Package ‘penppml’

January 3, 2022

Title Penalized Poisson Pseudo Maximum Likelihood Regression

Version 0.1.1

Description A set of tools that enables efficient estimation of penalized
Poisson Pseudo Maximum Likelihood regressions, using lasso or ridge penalties, for models
that feature one or more sets of high-dimensional fixed effects. The methodology is based on
Breinlich, Corradi, Rocha, Ruta, Santos Silva, and Zylkin (2021) <http://hdl.handle.net/10986/35451>
and takes advantage of the method of alternating projections of Gauré (2013)
<doi:10.1016/j.csda.2013.03.024> for dealing with HDFE, as well as
the coordinate descent algorithm of Friedman, Hastie and Tibshirani (2010)
<doi:10.18637/jss.v033.i01> for fitting lasso regressions. The package is also able to carry out
cross-validation and to implement the plugin lasso of Belloni, Chernozhukov, Hansen and Kozbur (2016)

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Author  Diego Ferreras Garrucho [aut],
         Tom Zylkin [aut],
         Nicolas Apfel [cre]

Maintainer  Nicolas Apfel <nicolas.apfel@gmail.com>

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**AtA**  
*Computing A'A*

**Description**  
Computes A'A using C++.

**Usage**  
AtA(A)

**Arguments**  
A  
A matrix.

---

**cluster_matrix**  
*Cluster-robust Standard Error Estimation*

**Description**  
cluster_matrix is a helper for computation of cluster-robust standard errors.

**Usage**  
cluster_matrix(e, cluster, x)

**Arguments**  
e  
Vector of residuals.  
cluster  
Vector of clusters.  
x  
Regressor matrix.

**Value**  
Gives the XeeX matrix.
collinearity_check  Checking for Perfect Multicollinearity

Description

collinearity_check checks for perfect multicollinearity in a model with high-dimensional fixed effects. It calls lfe::demeanlist in order to partial out the fixed effects, and then uses stats::lm.wfit to discard linearly dependent variables.

Usage

collinearity_check(y, x, fes, hdfetol)

Arguments

- **y**: Dependent variable (a numeric vector).
- **x**: Regressor matrix.
- **fes**: List of fixed effects.
- **hdfetol**: Tolerance for the centering, passed on to lfe::demeanlist.

Value

A numeric vector containing the variables that pass the collinearity check.

compute_fes  Fixed Effects Computation

Description

This function is a helper for xvalidate that computes FEs using PPML First Order Conditions (FOCs).

Usage

```r
compute_fes(
  y,
  fes,
  x,
  b,
  insample_obs = rep(1, n),
  onlymus = FALSE,
  tol = 1e-08,
  verbose = FALSE
)
```
countries

**Arguments**

- `y`: Dependent variable (a vector).
- `fes`: List of fixed effects.
- `x`: Regressor matrix.
- `b`: A vector of coefficient estimates.
- `insample_obs`: Vector of observations used to estimate the `b` coefficients.
- `onlymus`: Logical. If `TRUE`, returns only the conditional means.
- `tol`: A tolerance parameter.
- `verbose`: Logical. If `TRUE`, prints messages to the console while evaluating.

**Value**

If `onlymus = TRUE`, the vector of conditional means. Otherwise, a list with two elements:

- `mu`: conditional means.
- `fe_values`: fixed effects.

---

<table>
<thead>
<tr>
<th>countries</th>
<th>Country ISO Codes</th>
</tr>
</thead>
</table>

**Description**

An auxiliary data set with basic geographic information about country ISO 3166 codes included in the trade data set.

**Usage**

countries

**Format**

A data frame with 249 rows and 4 variables.

- `iso`: Country ISO 3166 code.
- `name`: Country name.
- `region`: Continent.
- `subregion`: sub-continental region.

**Source**

The source of the data set is Luke Duncalfe’s ISO-3166-Countries-with-Regional-Codes repository on GitHub ([https://github.com/lukes/ISO-3166-Countries-with-Regional-Codes#readme](https://github.com/lukes/ISO-3166-Countries-with-Regional-Codes#readme)).
eigenMatMult  Faster Matrix Multiplication

Description
Faster matrix multiplication using C++.

Usage
eigenMatMult(A, B)
eigenMapMatMult(A, B)

Arguments
A, B  Matrices.

fastolsCpp  Faster Least Squares Estimation

Description
Finds Least Squares solutions using C++.

Usage
fastolsCpp(X, y)

Arguments
X  Regressor matrix.
y  Dependent variable (a vector).

Value
The vector of parameter (beta) estimates.
fastridge

---

**Finding Ridge Regression Solutions**

**Description**

A wrapper around fastridgeCpp, for faster computation of the analytical solution for ridge regression.

**Usage**

```r
fastridge(x, y, weights = rep(1/n, n), lambda, standardize = TRUE)
```

**Arguments**

- `x`: Regressor matrix.
- `y`: Dependent variable (a numeric vector).
- `weights`: Vector of weights.
- `lambda`: Penalty parameter.
- `standardize`: Logical. If TRUE, x is standardized using the weights.

**Value**

A vector of coefficient (beta) estimates.

---

**Faster Ridge Regression**

**Description**

Finds Ridge solutions using C++.

**Usage**

```r
fastridgeCpp(X, y, lambda)
```

**Arguments**

- `X`: Regressor matrix.
- `y`: Dependent variable (a vector).
- `lambda`: Penalty parameter (a number).

**Value**

The vector of parameter (beta) estimates.
faststddev  

*Faster Standard Deviation*

**Description**

Computes standard deviation using C++.

**Usage**

`faststddev(X, w)`

**Arguments**

- `X`  
  Regressor matrix.
- `w`  
  Weights.

**Value**

Vector of standard deviations of the parameter estimates.

---

fastwmean  

*Faster Weighted Mean*

**Description**

Computes weighted mean using C++.

**Usage**

`fastwmean(X, w)`

**Arguments**

- `X`  
  Regressor matrix.
- `w`  
  Weights.

