Package ‘effClust’

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Title  Calculate Effective Number of Clusters for a Linear Model

Version  0.8.0

Description  Calculates the (approximate) effective number of clusters for a regression model, as described in Carter, Schnepel, and Steigerwald (2017) <doi:10.1162/REST_a_00639>. The effective number of clusters is a statistic to assess the reliability of asymptotic inference when sampling or treatment assignment is clustered. Methods are implemented for stats::lm(), plm::plm(), and fixest::feols(). There is also a formula method.

Depends  R (>= 3.5.0)

Suggests  plm, data.table

Imports  fixest, stats

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NeedsCompilation  no

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**Description**

Specifically, for each coefficient the function returns the quantity $G^*A$, the feasible version of $G^*$, introduced by Carter, Schnepel, and Steigerwald (2017). $G^*A$ does not accommodate multi-way clustering.

**Usage**

```r
## Default S3 method:
effClust(
  object,
  cluster,
  tags = colnames(object),
  rho = 0.999,
  nominal = FALSE,
  XpXinv = NULL,
  ...
)

## S3 method for class 'fixest'

```r
effClust(
  object,
  cluster,
  include.only = NULL,
  exclude = NULL,
  fixed = FALSE,
  nominal = FALSE,
  rho = 0.999,
  ...
)
```

```r
## S3 method for class 'formula'

```r
effClust(
  object,
  cluster,
  data,
  subset = NULL,
  include.only = NULL,
  exclude = NULL,
  fixed = FALSE,
  nominal = FALSE,
  rho = 0.999,
  ...
)"
## S3 method for class 'lm'

```
effClust(
  object,
  cluster,
  include.only = NULL,
  exclude = NULL,
  fixed = FALSE,
  nominal = FALSE,
  rho = 0.999,
  ...
)
```

## S3 method for class 'plm'

```
effClust(
  object,
  cluster,
  include.only = NULL,
  exclude = NULL,
  fixed = FALSE,
  nominal = FALSE,
  rho = 0.999,
  ...
)
```

```
effClust(object, cluster, ...)
```

### Arguments

- **object**: a formula or an object of class "lm", "plm", "fixest" (with method "feols"), or (for the default method) a matrix of regressors.
- **cluster**: cluster identifier: a variable, a formula (see details), or, a length one character vector naming a variable in data.
- **tags**: a character vector containing a subset of the column names of object.
- **rho**: numeric scalar that changes assumed variance matrix (see details).
- **nominal**: logical indicating whether the number of clusters should be included as the first element of the return vector.
- **XpXinv**: the $k \times k$ matrix $(X'X)^{-1}$ where $X$ is a $n \times k$ matrix object for the default method.
- **include.only** and **exclude**
- **fixed**: logical indicates how regular expressions in exclude or include.only should be evaluated (as in grep).
When object is a formula, it does not need a response variable (left-hand side), but if the response variable might have different missing cases than the right-hand side, it should be included.

Cluster fixed effects, if any, may be explicitly included in the main formula, or be specified with the syntax used by fixest:

\[ \sim X_1 + X_2 + \text{factor}(id) \] (fixed effects \(id\) in main formula)

\[ \sim X_1 + X_2 \mid id \] (fixest way to specify fixed effects)

The first approach can be computationally demanding if there are too many units. Alternatively, data can contain appropriately transformed variables (see the example below).

For regression objects, when cluster is a formula or a one element character vector, it is evaluated in the context of the data used for the model, and the data and subset arguments are ignored.

The data argument is required when object is a formula. In this case, object is evaluated in the context of the data argument. If cluster is a formula or length 1 character vector, it is interpreted as the name of a column of data.

If cluster is a variable, its length must equal \(nobs(object)\) for regression objects or the number of rows in data when object is a formula. If cluster contains NA, a warning is issued.

By default \(G^{*A}\) is returned for all coefficients. The output may be limited by using include.only or exclude. This does not affect the computation for coefficients that are included, only the vector returned.

The regular expressions used by include only or exclude should refer to the contents of `names(coef(object))`, which might differ from how the regression formula refers to the same things. For example, groups of variables entered by using something like `factor(statefip) in the regression formula show up in the coefficient vector names looking like `factor(statefip)27`. They can be excluded en mass by the regular expression `exclude="^factor\(statefip\)"` (parentheses need to be escaped in a regular expression). Alternatively, you can specify `fixed=TRUE`, which has the same meaning as for `grep`.

Carter et al. recommend assuming every element of the variance matrix of errors in a cluster is 1, a conservative scenario. However, as explained in "A Note on Computation," the default \(\rho\) is 0.999, so that the variance matrix has 1 on the diagonal and 0.999 off the diagonal. It is possible to set \(\rho=1\), but that produces incorrect values in when there are cluster fixed effects. In other cases the computation is not very sensitive to the value of \(\rho\), so there is no appreciable difference between \(\rho=1\) and \(\rho=0.999\). MacKinnon, Nielsen, and Webb (2022) argue that cluster fixed effects usually remove much of the intra-cluster correlation, justifying \(\rho\) close to zero. (However, this is inconsistent with the “worst case scenario” approach that motivates Carter et al.’s recommendation.)

effClust will return a value for a glm object (or a formula intended for a GLM). The result might or might not be a useful diagnostic. On one hand, \(G^{*}\) is fundamentally about the characteristics of the clusters. On the other hand, the derivation by Carter et. al. is based on linear regression.

**Default method.** The default method is a bare-bones function that does the actual calculation of the effective number of clusters; it is mainly intended to be a tool for adding methods. It provides none of the error checking that is normally performed by the effClust methods.
The matrix object must have column names. It also must include a column of ones if the hypothetical regression includes an intercept.

If \(XpXinv\) is provided, it will be indexed using tags, so its row and column names must be identical to (or a superset of) tags.

If object cannot be coerced to numeric, the function will fail. Logical columns of object will be coerced to numeric, but factors will not be expanded to dummy variables as done by `model.matrix`.

Value

vector of effective number of clusters for coefficients.

References


Examples

```r
# some data with correlated errors
set.seed(85914270)
G <- 50
cl.sizes <- sample(10:100, G, replace=TRUE)
n <- sum(cl.sizes)
id <- rep(1:G, cl.sizes)
X1 <- rchisq(n, 5)
X2 <- ifelse(id %% 4 == 0, 1, 0)
e <- rnorm(n)
eg <- rep(rnorm(G), cl.sizes)
Y <- 1 + 2*X1 + 3*X2 - 1*X1*X2 + e + eg
d <- data.frame(Y, X1, X2, id)

f1 <- Y ~ X1 + X1:X2 + factor(id)
f2 <- Y ~ X1 + X1:X2 | id # fixest syntax

r <- lm(f1, data=d)

effClust(r, ~d$id, exclude=c("factor\(id\)\),"Intercept"))
effClust(f2, ~id, data=d)

library(data.table)
setDT(d)
d[, '.:='(X1dot = X1 - mean(X1),

X2dot = X2 - mean(X2),

X1X2dot = X1*X2 - mean(X1*X2)),

by = id]`
effClust(~ -1+X1dot+X1X2dot, cluster=~id, data=d)
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