Package 'splm'

February 20, 2015

Title Econometric Models for Spatial Panel Data

Version 1.3-7

Date 2014-12-18

Description
ML and GM estimation and diagnostic testing of econometric models for spatial panel data.

Depends R (>= 2.12.0), spdep

Imports plm, maxLik, MASS, bdsmatrix, ibdreg, nlme, Matrix, spam

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LazyLoad yes

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Repository CRAN

Repository/R-Forge/Project splm

Repository/R-Forge/Revision 190

Repository/R-Forge/DateTimeStamp 2014-12-20 00:35:54

Date/Publication 2014-12-20 13:56:14

NeedsCompilation no

R topics documented:

`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. "C.3" is not implemented yet.
`...`	additional arguments to be passed

Value

an object of class `htest`

Author(s)

Giovanni Millo

References

Baltagi, B.H., Song, S.H., Jung B. and Koh, W. (2007) Testing panel data regression models with spatial and serial error correlation. *Journal of Econometrics*, **140**, 5-51.

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=TRUE, ...)
```

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)
...	additional arguments to be passed

Value

an object of class htest

Author(s)

Gianfranco Piras

References

Baltagi, B.H., Song, S.H. and Koh, W. (2003) Testing panel data regression models with spatial error correlation. *Journal of Econometrics*, **117**, 123–150.

Millo, G., Piras, G. (2012) splm: Spatial Panel Data Models in R. *Journal of Statistical Software*, **47(1)**, 1–38. URL http://www.jstatsoft.org/v47/i01/.

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 = mat2listw(usaww),
  test="LM1", standardize=TRUE)
```

---

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)

Author(s)

Gianfranco Piras

References

Elhorst, J.P. (2003) Specification and estimation of spatial panel data models, *International Regional Science Review*, **26**, pages 244–268.

Elhorst, J.P. (2009) Spatial panel data models, *In* Fischer, M.M. and Getis, A. (eds), *Handbook of Applied Spatial Analysis* Springer, Berlin.

See Also

`spml` `summary.effects.splm`

Examples

```
data(Produc, package = "plm")
data(usaww)
fm <- log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp
err <- spml(fm, data = Produc, listw = 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
rirs 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
inef 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

Giovanni Millo and Gaetano Carmeci, (2011) "Non-life insurance consumption in Italy: a sub-regional panel data analysis", *Journal of Geographical Systems*, **13:273–298**.

`itaww` *Spatial weights matrix - Italian provinces*

Description

Spatial weights matrix of the 103 Italian provinces as in 1992-2005.

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 *Interface between Matrix class objects and weights list*

Description

Interface between Matrix class objects and weights list

Usage

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

Arguments

listw	a listw object created for example by nb2listw
zero.policy	See lagsarlm for details

Value

Matrix class object: a sparse Matrix

Author(s)

Gianfranco Piras

Examples

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

print.splm *print method for class splm*

Description

Method to print objects of class summary.splm and splm

Usage

```
## 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 `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

`spml`, `spgm`

Examples

```
data(Produc, package = "plm")
data(usaww)
spremod<-spml(log(gsp)~log(pcap)+log(pc)+log(emp)+unemp, data=Produc,
listw = mat2listw(usaww), model="random", lag=TRUE, spatial.error="none")
summary(spremod)
```

RiceFarms *Production of Rice in Indonesia*

Description

A panel of 171 observations

number of observations : 1026

observation : farms

country : Indonesia

Usage

```
data(RiceFarms)
```

Format

A dataframe containing :

id the farm identifier

size the total area cultivated with rice, measured in hectares

status land status, on of `'owner'` (non sharecroppers, owner operators or leasholders 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 famer), `'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

totlabor total labor (excluding harvest labor)

wage labor wage in Rupiah per hour

goutput 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 six regions

Author(s)

Yves Croissant

Source

Qu Feng and William C. Horrace, (2012) "Alternative Measures of Technical Efficiency: Skew, Bias and Scale", *Journal of Applied Econometrics*, **forthcoming**.

`riceww` *Spatial weights matrix of Indonesian rice farms*

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

`slag` *Spatial lag operator*

Description

Spatial lagging method for vectors or `pseries` objects.