**Value**

Weighted mean.
**Generating a List of Fixed Effects**

**Description**

`genfes` generates a list of fixed effects by creating interactions of paired factors.

**Usage**

```r
genfes(data, inter)
```

**Arguments**

- `data`: A data frame including the factors.
- `inter`: A list: each element includes the variables to be interacted (both names and column

**Value**

A list containing the desired interactions of `vars`, with the same length as `inter`.

---

**Generating Model Structure**

**Description**

`genmodel` transforms a data frame into the needed components for our main functions (a y vector, a x matrix and a fes list).

**Usage**

```r
genmodel(
    data,
    dep = 1,
    indep = NULL,
    fixed = NULL,
    cluster = NULL,
    selectobs = NULL
)
```
Arguments

data A data frame containing all relevant variables.
dep A string with the name of the independent variable or a column number.
indep A vector with the names or column numbers of the regressors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.
fixed A vector with the names or column numbers of factor variables identifying the fixed effects, or a list with the desired interactions between variables in data.
cluster Optional. A string with the name of the clustering variable or a column number. It’s also possible to input a vector with several variables, in which case the interaction of all of them is taken as the clustering variable.
selectobs Optional. A vector indicating which observations to use.

Value

A list with four elements:

- y: y vector.
- x: x matrix.
- fes: list of fixed effects.
- cluster: cluster vector.

hdfeppml

PPML Estimation with HDFE

Description

hdfeppml fits an (unpenalized) Poisson Pseudo Maximum Likelihood (PPML) model with high-dimensional fixed effects (HDFE).

Usage

hdfeppml(
  data,  
  dep = 1,  
  indep = NULL,  
  fixed = NULL,  
  cluster = NULL,  
  selectobs = NULL,  
  ...  
)
Arguments

data | A data frame containing all relevant variables.
dep | A string with the name of the independent variable or a column number.
indep | A vector with the names or column numbers of the regressors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.
fixed | A vector with the names or column numbers of factor variables identifying the fixed effects, or a list with the desired interactions between variables in data.
cluster | Optional. A string with the name of the clustering variable or a column number. It’s also possible to input a vector with several variables, in which case the interaction of all of them is taken as the clustering variable.
selectobs | Optional. A vector indicating which observations to use (either a logical vector or a numeric vector with row numbers, as usual when subsetting in R).
... | Further options. For a full list, see `hdfeppml_int`.

Details

This function is a thin wrapper around `hdfeppml_int`, providing a more convenient interface for data frames. Whereas the internal function requires some preliminary handling of data sets (y must be a vector, x must be a matrix and fixed effects fes must be provided in a list), the wrapper takes a full data frame in the data argument, and users can simply specify which variables correspond to y, x and the fixed effects, using either variable names or column numbers.

More formally, `hdfeppml_int` performs iteratively re-weighted least squares (IRLS) on a transformed model, as described in Correia, Guimarães and Zylkin (2020) and similar to the ppm1hdfe package in Stata. In each iteration, the function calculates the transformed dependent variable, partials out the fixed effects (calling `collapse:fhdwithin`) and then solves a weighted least squares problem (using fast C++ implementation).

Value

A list with the following elements:

- coefficients: a 1 x ncol(x) matrix with coefficient (beta) estimates.
- residuals: a 1 x length(y) matrix with the residuals of the model.
- mu: a 1 x length(y) matrix with the final values of the conditional mean µ.
- deviance:
- bic: Bayesian Information Criterion.
- x_resid: matrix of demeaned regressors.
- z_resid: vector of demeaned (transformed) dependent variable.
- se: standard errors of the coefficients.
References


Examples

# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
test <- hdfepml(data = trade[, -(5:6)],
dep = "export",
fixed = list(c("exp", "time"),
            c("imp", "time"),
            c("exp", "imp")),
selectobs = (trade$imp %in% americas) & (trade$exp %in% americas))

hdfepml_int  PPML Estimation with HDFE

Description

hdfepml_int is the internal algorithm called by hdfepml to fit an (unpenalized) Poisson Pseudo Maximum Likelihood (PPML) regression with high-dimensional fixed effects (HDFE). It takes a vector with the dependent variable, a regressor matrix and a set of fixed effects (in list form: each element in the list should be a separate HDFE).

Usage

hdfepml_int(
    y,
    x,
    fes,
    tol = 1e-08,
hdfetol = 1e-04,
colcheck = TRUE,
    mu = NULL,
Arguments

- **y**: Dependent variable (a vector)
- **x**: Regressor matrix.
- **fes**: List of fixed effects.
- **tol**: Tolerance parameter for convergence of the IRLS algorithm.
- **hdfetol**: Tolerance parameter for the within-transformation step, passed on to `collapse::fhdwithin`.
- **colcheck**: Logical. If `TRUE`, checks for perfect multicollinearity in `x`.
- **mu**: Optional: initial values of the conditional mean \( \mu \), to be used as weights in the first iteration of the algorithm.
- **saveX**: Logical. If `TRUE`, it returns the values of `x` and `z` after partialling out the fixed effects.
- **init_z**: Optional: initial values of the transformed dependent variable, to be used in the first iteration of the algorithm.
- **verbose**: Logical. If `TRUE`, it prints information to the screen while evaluating.
- **maxiter**: Maximum number of iterations (a number).
- **cluster**: Optional: a vector classifying observations into clusters (to use when calculating SEs).
- **vcv**: Logical. If `TRUE` (the default), it returns standard errors.

Details

More formally, `hdfepml_int` performs iteratively re-weighted least squares (IRLS) on a transformed model, as described in Correia, Guimarães and Zylkin (2020) and similar to the `ppm1hdfe` package in Stata. In each iteration, the function calculates the transformed dependent variable, partials out the fixed effects (calling `collapse::fhdwithin`, which uses the algorithm in Gaure (2013)) and then solves a weighted least squares problem (using fast C++ implementation).

