Package ‘feisr’

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Title Estimating Fixed Effects Individual Slope Models
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Description Provides the function feis() to estimate fixed effects individual slope (FEIS) models. The FEIS model constitutes a more general version of the often-used fixed effects (FE) panel model, as implemented in the package ‘plm’ by Croissant and Millo (2008) <doi:10.18637/jss.v027.i02>. In FEIS models, data are not only person demeaned like in conventional FE models, but detrended by the predicted individual slope of each person or group. Estimation is performed by applying least squares lm() to the transformed data. For more details on FEIS models see Bruederl and Ludwig (2015, ISBN:1446252442); Frees (2001) <doi:10.2307/3316008>; Polachek and Kim (1994) <doi:10.1016/0304-4076(94)90075-2>; Ruettenauer and Ludwig (2020) <doi:10.1177/0049124120926211>; Wooldridge (2010, ISBN:0262294354). To test consistency of conventional FE and random effects estimators against heterogeneous slopes, the package also provides the functions feistest() for an artificial regression test and bsfeistest() for a bootstrapped version of the Hausman test.
Depends R (>= 3.4.0)
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Encoding UTF-8
LazyData true
RdMacros Rdpack
Imports aod, Formula, plm, Rdpack, stats, dplyr
Suggests texreg (>= 1.37.1), testthat, knitr, rmarkdown, ggplot2
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VignetteBuilder knitr
Description

The main purpose of the package feisr is the estimation of fixed effects individual slopes models and respective test statistics. The fixed effects individual slopes (FEIS) estimator is a more general version of the well-known fixed effects estimator (FE), which allows to control for heterogeneous slopes in addition to time-constant heterogeneity (Bruederl and Ludwig 2015; Ruettenauer and Ludwig 2020; Wooldridge 2010). This is done by running an \texttt{lm()} model on pre-transformed data, where we (1) estimate the individual-specific predicted values for the dependent variable and each covariate based on an individual intercept and the additional slope variables, (2) detrend the original data by these individual-specific predicted values, and (3) run an OLS model on the residual data. The package also provides two specification test for heterogeneous slopes (more details and examples can be found in Ruettenauer and Ludwig 2020).

Details

The main functions of the \texttt{feisr} package are:

- \texttt{feis()}: fixed effects individual slopes estimator by applying \texttt{lm} to detrended data.
- \texttt{feistest()}: regression-based Hausman test for fixed effects individual slope models.
- \texttt{bsfeistest()}: bootstrapped Hausman test for fixed effects individual slope models.
The functions included in the R package `feisr` are also available in the `xtfeis ado` (https://ideas.repec.org/c/boc/bocode/s458045.html) for Stata. The `plm-package` provides functions for estimation of related models, like the mean group (MG) or common correlated effects mean groups (CCEMG) estimator via `pmg` or models with variable coefficients via `pvcm`.

**Author(s)**

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Volker Ludwig

**References**


**See Also**

`plm`, `pvcm`, `pmg`

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### bsfeistest

*Bootstrapped Regression Test*

**Description**

Estimates a bootstrapped Hausman test for fixed effects individual slope models.

**Usage**

```r
bsfeistest(
  model = NA,
  type = c("all", "bs1", "bs2", "bs3"),
  terms = NULL,
  rep = 500,
  seed = NULL,
  prog = TRUE,
  ...
)
```
Arguments

model
an object of class "feis".

type
one of "all" (the Default), "bs1" for test of FEIS against FE only, "bs2" for test of FE against RE only, and "bs3" for test of FEIS against RE only (see also Details).

terms
An optional character vector specifying which coefficients should be jointly tested. By default, all covariates are included in the Wchi-squared test. For "type=art2", the slope variable is always included in "terms".

rep
the number of repetitions to be used in bootstrapping (default is 500).

seed
the seed used for random sampling in bootstrapping. Needs to be a valid integer. If not specified, the current seed is used.

prog
... logical. If TRUE (the Default) shows the progress in the output window.

... further arguments.

Details

The function computes a bootstrapped version of the Hausman test (Hausman 1978). Pairs cluster bootstrapping (Cameron et al. 2008; Ruettenauer and Ludwig 2020) is used to obtain the empirical variance-covariance matrix of the estimators, either for FEIS and conventional FE, convention FE and RE, or FEIS and RE.

type="bs1" estimates a bootstrapped Hausman test comparing fixed effects individual slope models and conventional fixed effects models. In this case, bsfeistest tests for inconsistency of the conventional FE model due to heterogeneous slopes. type="bs2" estimates a bootstrapped version of the well-known Hausman test comparing conventional fixed effects models against random effects models. type="bs3" estimates a bootstrapped Hausman directly comparing FEIS against RE, thereby testing for inconsistency of the RE model due to either heterogeneous slopes or time-constant omitted heterogeneity. Bootstrapping is performed by resampling with replacement while keeping the number of groups identical to the number of groups in the original dataset. wald.test is used to perform a Wald chi-squared test on the differences between coefficients.