Usage

```
## S3 method for class 'pseries'
slag(x, listw, maxlag, ...)
```

Arguments

`x`	an object of class `pseries`
`listw`	an object of class `listw`
`maxlag`	the spatial lag order (including lower)
`...`	additional arguments to be passed

Value

a `pseries`

Author(s)

Giovanni Millo

Examples

```
data(Produc, package="plm")
data(usaww)
usalw <- 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")
```

spgm *GM estimation of spatial panel data models*

Description

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

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

$$u_N(t) = \rho W_N u_N(t) + \epsilon(t)$$

$$\epsilon_N = (e_T \otimes I_N)\mu_N + \nu_N$$

where ρ, and the variance components σ_μ^2 and σ_ν^2 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,
         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 obect 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
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 ρ 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 teh 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 weigths 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, σ_μ^2 is not reported. σ_1^2 is reported instead. However, a value for σ_μ^2 can easily be obtained from:

$$\sigma_1^2 = \sigma_\nu^2 + T\sigma_\mu^2$$

The function also produces an estimate for θ 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`	'random effect GM'
`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

Kapoor, M., Kelejian, H.H. and Prucha, I.R. (2007) Panel data model with spatially correlated error components, *Journal of Econometrics*, **140**, pages 97–130.

Mutl, J., and Pfaffermayr, M. (2011) The Hausman test in a Cliff and Ord panel model, *Econometrics Journal*, **14**, pages 48–76.

Kelejian, H.H. and Prucha, I.R. (1999) A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model, *International Economic Review*, **40**, pages 509–533.

Kelejian, H.H. and Prucha, I.R. (1999) A Generalized Spatial Two Stage Least Square Procedure for Estimating a Spatial Autoregressive Model with Autoregressive Disturbances, *Journal of Real Estate Finance and Economics*, **17**, pages 99–121.

Millo, G., Piras, G. (2012) splm: Spatial Panel Data Models in R. *Journal of Statistical Software*, **47(1)**, 1–38. URL http://www.jstatsoft.org/v47/i01/.

Examples

```
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)
```

---

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 obect 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 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

Millo, G., Piras, G. (2012) splm: Spatial Panel Data Models in R. *Journal of Statistical Software*, **47(1)**, 1–38. URL http://www.jstatsoft.org/v47/i01/.

See Also

spgm

Examples

```
data(Produc, package="plm")
data(usaww)
fm <- log(gsp)~log(pcap)+log(pc)+log(emp)+unemp
test1<-sphtest(fm,data=Produc, listw = 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

```
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"),
                ...)
```

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

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 retreived from the estimation of the nested specifications. Alternatively, a numeric vector can be specified. x.tol: Tolerance. See nlminb for details. rel.tol: Relative tolerance. See nlminb for details.

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 $\hat{y} = X\hat{\beta}$
`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 `errors` argument

Author(s)

Giovanni Millo

References

Baltagi, B.H., Song, S.H., Jung B. and Koh, W. (2007) Testing panel data regression models with spatial and serial error correlation. *Journal of Econometrics*, **140**, 5-51.

Millo, G., Piras, G. (2012) splm: Spatial Panel Data Models in R. *Journal of Statistical Software*, **47(1)**, 1–38. URL http://www.jstatsoft.org/v47/i01/.

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 = mat2listw(usaww),
                  model="within", spatial.error="b", Hess = FALSE)
summary(fespaterr)
## random effects panel with spatial lag
respatlag <- spml(fm, data = Produc, listw = mat2listw(usaww),
                  model="random", spatial.error="none", lag=TRUE)
summary(respatlag)
impac1 <- impacts(respatlag, listw = 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"),
          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.
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 retreived from the estimation of the nested specifications. Alternatively, a numeric vector can be specified.
x.tol	control parameter for tolerance. See nlminb for details.
rel.tol	control parameter for relative tolerance. See nlminb 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 $\hat{y} = X\hat{\beta}$
`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 `errors` argument

Author(s)

Giovanni Millo

References

Millo, G. (2014) Maximum likelihood estimation of spatially and serially correlated panels with random effects. *Computational Statistics and Data Analysis*, **71**, 914–933.

See Also

`spml`

Examples

```
data(Produc, package = "plm")
data(usaww)
fm <- log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp
## random effects panel with spatial lag and serial error correlation
## optimization method set to "BFGS"
sarsrmod <- spreml(fm, data = Produc, w = usaww, errors="sr", lag=TRUE,
                   method="BFGS")
summary(sarsrmod)
```

`summary.splm` *summary method for class splm*

Description

Method for summarizing the results of objects of class `'splm'`

Usage

```
## 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 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.

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

```
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 criterium.

Usage

```
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 criterium, 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

Zeileis, A. (2006) Object-Oriented Computation of Sandwich Estimators. *Journal of Statistical Software*, **16(9)**, 1-16.

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 = 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)")
```

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