Value

A list with the following elements:

- **coefficients**: a 1 x `ncol(x)` matrix with coefficient (beta) estimates.
- **residuals**: a 1 x `length(y)` matrix with the residuals of the model.
- **mu**: a 1 x `length(y)` matrix with the final values of the conditional mean \( \mu \).
- **deviance**:
- **bic**: Bayesian Information Criterion.
• x_resid: matrix of demeaned regressors.
• z_resid: vector of demeaned (transformed) dependent variable.
• se: standard errors of the coefficients.

References


Examples

# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
trade <- trade[(trade$imp %in% americas) & (trade$exp %in% americas), ]
# Now generate the needed x, y and fes objects:
y <- trade$export
x <- data.matrix(trade[, -1:-6])
fes <- list(exp_time = interaction(trade$exp, trade$time),
imp_time = interaction(trade$imp, trade$time),
pair = interaction(trade$exp, trade$imp))
# Finally, the call to hdfeppml_int:
reg <- hdfeppml_int(y = y, x = x, fes = fes)

iceberg  

**Iceberg Lasso Implementation (in development)**

Description

A function performs standard plugin lasso PPML estimation (without fixed effects) for several dependent variables in a single step. This is still IN DEVELOPMENT; at the current stage, only coefficient estimates are provided and there is no support for clustered errors.

Usage

```
iceberg(data, dep, indep = NULL, selectobs = NULL, ...)
```
Arguments

data  
A data frame containing all relevant variables.

dep  
A string with the names of the independent variables or their column numbers.

indep  
A vector with the names or column numbers of the regresors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.

selectobs  
Optional. A vector indicating which observations to use (either a logical vector or a numeric vector with row numbers, as usual when subsetting in R).

...  
Further arguments, including:

  • tol: Tolerance parameter for convergence of the IRLS algorithm.
  • glmnettol: Tolerance parameter to be passed on to glmnet::glmnet.
  • penweights: Optional: a vector of coefficient-specific penalties to use in plugin lasso.
  • colcheck: Logical. If TRUE, checks for perfect multicollinearity in x.
  • K: Maximum number of iterations.
  • verbose: Logical. If TRUE, prints information to the screen while evaluating.
  • lambda: Penalty parameter (a number).
  • phipost: Logical. If TRUE, it carries out a post-lasso estimation with just the selected variables and reports the coefficients from this regression.

Details
This function enables users to implement the "iceberg" step in the two-step procedure described in Breinlich, Corradi, Rocha, Ruta, Santos Silva and Zylkin (2020). To do this after using the plugin method in mlfitppml, just select all the variables with non-zero coefficients in dep and the remaining regressors in indep. The function will then perform separate lasso estimation on each of the selected dependent variables and report the coefficients.

Value

A matrix with coefficient estimates for all dependent variables.

References


Examples

```r
iceberg_results <- iceberg(data = trade[, -(1:6)],
  dep = c("ad_prov_14", "cp_prov_23", "tbt_prov_07",
          "tbt_prov_33", "tf_prov_41", "tf_prov_45"),
  selectobs = (trade$time == "2016"))
```

---

**manyouter**

*Many Outer Products*

**Description**

Compute a large number of outer products (useful for clustered SEs) using C++.

**Usage**

```r
manyouter(A, B, c)
```

**Arguments**

- `A`, `B` Numeric vectors.
- `c` Integer.

---

**mlfitppml**

*General Penalized PPML Estimation*

**Description**

`mlfitppml` is a general-purpose wrapper function for penalized PPML estimation. This is a flexible tool that allows users to select:

- Penalty type: either lasso or ridge.
- Penalty parameter: users can provide a single global value for lambda (a single regression is estimated), a vector of lambda values (the function estimates the regression using each of them, sequentially) or even coefficient-specific penalty weights.
- Method: plugin lasso estimates can be obtained directly from this function too.
- Cross-validation: if this option is enabled, the function uses IDs provided by the user to perform k-fold cross-validation and reports the resulting RMSE for all lambda values.
Usage

```r
mlfitppml(
  data,
  dep = 1,
  indep = NULL,
  fixed = NULL,
  cluster = NULL,
  selectobs = NULL,
  ...
)
```

Arguments

- **data**: A data frame containing all relevant variables.
- **dep**: A string with the name of the independent variable or a column number.
- **indep**: A vector with the names or column numbers of the regressors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.
- **fixed**: A vector with the names or column numbers of factor variables identifying the fixed effects, or a list with the desired interactions between variables in `data`.
- **cluster**: Optional. A string with the name of the clustering variable or a column number. It's also possible to input a vector with several variables, in which case the interaction of all of them is taken as the clustering variable.
- **selectobs**: Optional. A vector indicating which observations to use (either a logical vector or a numeric vector with row numbers, as usual when subsetting in R).
- **...**: Further arguments, including:
  - **penalty**: A string indicating the penalty type. Currently supported: "lasso" and "ridge".
  - **method**: The user can set this equal to "plugin" to perform the plugin algorithm with coefficient-specific penalty weights (see details). Otherwise, a single global penalty is used.
  - **post**: Logical. If TRUE, estimates a post-penalty regression with the selected variables.
  - **xval**: Logical. If TRUE, cross-validation is performed using the IDs provided in the `IDs` argument as folds. Note that, by default, observations are assigned individual IDs, which makes the cross-validation algorithm very time-consuming.

For a full list of options, see `mlfitppml_int`.

Details

This function is a thin wrapper around `mlfitppml_int`, providing a more convenient interface for data frames. Whereas the internal function requires some preliminary handling of data sets (y must be a vector, x must be a matrix and `fes` must be provided in a list), the wrapper takes a full data frame in the `data` argument, and users can simply specify which variables correspond to y, x and the fixed effects, using either variable names or column numbers.
For technical details on the algorithms used, see hdpml (post-lasso regression), penhdpml (standard penalized regression), penhdpml_cluster (plugin lasso), and xvalidate (cross-validation).

