymptotic variance of the estimated spatial lag parameter

vcov.errcomp the asymptotic variance covariance matrix of the estimated error covariance parameters

type 'random effects ML'

residuals the model residuals

fitted.values the fitted values, calculated as \( \hat{y} = X \hat{\beta} \)
Method for summarizing the results of objects of class 'splm'

## S3 method for class 'splm'
summary(object, ...)

### Arguments

- **object**: an object of class 'splm'
- **...**: additional arguments to be passed
Details

The summary function `summary.splm` returns an object of class 'splm' organized in a coefficient matrix.

Also a matrix for the error components, or the spatial coefficients will be generated depending on the estimated model.

When the 'splm' is produced by the function 'spsegm', the summary will be generated looping over the number of equations in the system.

Value

An object of class 'summary.splm'

Author(s)

Giovanni Millo, Gianfranco Piras

See Also

spml, spgm

Examples

```r
data(Produc, package = "plm")
data(usaww)
GM <- spgm(log(gsp)~log(pcap)+log(pc)+log(emp)+unemp, data=Produc, listw=usaww, moments = "fullweights", spatial.error = TRUE)
summary(GM)
```

usaww  

Spatial weights matrix - US states

Description

Spatial weights matrix of the 48 continental US States based on the queen contiguity criterion.

Usage

```r
data(usaww)
```

Format

A matrix with elements different from zero if state i and j are neighbors. Weights are row standardized. According to the queen contiguity criterion, Arizona and Colorado are considered neighbours.

Author(s)

Giovanni Millo
vcov.splm  Covariance extractor method for splm objects

Description

Covariance extractor method for splm objects. Seldom used as such but needed, e.g., for interoperability with testing functions in lmtest and car.

Usage

## S3 method for class 'splm'
vcov(object, ...)

Arguments

  object  an object of class splm
  ...  additional arguments to be passed; currently not used

Value

  a covariance matrix of beta coefficients

Author(s)

Giovanni Millo

References


Examples

  ## not run:
  ## data(Produc, package="plm")
  ## data(usaww)
  ## fm <- log(gsp)-log(pcap)+log(pc)+log(emp)+unemp
  ## sarremod <- spml(fm, data=Produc, listw = spdep::mat2listw(usaww),
  ##   model="random", lag=TRUE, spatial.error="none")
  ## ## compact representation of betas
  ## library(lmtest)
  ## coeftest(sarremod)
  ## ## linear hypothesis test
  ## library(car)
  ## lht(sarremod, "log(pcap)=log(pc)")
Index

* datasets
  Insurance, 5
  itaww, 6
  RiceFarms, 8
  riceww, 9
  usaww, 28

* htest
  bsktest, 3
  rwtest, 10
  slmtest, 13
  sphtest, 20

* slag
  slag, 12

* spatial
  effects.splm, 4
  listw2dgCMatrix, 7
  print.splm, 7
  spgm, 15
  spml, 22
  spreml, 25
  summary.splm, 27

* vcov
  vcov.splm, 29

bsjktest, 2
bsktest, 3

effects.splm, 4

impacts(spml), 22
Insurance, 5
itaww, 6
ivspml(spgm), 15

listw2dgCMatrix, 7

print.effects.splm/effects.splm, 4
print.splm, 7

RiceFarms, 8

riceww, 9
rwtest, 10

slag, 12
slmtest, 13
sperrorgm(spgm), 15
spgm, 15
sphtest, 20
spml, 22
spreml, 25
spsarargm(spgm), 15
summary.splm, 27

usaww, 28

vcov.splm, 29