Package ‘spfrontier’

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Author Dmitry Pavlyuk <Dmitry.V.Pavlyuk@gmail.com>
Maintainer Dmitry Pavlyuk <Dmitry.V.Pavlyuk@gmail.com>
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spfrontier-package  Spatial Stochastic Frontier

Description

Spatial Stochastic Frontier

Details

A set of tools for estimation (MLE) of various spatial specifications of stochastic frontier models

Author(s)

Dmitry Pavlyuk <Dmitry.V.Pavlyuk@gmail.com>

airports  European airports statistical data

Description

The spfrontier package includes the dataset airports, containing information about European airports infrastructure and traffic statistics in 2011.

Format

An unbalanced panel of 395 European airports in 2008-2012 (1763 observations) on the following 31 variables.

- **ICAO**: Airport ICAO code
- **AirportName**: Airport official name
- **Country**: Airport’s country name
- **longitude**: Airport longitude
- **latitude**: Airport latitude
- **Year**: Observation year
- **PAX**: A number of carried passengers
- **ATM**: A number of air transport movements served by an airport
- **Cargo**: A total volume of cargo served by an airport
- **Population100km**: A number of inhabitants, living in 100 km around an airport
- **Population200km**: A number of inhabitants, living in 200 km around an airport
- **Island**: 1 if an airport is located on an island; 0 otherwise
- **GDPpc**: Gross domestic product per capita in airport’s NUTS3 region
**RevenueTotal**  Airport total revenue  
**RevenueAviation**  Airport aviation revenue  
**RevenueNonAviation**  Airport non-aviation revenue  
**RevenueHandling**  Airport revenue from handling services  
**RevenueParking**  Airport revenue from parking services  
**EBITDA**  Airport earnings before interest, taxes, depreciation, and amortization  
**NetProfit**  Airport net profit  
**DA**  Airport depreciation, and amortization  
**StaffCount**  A number of staff employed by an airport  
**StaffCost**  Airport staff cost  
**RunwayCount**  A number of airport runways  
**CheckinCount**  A number of airport check-in facilities  
**GateCount**  A number of airport gates  
**TerminalCount**  A number of airport terminals  
**ParkingSpaces**  A number of airport parking spaces  
**RoutesDeparture**  A number of departure routes, served by an airport  
**RoutesArrival**  A number of arrival routes, served by an airport  
**Routes**  \((\text{RoutesDeparture} + \text{RoutesArrival})/2\)

**Source**


Airports’ statistical reports(2011)


TDC (2012). Informe de fiscalizacion de la imputacion por la entidad "Aeropuertos Espanoles y Navegacion Aerea" (AENA) a cada uno de los aeropuertos de los ingresos, gastos, e inversiones correspondientes a la actividad aeroportuaria, en los ejercicios 2009 y 2010., Tribunal de Cuentas, Spain, Doc 938.

Description

The spfrontier package includes the dataset airports, containing information about Greece airports infrastructure and traffic statistics in 2011.

Format

A dataframe with 39 observations on the following 24 variables.

- **name**  
  Airport title
- **ICAO_code**  
  Airport ICAO code
- **lat**  
  Airport latitude
- **lon**  
  Airport longitude
- **APM_winter**  
  A number of passengers carried during winter period
- **APM_summer**  
  A number of passengers carried during summer period
- **APM**  
  A number of passengers carried (winter + summer)
- **cargo_winter**  
  A total volume of cargo served by an airport during winter period
- **cargo_summer**  
  A total volume of cargo served by an airport during summer period
- **cargo**  
  A number volume of cargo served by an airport (winter + summer)
- **ATM_winter**  
  A number of air transport movements served by an airport during winter period
- **ATM_summer**  
  A number of air transport movements served by an airport during summer period
- **ATM**  
  A number of air transport movements served by an airport (winter + summer)
- **openning_hours_winter**  
  A total number openning hours during winter period
- **openning_hours_summer**  
  A total number openning hours during summer period
- **openning_hours**  
  A total number openning hours (winter + summer)
- **runway_area**  
  A total area of airport runways
- **terminal_area**  
  A total area of airport terminal(s)
- **parking_area**  
  A total area of airport parking area
- **island**  
  1 if an airpiort is located on an island; 0 otherwise
- **international**  
  1 if an airpiort is international; 0 otherwise
- **mixed_use**  
  1 if an airpiort is in mixed use; 0 otherwise
- **WLU**  
  A total volume of work load units (WLU) served by an airport
- **NearestCity**  
  A road network distance between an airport and its nearest city

Source

Description

genW generates a spatial contiguity matrix (rook or queen)
rowStdrt standardizes spatial contiguity matrix by rows
constructW constructs a spatial contiguity matrix using object longitude and latitude coordinates

Usage

genW(n, type = "rook", seed = NULL)
rowStdrt(W)
constructW(coords, labels)