Value

A list with the following elements:

- **beta**: if post = FALSE, a length(lambdas) x ncol(x) matrix with coefficient (beta) estimates from the penalized regressions. If post = TRUE, this is the matrix of coefficients from the post-penalty regressions.
- **beta_pre**: if post = TRUE, a length(lambdas) x ncol(x) matrix with coefficient (beta) estimates from the penalized regressions.
- **bic**: Bayesian Information Criterion.
- **lambdas**: vector of penalty parameters.
- **ses**: standard errors of the coefficients of the post-penalty regression. Note that these are only provided when post = TRUE.
- **rmse**: if xval = TRUE, a matrix with the root mean squared error (RMSE - column 2) for each value of lambda (column 1), obtained by cross-validation.
- **phi**: coefficient-specific penalty weights (only if method == "plugin").

References


Examples

```r
# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
# Now we can use our main functions on the reduced trade data set:
test <- mlfitppml(data = trade[, -(5:6)],
               dep = "export",
               fixed = list(c("exp", "time"),
                           c("imp", "time"),
                           c("exp", "imp")),
               selectobs = (trade$imp %in% americas) & (trade$exp %in% americas),
               lambdas = c(0.01, 0.001),
```
Description

`mlfitppml_int` is the internal wrapper called by `mlfitppml` for penalized PPML estimation. This in turn calls `penhdfeppml_int`, `penhdfeppml_cluster_int` and `hdfeppml_int` as needed. It takes a vector with the dependent variable, a regressor matrix and a set of fixed effects (in list form: each element in the list should be a separate HDFE). This is a flexible tool that allows users to select:

- Penalty type: either lasso or ridge.
- Penalty parameter: users can provide a single global value for lambda (a single regression is estimated), a vector of lambda values (the function estimates the regression using each of them, sequentially) or even coefficient-specific penalty weights.
- Method: plugin lasso estimates can be obtained directly from this function too.
- Cross-validation: if this option is enabled, the function uses IDs provided by the user to perform k-fold cross-validation and reports the resulting RMSE for all lambda values.

Usage

```r
mlfitppml_int(
  y,
  x,
  fes,
  lambdas,
  penalty = "lasso",
  tol = 1e-08,
  hdfetol = 1e-04,
  colcheck = TRUE,
  post = TRUE,
  cluster = NULL,
  method = "bic",
  IDs = 1:n,
  verbose = FALSE,
  xval = FALSE,
  standardize = TRUE,
  vcv = TRUE,
  penweights = NULL,
  K = 15
)
```
Arguments

- **y**: Dependent variable (a vector)
- **x**: Regressor matrix.
- **fes**: List of fixed effects.
- **lambdas**: Vector of penalty parameters.
- **penalty**: A string indicating the penalty type. Currently supported: "lasso" and "ridge".
- **tol**: Tolerance parameter for convergence of the IRLS algorithm.
- **hdfetol**: Tolerance parameter for the within-transformation step, passed on to `collapse::fhdwithin`.
- **colcheck**: Logical. If TRUE, checks for perfect multicollinearity in x.
- **post**: Logical. If TRUE, estimates a post-penalty regression with the selected variables.
- **cluster**: Optional: a vector classifying observations into clusters (to use when calculating SEs).
- **method**: The user can set this equal to "plugin" to perform the plugin algorithm with coefficient-specific penalty weights (see details). Otherwise, a single global penalty is used.
- **IDs**: A vector of fold IDs for k-fold cross validation. If left unspecified, each observation is assigned to a different fold (warning: this is likely to be very resource-intensive).
- **verbose**: Logical. If TRUE, it prints information to the screen while evaluating.
- **xval**: Logical. If TRUE, it carries out cross-validation.
- **standardize**: Logical. If TRUE, x variables are standardized before estimation.
- **vcv**: Logical. If TRUE (the default), the post-estimation model includes standard errors.
- **penweights**: Optional: a vector of coefficient-specific penalties to use in plugin lasso when method == "plugin".
- **K**: Maximum number of iterations for the plugin algorithm to converge.

Details

For technical details on the algorithms used, see `hdfepml_int` (post-lasso regression), `penhdfepml_int` (standard penalized regression), `penhdfepml_cluster_int` (plugin lasso), and `xvalidate` (cross-validation).

Value

A list with the following elements:

- **beta**: if post = FALSE, a `length(lambdas) x ncol(x)` matrix with coefficient (beta) estimates from the penalized regressions. If post = TRUE, this is the matrix of coefficients from the post-penalty regressions.
- **beta_pre**: if post = TRUE, a `length(lambdas) x ncol(x)` matrix with coefficient (beta) estimates from the penalized regressions.
- **bic**: Bayesian Information Criterion.
• lambdas: vector of penalty parameters.
• ses: standard errors of the coefficients of the post-penalty regression. Note that these are only provided when post = TRUE.
• rmse: if xval = TRUE, a matrix with the root mean squared error (RMSE - column 2) for each value of lambda (column 1), obtained by cross-validation.
• phi: coefficient-specific penalty weights (only if method == "plugin").

References


Examples

# First, we need to transform the data (this is what mlfitppml handles internally). Start by filtering the data set to keep only countries in the Americas:
Americas <- countries$iso[countries$region == "Americas"]
trade <- trade[(trade$imp %in% Americas) & (trade$exp %in% Americas)]
# Now generate the needed x, y and fes objects:
y <- trade$export
x <- data.matrix(trade[, -1:-6])

fes <- list(exp_time = interaction(trade$exp, trade$time),
imp_time = interaction(trade$imp, trade$time),
pair = interaction(trade$exp, trade$imp))
# Finally, we try mlfitppml_int with a lasso penalty (the default) and two lambda values:
reg <- mlfitppml_int(y = y, x = x, fes = fes, lambdas = c(0.1, 0.01))

# We can also try plugin lasso:
reg <- mlfitppml_int(y = y, x = x, fes = fes, cluster = fes$pair, method = "plugin")

# For an example with cross-validation, please see the vignette.
Description

`penhdfeppml` fits a penalized PPML regression for a given type of penalty and a given value of the penalty parameter. The penalty can be either lasso or ridge, and the plugin method can be enabled via the `method` argument.