Value

An object of class "feistest", containing the following elements:

wald_feis
an object of class "wald.test" (see wald.test) testing the fixed effects individual slopes model against the conventional fixed effects model (type="bs1").

wald_fe
an object of class "wald.test" (see wald.test) testing the fixed effects model against the random effects model (type="bs2").

wald_re
an object of class "wald.test" (see wald.test) testing the fixed effects individual slopes model against the random effects model (type="bs3").

vcov1
the empirical (bootstrapped) variance-covariance matrix of the coefficients obtained from FEIS and FE (type="bs1").

vcov2
the empirical (bootstrapped) variance-covariance matrix of the coefficients obtained from FE and RE (type="bs2").
bsfeistest

vcov3  the empirical (bootstrapped) variance-covariance matrix of the coefficients obtained from FEIS and RE (type="bs3").
bscoef.feis  a matrix containing the estimated FEIS coefficients of each bootstrap run.
bscoef.fe  a matrix containing the estimated FE coefficients of each bootstrap run.
bscoef.re  a matrix containing the estimated RE coefficients of each bootstrap run.
call  the matched call.
formula  an object of class "Formula" describing the model.
type  the type of performed test(s).
sample  a list containing the IDs sampled in each run.
seed  the seed used for bootstrapping.
terms  character vector of covariates are included in the Wchi-squared test.

References


See Also

summary.feistest, feistest, feis, plm, wald.test, phtest

Examples

data("mwp", package = "feisr")
## Not run:
feis.mod <- feis(lnw ~ marry + enrol | year,
    data = mwp, id = "id", robust = TRUE)
bsht <- bsfeistest(feis.mod, type = "bs1", rep = 100, seed = 1234)
summary(bsht)
## End(Not run)
### detrend

**Detrend data by individual slopes**

**Description**

Detrends the input data by the predicted values based on the slope parameters within each group specified by id. The result is equal to the transformed data used for estimation in `feis`.

**Usage**

```r
detrend(
  data,  
slopes,  
id = NULL,  
intercept = TRUE,  
na.action = c("na.exclude", "na.omit"),  
tol = .Machine$double.eps,
...  
)
```

**Arguments**

- `data` a data.frame, matrix, or vector of data to be detrended. If `id` and/or `slopes` are given as character (see below), must contain `id` and/or `slopes` as variable(s). Otherwise must be excluded.
- `slopes` a data.frame, matrix, or vector of slopes to be used for detrending, not containing an intercept. Optionally, a character vector of the names of slope variables in `data`. For pure de-meaning use "slopes = 1".
- `id` a vector of a unique group/person identifier. Optionally, a character of the name of the unique group/person identifier in `data`. For overall detrending, use "id = 1".
- `intercept` logical. If TRUE the slopes will contain an individual intercept (default is TRUE). For "id = 1", this is an overall intercept. Ignored if "slopes = 1".
- `na.action` character, either `na.exclude` (default) or `na.omit` indicates the use of NAs. `na.exclude` passes NAs through to the output (same length as input). `na.omit` drops NA rows (list-wise).
- `tol` the tolerance for detecting linear dependencies in the residual maker transformation (see `solve`).
- `...` further arguments.

**Details**

`detrend` performs within-group "residual maker" transformation on the origin data. Within each group, the predicted values of the columns in `data` are computed based on the slope columns plus an individual intercept if `intercept = TRUE` (the default). Subsequently the predicted values are subtracted from the origin data. The transformed data can, for instance, be used to obtain coefficients.
of a fixed effects individual slopes estimator via `lm` (Bruederl and Ludwig 2015; Ruettenauer and Ludwig 2020; Wooldridge 2010).

Estimation requires at least $q+1$ observations per unit, where $q$ is the number of slope parameters (including a constant). `detrend` automatically selects only those groups from the current data set which have at least $q+1$ observations, and returns NA for all groups with $n_i < q+1$.

NA values in the input data are handled by list-wise deletion based on the data to be detrended and the slopes.

Value

An object of class "data.frame" or "numeric (if only one data column), containing the detrended data with `row.names` equal to the `row.names` of the origin data. If input is an unnamed vector, names are 1:length.