Arguments

n a number of objects with spatial interaction to be arranged. See 'Details' for objects arranging principle
type an optional type of spatial interaction. Currently 'rook' and 'queen' values are supported, to produce Rook and Queen Contiguity matrix. See references for more info. By default set to rook.
seed an optional random number generator seed for random matrices
W a spatial contiguity matrix to be standartised
coords a matrix of two columns, where every row is a longitude-latitude pair of object coordinates
labels a vector of object labels to mark rows and columns of the resulting contiguity matrix

Details

To generate spatial interaction between n objects the function arranges them on a chess board. A number of columns is calculated as a square root of n, rounded to the top. The last row contains empty cells, if n is not quadratic

The function divides every element in an argument matrix by the sum of elements in its row. Some spatial estimation requires this standartisation (generally - for faster calculations)

The function constructs a spatial contiguity matrix using object longitude and latitude coordinates. Euclidean distance is currently used.

References

logLikelihood

Examples

# Completely filled 10x10 rook contiguity matrix
rookW <- genW(100)
rookW

# Partly filled 10x10 rook contiguity matrix
rookW <- genW(90)
rookW

# Completely filled 10x10 queen contiguity matrix
queenW <- genW(100, type="queen")
queenW

# Completely filled 10x10 queen contiguity matrix
queenW <- genW(100, type="queen")
queenW

# Standardisation
stQueenW <- rowStdrt(queenW)
stQueenW

data(airports)

W <- constructW(cbind(airports$lon, airports$lat), airports$ICAO_code)

logLikelihood Calculation of the log likelihood function for the spatial stochastic frontier model

Description

logLikelihood returns a value of the log likelihood function for the spatial stochastic frontier model

Usage

logLikelihood(
  formula,
  data,
  W_y = NULL,
  W_v = NULL,
  W_u = NULL,
  inefficiency = "half-normal",
  values,
  logging = c("quiet", "info", "debug"),
  costFrontier = F
)
Arguments

- **formula**: an object of class "formula"
- **data**: data frame, containing the variables in the model
- **W_y**: a spatial weight matrix for spatial lag of the dependent variable
- **W_v**: a spatial weight matrix for spatial lag of the symmetric error term
- **W_u**: a spatial weight matrix for spatial lag of the inefficiency error term
- **inefficiency**: sets the distribution for inefficiency error component. Possible values are 'half-normal' (for half-normal distribution) and 'truncated' (for truncated normal distribution). By default set to 'half-normal'.
- **values**: a vector of log likelihood function parameters
- **logging**: an optional level of logging. Possible values are 'quiet', 'warn', 'info', 'debug'. By default set to quiet.
- **costFrontier**: is designed for selection of cost or production frontier

Details

This function is exported from the package for testing and presentation purposes. A list of arguments of the function exactly matches the corresponding list of the `spfrontier` function.

Description

ModelEstimates stores information about MLE estimates of a spatial stochastic frontier model.

Usage

- `status(object)`
- `resultParams(object)`
- `hessian(object)`
- `stdErrors(object)`
- `efficiencies(object)`

## S4 method for signature 'ModelEstimates'
- `show(object)`

## S4 method for signature 'ModelEstimates'
- `coefficients(object)`
Arguments

object an object of ModelEstimates class

Details

ModelEstimates stores all parameter estimates and additional statistics, available after estimation of a spatial stochastic frontier model.

Slots

coefficients estimated values of model parameters
resultParams raw estimated values
status model estimation status:
  0 - Success
  1 - Failed; convergence is not achieved
  1000 - Failed; unexpected exception
  1001 - Failed; Initial values for MLE cannot be estimated
  1002 - Failed; Maximum likelihood function is infinite

logL value of the log-likelihood function
logLcalls information about a number of log-likelihood function and its gradient function calls
hessian Hessian matrix for estimated coefficients
RTEpaper

stdErrors standard errors of estimated coefficients
residuals model residuals
fitted model fitted values
efficiencies estimates of efficiency values for sample observations

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RTEpaper European airports statistical data (used for the RTE paper)

Description


Format

A dataframe with 39 observations on the following 24 variables.

- **ID**  
  Airport identifier
- **ICAO_code**  
  Airport ICAO code
- **Country**  
  Airport country
- **AirportName**  
  Airport title
- **latitude**  
  Airport latitude
- **longitude**  
  Airport longitude
- **Year**  
  Year of observation
- **PAX**  
  A number of passengers served by an airport
- **cargo**  
  A total volume of cargo served by an airport
- **Population100km**  
  A number of inhabitants, living in 100 km around an airport
- **Island**  
  1 if an airport is located on an island; 0 otherwise
- **SouthIsland**  
  1 if an airport is located on a European South island; 0 otherwise
- **Routes**  
  Number of routes, served by the airport
- **RunwayCount**  
  A number of airport runways
- **NUTS0**  
  NUTS0 region
- **NUTS1**  
  NUTS1 region
- **NUTS2**  
  NUTS2 region
- **NUTS3**  
  NUTS3 region
- **Tourists**  
  Number of tourists in airport’s NUTS2 region
- **Area**  
  Area of airport’s NUTS2 region
- **GDPpc**  
  Gross domestic product per capita in airport’s NUTS3 region
- **hub**  
  Hub status of the airport, based on the number of served routes
- **international**  
  International status of the airport
- **ownership**  
  Ownership of the airport - public, minor private, major private, private
- **RunwayLength**  
  Total length of the airport’s runways
spfrontier

Spatial stochastic frontier model

Description

spfrontier estimates spatial specifications of the stochastic frontier model.