Usage

```r
penhdfeppml(
  data, 
  dep = 1, 
  indep = NULL, 
  fixed = NULL, 
  cluster = NULL, 
  selectobs = NULL, 
  ... 
)
```

Arguments

- `data` A data frame containing all relevant variables.
- `dep` A string with the name of the independent variable or a column number.
- `indep` A vector with the names or column numbers of the regressors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.
- `fixed` A vector with the names or column numbers of factor variables identifying the fixed effects, or a list with the desired interactions between variables in `data`.
- `cluster` Optional. A string with the name of the clustering variable or a column number. It’s also possible to input a vector with several variables, in which case the interaction of all of them is taken as the clustering variable.
- `selectobs` Optional. A vector indicating which observations to use (either a logical vector or a numeric vector with row numbers, as usual when subsetting in R).
- `...` Further options, including:
  - `penalty`: A string indicating the penalty type. Currently supported: "lasso" and "ridge".
  - `method`: The user can set this equal to "plugin" to perform the plugin algorithm with coefficient-specific penalty weights (see details). Otherwise, a single global penalty is used.

For a full list of options, see `penhdfeppml_int`. 
penhdfeppml

Details

This function is a thin wrapper around penhdfeppml_int, providing a more convenient interface for data frames. Whereas the internal function requires some preliminary handling of data sets (y must be a vector, x must be a matrix and fes must be provided in a list), the wrapper takes a full data frame in the data argument, and users can simply specify which variables correspond to y, x and the fixed effects, using either variable names or column numbers.

More formally, penhdfeppml_int performs iteratively re-weighted least squares (IRLS) on a transformed model, as described in Breinlich, Corradi, Rocha, Ruta, Santos Silva and Zylkin (2021). In each iteration, the function calculates the transformed dependent variable, partials out the fixed effects (calling lfe::fhdwithin) and then calls glmnet::glmnet if the selected penalty is lasso (the default). If the user has selected ridge, the analytical solution is instead computed directly using fast C++ implementation.

For information on how the plugin lasso method works, see penhdfeppml_cluster.

Value

If method == "lasso" (the default), an object of class elnet with the elements described in glmnet, as well as:

- mu: a 1 x length(y) matrix with the final values of the conditional mean \( \mu \).
- deviance.
- bic: Bayesian Information Criterion.
- phi: coefficient-specific penalty weights (only if method == "plugin").
- x_resid: matrix of demeaned regressors.
- z_resid: vector of demeaned (transformed) dependent variable.

If method == "ridge", a list with the following elements:

- beta: a 1 x ncol(x) matrix with coefficient (beta) estimates.
- mu: a 1 x length(y) matrix with the final values of the conditional mean \( \mu \).
- deviance.
- bic: Bayesian Information Criterion.
- x_resid: matrix of demeaned regressors.
- z_resid: vector of demeaned (transformed) dependent variable.

References


**Examples**

```r
# To reduce run time, we keep only countries in the Americas:
Americas <- countries$iso[countries$region == "Americas"]
test <- penhdfeppml(data = trade[, -(5:6)],
                    dep = "export",
                    fixed = list(c("exp", "time"),
                                  c("imp", "time"),
                                  c("exp", "imp")),
                    lambda = 0.05,
                    selectobs = (trade$imp %in% Americas) & (trade$exp %in% Americas))
```

---

**penhdfeppml_cluster**  
*Plugin Lasso Estimation*

**Description**

Performs plugin lasso - PPML estimation with HDFE. This is an internal function, called by `mlfitppml` and `penhdfeppml` when users select the `method = "plugin"` option, but it's made available as a stand-alone option for advanced users who may prefer to avoid some overhead imposed by the wrappers.

**Usage**

```r
penhdfeppml_cluster(
  data = NULL,
  dep = 1,
  indep = NULL,
  fixed = NULL,
  cluster = NULL,
  selectobs = NULL,
  ...
)
```

**Arguments**

- **data**: A data frame containing all relevant variables.
- **dep**: A string with the name of the independent variable or a column number.
- **indep**: A vector with the names or column numbers of the regressors. If left unspecified, all remaining variables (excluding fixed effects) are included in the regressor matrix.
**penhdfepm_cluster**

- **fixed**: A vector with the names or column numbers of factor variables identifying the fixed effects, or a list with the desired interactions between variables in data.

- **cluster**: A string with the name of the clustering variable or a column number. It's also possible to input a vector with several variables, in which case the interaction of all of them is taken as the clustering variable. Note that this is **NOT OPTIONAL** in this case: our plugin algorithm requires clusters to be specified.

- **selectobs**: Optional. A vector indicating which observations to use (either a logical vector or a numeric vector with row numbers, as usual when subsetting in R).

  ... Further options. For a full list of options, see **penhdfepm_cluster_int**.

**Details**

This function is a thin wrapper around **penppml_cluster_int**, providing a more convenient interface for data frames. Whereas the internal function requires some preliminary handling of data sets (y must be a vector, x must be a matrix and fes must be provided in a list), the wrapper takes a full data frame in the data argument, and users can simply specify which variables correspond to y, x and the fixed effects, using either variable names or column numbers.

The plugin method uses coefficient-specific penalty weights that account for heteroskedasticity. The penalty parameters are calculated automatically by the function using statistical theory - for a brief discussion of this, see Breinlich, Corradi, Rocha, Ruta, Santos Silva and Zylkin (2021), and for a more in-depth analysis, check Belloni, Chernozhukov, Hansen, and Kozbur (2016), which introduced the specific implementation used in this package. Heuristically, the penalty parameters are set at a level high enough so that the absolute value of the score for each regressor must be statistically large relative to its standard error in order for the regressors to be selected.

**Value**

An object of class **elnet** with the elements described in **glmnet**, as well as the following:

- **mu**: a 1 x length(y) matrix with the final values of the conditional mean $\mu$.
- **deviance**.
- **bic**: Bayesian Information Criterion.
- **phi**: coefficient-specific penalty weights.
- **x_resid**: matrix of demeaned regressors.
- **z_resid**: vector of demeaned (transformed) dependent variable.

**References**


Examples

# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
test <- penhdfeppml_cluster(data = trade[, -(5:6)],
  dep = "export",
  fixed = list(c(\"exp\", \"time\"),
               c(\"imp\", \"time\"),
               c(\"exp\", \"imp\")),
  cluster = c("exp", "imp"),
  selectobs = (trade$imp %in% americas) & (trade$exp %in% americas),
  tol = 1e-5, hdfetol = 1e-1)

penhdfeppml_cluster_int

*Plugin Lasso Estimation*

Description

Performs plugin lasso - PPML estimation with HDFE. This is an internal function, called by mlfitppml_int and penhdfeppml_int when users select the method = "plugin" option, but it’s made available as a stand-alone option for advanced users who may prefer to avoid some overhead imposed by the wrappers.

Usage

penhdfeppml_cluster_int(
  y, x, fes, cluster,
  tol = 1e-08, hdfetol = 1e-04, glmnettol = 1e-12,
  penalty = "lasso", penweights = NULL, saveX = TRUE,
  mu = NULL, colcheck = TRUE, K = 15,
  init_z = NULL)
```r
post = FALSE,
verbose = FALSE,
lambda = NULL
)
```

**Arguments**

- **y**: Dependent variable (a vector)
- **x**: Regressor matrix.
- **fes**: List of fixed effects.
- **cluster**: Optional: a vector classifying observations into clusters (to use when calculating SEs).
- **tol**: Tolerance parameter for convergence of the IRLS algorithm.
- **hdfetol**: Tolerance parameter for the within-transformation step, passed on to `collapse::fhdwithin`.
- **glmnettol**: Tolerance parameter to be passed on to `glmnet::glmnet`.
- **penalty**: Only "lasso" is supported at the present stage.
- **penweights**: Optional: a vector of coefficient-specific penalties to use in plugin lasso when method == "plugin".
- **saveX**: Logical. If TRUE, it returns the values of x and z after partialling out the fixed effects.
- **mu**: Optional: initial values of the conditional mean \( \mu \), to be used as weights in the first iteration of the algorithm.
- **colcheck**: Logical. If TRUE, checks for perfect multicollinearity in x.
- **K**: Maximum number of iterations.
- **init_z**: Optional: initial values of the transformed dependent variable, to be used in the first iteration of the algorithm.
- **post**: Logical. If TRUE, estimates a post-penalty regression with the selected variables.
- **verbose**: Logical. If TRUE, it prints information to the screen while evaluating.
- **lambda**: Penalty parameter (a number).

**Details**

The plugin method uses coefficient-specific penalty weights that account for heteroskedasticity. The penalty parameters are calculated automatically by the function using statistical theory - for a brief discussion of this, see Breinlich, Corradi, Rocha, Ruta, Santos Silva and Zylkin (2021), and for a more in-depth analysis, check Belloni, Chernozhukov, Hansen, and Kozbur (2016), which introduced the specific implementation used in this package. Heuristically, the penalty parameters are set at a level high enough so that the absolute value of the score for each regressor must be statistically large relative to its standard error in order for the regressors to be selected.
Value

An object of class elnet with the elements described in glmnet, as well as the following:

- mu: a 1 x length(y) matrix with the final values of the conditional mean µ.
- deviance.
- bic: Bayesian Information Criterion.
- phi: coefficient-specific penalty weights.
- x_resid: matrix of demeaned regressors.
- z_resid: vector of demeaned (transformed) dependent variable.

References


Examples

```r
# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
trade <- trade[(trade$imp %in% americas) & (trade$exp %in% americas), ]
# Now generate the needed x, y and fes objects:
y <- trade$export
x <- data.matrix(trade[, -1:-6])
fes <- list(exp_time = interaction(trade$exp, trade$time),
imp_time = interaction(trade$imp, trade$time),
pair = interaction(trade$exp, trade$imp))
# Finally, we try penhdfeppml_cluster_int:
reg <- penhdfeppml_cluster_int(y = y, x = x, fes = fes, cluster = fes$pair)
```
**Description**

`penhdfeppml_int` is the internal algorithm called by `penhdfeppml` to fit a penalized PPML regression for a given type of penalty and a given value of the penalty parameter. It takes a vector with the dependent variable, a regressor matrix and a set of fixed effects (in list form: each element in the list should be a separate HDFE). The penalty can be either lasso or ridge, and the plugin method can be enabled via the `method` argument.

**Usage**

```
penhdfeppml_int(
  y,  # Dependent variable (a vector)
  x,  # Regressor matrix.
  fes,  # List of fixed effects.
  lambda,  # Penalty parameter (a number).
  tol = 1e-08,  # Tolerance parameter for convergence of the IRLS algorithm.
  hdfetol = 1e-04,  # Tolerance parameter for the within-transformation step, passed on to collapse::fhdwithin.
  glmnettol = 1e-12,  # Tolerance parameter to be passed on to glmnet::glmnet.
  penalty = "lasso",  # A string indicating the penalty type. Currently supported: "lasso" and "ridge".
  penweights = NULL,
  saveX = TRUE,
  mu = NULL,
  colcheck = TRUE,
  init_z = NULL,
  post = FALSE,
  verbose = FALSE,
  standardize = TRUE,
  method = "placeholder",
  cluster = NULL,
  debug = FALSE
)
```

**Arguments**

- `y` - Dependent variable (a vector)
- `x` - Regressor matrix.
- `fes` - List of fixed effects.
- `lambda` - Penalty parameter (a number).
- `tol` - Tolerance parameter for convergence of the IRLS algorithm.
- `hdfetol` - Tolerance parameter for the within-transformation step, passed on to collapse::fhdwithin.
- `glmnettol` - Tolerance parameter to be passed on to glmnet::glmnet.
- `penalty` - A string indicating the penalty type. Currently supported: "lasso" and "ridge".
penweights: Optional: a vector of coefficient-specific penalties to use in plugin lasso when `method == "plugin"`

saveX: Logical. If TRUE, it returns the values of x and z after partialling out the fixed effects.