Usage

spfrontier(
  formula,
  data,
  W_y = NULL,
  W_v = NULL,
  W_u = NULL,
  inefficiency = "half-normal",
  initialValues = "errorsarlm",
  logging = c("quiet", "info", "debug"),
  control = NULL,
  onlyCoef = F,
  costFrontier = F
)

Arguments

formula an object of class "formula": a symbolic description of the model to be fitted. The details of model specification are given under 'Details'.
data data frame, containing the variables in the model
W_y a spatial weight matrix for spatial lag of the dependent variable
W_v a spatial weight matrix for spatial lag of the symmetric error term
W_u a spatial weight matrix for spatial lag of the inefficiency error term
inefficiency sets the distribution for inefficiency error component. Possible values are 'half-normal' (for half-normal distribution) and 'truncated' (for truncated normal distribution). By default set to 'half-normal'. See references for explanations
initialValues an optional vector of initial values, used by maximum likelihood estimator. If not defined, estimator-specific method of initial values estimation is used.
logging an optional level of logging. Possible values are 'quiet', 'warn', 'info', 'debug'. By default set to quiet.
control an optional list of control parameters, passed to optim estimator from the 'stats' package
onlyCoef allows calculating only estimates for coefficients (with inefficiencies and other additional statistics). Developed generally for testing, to speed up the process.

costFrontier is designed for selection of cost or production frontier

Details

Models for estimation are specified symbolically, but without any spatial components. Spatial components are included implicitly on the base of the model argument.

References


Examples

data(airports)
airports2011 <- subset(airports, Year==2011)
W <- constructW(cbind(airports2011$longitude, airports2011$latitude),airports2011$ICAO)
formula <- log(PAX) ~ log(Population100km) + log(Routes) + log(GDPpc)
ols <- lm(formula , data=airports2011)
summary(ols)
plot(density(stats::residuals(ols)))
skewness(stats::residuals(ols))

# Takes >5 sec, see demo for more examples
# model <- spfrontier(formula , data=airports2011)
# summary(model )

# model <- spfrontier(formula , data=airports2011, W_y=W)
# summary(model )

spfrontier.true.value

Description

spfrontier.true.value returns true parameter values for a simulation process
ezsimspfrontier tests estimators of a spatial stochastic frontier model with different parameters

Usage

spfrontier.true.value()
ezsimspfrontier(runs,
spfrontier.true.value

params,
inefficiency = "half-normal",
logging = "info",
control = list()
)

Arguments

runs            a number of simulated samples
params          a set with parameters to be used in simulation.
inefficiency    sets the distribution for inefficiency error component. Possible values are 'half-
                normal' (for half-normal distribution) and 'truncated' (for truncated normal dis-
                tribution). By default set to 'half-normal'. See references for explanations
logging         an optional level of logging. Possible values are 'quiet','warn','info','debug'.
                 By default set to quiet.
control         an optional list of control parameters for simulation process. Currently the pro-
                 cedure supports:
                 ignoreWy (TRUE/FALSE) - the spatial contiguity matrix for a dependent vari-
                 able is not provided to spfrontier estimator (but used in DGP)
                 ignoreWv (TRUE/FALSE) - the spatial contiguity matrix for a symmetric error term is not
                 provided to spfrontier estimator (but used in DGP)
                 ignoreWu (TRUE/FALSE) - the spatial contiguity matrix for a inefficiency error term is not
                 provided to spfrontier estimator (but used in DGP)
                 parallel (TRUE/FALSE) - whether to use parallel computer seed - a state for random number generation in R. If NULL
                 (default), the initial state is random. See set.seed for details. auto_save - saves
                 intermediate results to files. See ezsim for details.

Details

The spfrontier.true.value function should notbe used directly, it is exported for supporting

The ezsimspfrontier function executes multiple calls of the spfrontier estimator on a simulated
data set, generated on the base of provided parameters. The resulting estimates can be analysed for
biasedness, efficiency, etc.

See Also

ezsim

Examples

params000 <- list(n=c(50, 100),beta0=5,
                  beta1=10,
                  beta2=1,
                  sigmaV=0.5,
                  sigmaU=2.5)
ctrl <- list(seed=999, cores=1)
res000 <- ezsimspfrontier(2, params = params000,
inefficiency = "half-normal",
logging = "info",
control=ctrl)

summary(res000)
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