mu: Optional: initial values of the conditional mean $\mu$, to be used as weights in the first iteration of the algorithm.

colcheck: Logical. If TRUE, checks for perfect multicollinearity in x.

init_z: Optional: initial values of the transformed dependent variable, to be used in the first iteration of the algorithm.

post: Logical. If TRUE, estimates a post-penalty regression with the selected variables.

verbose: Logical. If TRUE, it prints information to the screen while evaluating.

standardize: Logical. If TRUE, x variables are standardized before estimation.

method: The user can set this equal to "plugin" to perform the plugin algorithm with coefficient-specific penalty weights (see details). Otherwise, a single global penalty is used.

cluster: Optional: a vector classifying observations into clusters (to use when calculating SEs).

dump: Logical. If TRUE, this helps with debugging penalty weights by printing output of the first iteration to the console and stopping the estimation algorithm.

Details

More formally, `penhdfeppml_int` performs iteratively re-weighted least squares (IRLS) on a transformed model, as described in Breinlich, Corradi, Rocha, Ruta, Santos Silva and Zylkin (2020). In each iteration, the function calculates the transformed dependent variable, partials out the fixed effects (calling `collapse::fhdwithin`) and then and then calls `glmnet::glmnet` if the selected penalty is lasso (the default). If the user selects ridge, the analytical solution is instead computed directly using fast C++ implementation.

For information on the plugin lasso method, see `penhdfeppml_cluster_int`.

Value

If `method == "lasso"` (the default), an object of class `elnet` with the elements described in `glmnet`, as well as:

- `mu`: a 1 x `length(y)` matrix with the final values of the conditional mean $\mu$.
- `deviance`.
- `bic`: Bayesian Information Criterion.
- `phi`: coefficient-specific penalty weights (only if `method == "plugin"`.
- `x_resid`: matrix of demeaned regressors.
- `z_resid`: vector of demeaned (transformed) dependent variable.

If `method == "ridge"`, a list with the following elements:

- `beta`: a 1 x `ncol(x)` matrix with coefficient (beta) estimates.
• mu: a 1 x length(y) matrix with the final values of the conditional mean \( \mu \).
• deviance.
• bic: Bayesian Information Criterion.
• x_resid: matrix of demeaned regressors.
• z_resid: vector of demeaned (transformed) dependent variable.

References


Examples

# To reduce run time, we keep only countries in the Americas:
americas <- countries$iso[countries$region == "Americas"]
trade <- trade[(trade$imp %in% americas) & (trade$exp %in% americas), ]
# Now generate the needed x, y and fes objects:
y <- trade$export
x <- data.matrix(trade[, -1:-6])
fes <- list(exp_time = interaction(trade$exp, trade$time),
            imp_time = interaction(trade$imp, trade$time),
            pair = interaction(trade$exp, trade$imp))
# Finally, we try penhdfeppml_int with a lasso penalty (the default):
reg <- penhdfeppml_int(y = y, x = x, fes = fes, lambda = 0.1)

# We can also try ridge:
reg <- penhdfeppml_int(y = y, x = x, fes = fes, lambda = 0.1, penalty = "ridge")

Description

This is the internal function upon which the iceberg wrapper is built. It performs standard plugin lasso PPML estimation without fixed effects, relying on glmnet::glmnet. As the other internals in the package, it needs a y vector and an x matrix.
select_fes

Usage

```r
plugin_lasso_int(
  y,
  x,
  tol = 1e-08,
  glmnettol = 1e-12,
  penweights = NULL,
  colcheck = FALSE,
  K = 50,
  verbose = FALSE,
  lambda = NULL,
  phipost = FALSE
)
```

Arguments

- **y**: Dependent variable (a vector).
- **x**: Regressor matrix.
- **tol**: Tolerance parameter for convergence of the IRLS algorithm.
- **glmnettol**: Tolerance parameter to be passed on to `glmnet::glmnet`.
- **penweights**: Optional: a vector of coefficient-specific penalties to use in plugin lasso.
- **colcheck**: Logical. If `TRUE`, checks for perfect multicollinearity in `x`.
- **K**: Maximum number of iterations.
- **verbose**: Logical. If `TRUE`, prints information to the screen while evaluating.
- **lambda**: Penalty parameter (a number).
- **phipost**: Logical. If `TRUE`, it carries out a post-lasso estimation with just the selected variables and reports the coefficients from this regression.

Value

A list with 14 elements, including `beta`, which is the only one we use in the wrapper. For a full list, see `glmnet`.

select_fes

 Filtering fixed effect lists

Description

A helper function for `xvalidate` that filters a list of fixed effects and returns the modified list. Used to split the fixed effects for cross-validation.

Usage

```r
select_fes(fe_list, select_obs, list = TRUE)
```
`standardize_wt` (Weighted Standardization)

**Arguments**

- `fe_list` A list of fixed effects.
- `select_obs` A vector of selected observations/rows.
- `list` Logical. If `TRUE`, it returns a list. Otherwise, a data frame.

**Value**

A modified list of fixed effects.

---

---

**Description**

Performs weighted standardization of x variables. Used in fastridge.

**Usage**

```r
standardize_wt(x, weights = rep(1/n, n), intercept = TRUE, return.sd = FALSE)
```

**Arguments**

- `x` Regressor matrix.
- `weights` Weights.
- `intercept` Logical. If `TRUE`, adds an intercept.
- `return.sd` Logical. If `TRUE`, it returns standard errors for the means.

**Value**

If `return.sd == FALSE`, it gives the matrix of standardized regressors. If `return.sd == TRUE`, then it returns the vector of standard errors of the means of the variables.

---

**trade** (International trade agreements data set)

**Description**

A panel data set containing bilateral trade flows between 210 exporters and 262 importers between 1964 and 2016. The data set also contains information about trade agreements in force between country pairs, as well as 16 dummies for specific provisions in those agreements (a small selection from a broader data set).

**Usage**

```r
trade
```
Format

A data frame with 194,092 rows and 22 variables:

exp  Exporter country (ISO 3166 code)
imp  Importer country (ISO 3166 code).
time Year.
export Merchandise trade exports in USD.
id Agreement ID code.
agreement Agreement name.
ad_prov_14 Anti-dumping actions allowed and with specific provisions for material injury.
cp_prov_23 Does the agreement contain provisions that promote transparency?
tbt_prov_07 Technical Regulations - Is the use of international standards promoted?
tbt_prov_33 Does the agreement go beyond the TBT (Technical Barriers to Trade) Agreement?
tf_prov_41 Harmonization and common legal framework
tf_prov_45 Issuance of proof of origin
ser_prov_47 Does the agreement contain a standstill provision?
inv_prov_22 Does the agreement grant Fair and Equitable Treatment (FET)?
et_prov_38 Prohibits export-related performance requirements, subject to exemptions.
ipr_prov_44 Stipulates that GIs can be registered and protected through a TM system
env_prov_18 Does the agreement require states to control ozone-depleting substances?
ipr_prov_15 Incorporates/reaffirms all multilateral agreements to which both parties are a party (general obligation)
moc_prov_21 Does the transfer provision explicitly exclude “good faith and non-discriminatory application of its laws” related to bankruptcy, insolvency or creditor rights protection?
ste_prov_30 Does the agreement regulate subsidization to state enterprises?
lm_prov_10 Does the agreement include reference to internationally recognized labor standards?
cp_prov_26 Does the agreement regulate consumer protection?

Source

**XeeX Matrix Computation**

**Description**
Given matrix ee' and matrix X, compute X(k)ee'X(k) for each regressor X.

**Usage**
\[ xeex(X, e, S) \]

**Arguments**
- **X**: Regressor matrix.
- **e**: Residuals.
- **S**: Cluster sizes.

**Value**
The matrix product X(k)ee'X(k).

---

**xvalidate**

**Implementing Cross Validation**

**Description**
This is the internal function called by mlfitppml_int to perform cross-validation, if the option is enabled. It is available also on a stand-alone basis in case it is needed, but generally users will be better served by using the wrapper mlfitppml.

**Usage**
\[ xvalidate(y, x, fes, IDs, testID = NULL, tol = 1e-08, hdfetol = 1e-04, colcheck = TRUE, init_mu = NULL, init_x = NULL, init_z = NULL, verbose = FALSE, \]
cluster = NULL,
penalty = "lasso",
method = "placeholder",
standardize = TRUE,
penweights = rep(1, ncol(x_reg)),
lambda = 0
)

Arguments

y Dependent variable (a vector)
x Regressor matrix.
fes List of fixed effects.
IDs A vector of fold IDs for k-fold cross validation. If left unspecified, each observation is assigned to a different fold (warning: this is likely to be very resource-intensive).
testID Optional. A number indicating which ID to hold out during cross-validation. If left unspecified, the function cycles through all IDs and reports the average RMSE.
tol Tolerance parameter for convergence of the IRLS algorithm.
hdfetol Tolerance parameter for the within-transformation step, passed on to collapse::fhdwithin.
colcheck Logical. If TRUE, checks for perfect multicollinearity in x.
init_mu Optional: initial values of the conditional mean \( \mu \), to be used as weights in the first iteration of the algorithm.
init_x Optional: initial values of the independent variables.
init_z Optional: initial values of the transformed dependent variable, to be used in the first iteration of the algorithm.
verbose Logical. If TRUE, it prints information to the screen while evaluating.
cluster Optional: a vector classifying observations into clusters (to use when calculating SEs).
penalty A string indicating the penalty type. Currently supported: "lasso" and "ridge".
method The user can set this equal to "plugin" to perform the plugin algorithm with coefficient-specific penalty weights (see details). Otherwise, a single global penalty is used.
standardize Logical. If TRUE, x variables are standardized before estimation.
penweights Optional: a vector of coefficient-specific penalties to use in plugin lasso when method == "plugin".
lambda Penalty parameter, to be passed on to penhdfeppml_int or penhdfeppml_cluster_int.

Details

xvalidate carries out cross-validation with the user-provided IDs by holding out each one of them, sequentially, as in the k-fold procedure (unless testID is specified, in which case it just uses this ID for validation). After filtering out the holdout sample, the function simply calls penhdfeppml_int and penhdfeppml_cluster_int to estimate the coefficients, it predicts the conditional means for the held-out observations and finally it calculates the root mean squared error (RMSE).
Value

A list with two elements:

- `rmse`: root mean squared error (RMSE).
- `mu`: conditional means.

References


Examples

```r
# First, we need to transform the data. Start by filtering the data set to keep only countries in # the Americas:
americas <- countries$iso[countries$region == "Americas"]
trade <- trade[(trade$imp %in% americas) & (trade$exp %in% americas), ]
# Now generate the needed x, y and fes objects:
y <- trade$export
x <- data.matrix(trade[, -1:-6])
fes <- list(exp_time = interaction(trade$exp, trade$time),
            imp_time = interaction(trade$imp, trade$time),
            pair = interaction(trade$exp, trade$imp))
# We also need to create the IDs. We split the data set by agreement, not observation:
id <- unique(trade[, 5])
nfolds <- 10
unique_ids <- data.frame(id = id, fold = sample(1:nfolds, size = length(id), replace = TRUE))
cross_ids <- merge(trade[, 5, drop = FALSE], unique_ids, by = "id", all.x = TRUE)
# Finally, we try xvalidate with a lasso penalty (the default) and two lambda values:
reg <- xvalidate(y = y, x = x, fes = fes, lambda = 0.001,
                 IDs = cross_ids$fold, verbose = TRUE)
```
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