References


See Also

feis

Examples

data("mwp", package = "feisr")

# Detrend entire data.frame
mwp_det <- detrend(data = mwp, slopes = c("exp", "expq"), id = "id")

# Detrend single variable
lnw_det <- detrend(data = mwp$lnw, slopes = mwp[, c("exp", "expq")], id = mwp$id)
Fixed Effects Individual Slope Estimator

**Description**

Estimates fixed effects individual slope estimators by applying linear `lm` models to "detrended" data.

**Usage**

```r
feis(
  formula,
  data,
  id,
  weights = NULL,
  robust = FALSE,
  intercept = FALSE,
  dropgroups = FALSE,
  tol = .Machine$double.eps,
  ...
)
```

```r
## S3 method for class 'Var'
feis(Var)
```

```r
## S3 method for class 'Var'
formula(Var,_lhs = NULL, rhs = NULL, ...)
```

```r
## S3 method for class 'Var'
terms(Var, lhs = NULL, rhs = NULL, ...)
```

```r
## S3 method for class 'Var'
residuals(object, ...)
```

```r
## S3 method for class 'Var'
df.residual(object, ...)
```

```r
## S3 method for class 'Var'
coef(object, ...)
```

```r
## S3 method for class 'Var'
sigma(object, ...)
```

```r
## S3 method for class 'Var'
deviance(object, ...)
```

```r
## S3 method for class 'Var'
nobs(object, ...)
```

```r
## S3 method for class 'Var'
fitted(object, ...)
```
## S3 method for class 'feis'
hatvalues(model, ...)

### Arguments

- **formula**: a symbolic description for the model to be fitted (see Details).
- **data**: a data.frame containing the specified variables.
- **id**: the name of a unique group / person identifier (as string).
- **weights**: an optional vector of weights to be used in the fitting process. See `lm`.
- **robust**: logical. If TRUE estimates cluster robust standard errors (default is FALSE).
- **intercept**: logical. If TRUE estimates the model with an intercept (default is FALSE).
- **dropgroups**: logical. If TRUE groups without any within variance on a slope variable are dropped, if FALSE those variables are omitted for the respective groups only (default is FALSE).
- **tol**: the tolerance for detecting linear dependencies in the residual maker transformation (see `solve`). The argument is forwarded to `bsfeistest`.
- **...**: further arguments.
- **lhs, rhs**: indexes of the left- and right-hand side for the methods formula and terms.
- **object, x, model**: an object of class "feis".

### Details

`feis` is a special function to estimate linear fixed effects models with individual-specific slopes. In contrast to conventional fixed effects models, data are not person "demeaned", but "detrended" by the predicted individual slope of each person (Bruederl and Ludwig 2015; Ruettenauer and Ludwig 2020; Wooldridge 2010).

Estimation requires at least \( q+1 \) observations per unit, where \( q \) is the number of slope parameters (including a constant). `feis` automatically selects only those groups from the current data set which have at least \( q+1 \) observations. The function returns a warning if units with \(<q+1\) observations are dropped.

The function requires a two-part formula, in which the second part indicates the slope parameter(s). If, for example, the model is \( y \sim x_1 + x_2 \), with the slope variables \( x_3 \) and \( x_4 \), the model can be estimated with:

- **formula** = \( y \sim x_1 + x_2 \mid x_3 + x_4 \)

To estimate a conventional fixed effects model without individual slopes, please use \( y \sim x_1 + x_2 \mid 1 \) to indicate that the slopes should only contain an individual-specific intercept.

If specified, `feis` estimates panel-robust standard errors. Panel-robust standard errors are robust to arbitrary forms of serial correlation within groups formed by `id` as well as heteroscedasticity across groups (see Wooldridge 2010, pp. 379-381).

The model output can be exported using the `texreg` package.
Value

An object of class "feis", containing the following elements:

- **coefficients**: the vector of coefficients.
- **vcov**: the scaled (if specified, robust) variance-covariance matrix of the coefficients. See `vcov.feis` for unscaled vcov.

- **residuals**: the vector of residuals (computed from the "detrended" data).
- **df.residual**: degrees of freedom of the residuals.
- **formula**: an object of class "Formula" describing the model.
- **model**: the original model frame as a data.frame containing the original variables used for estimation.
- **modelhat**: a constructed model frame as a data.frame containing the predicted values from the first stage regression using the slope variable(s) as predictor(s).
- **modeltrans**: a constructed model frame as a data.frame containing the "detrended" variables used for the final model estimation. Note that the weights are already used for detrending if specified.
- **response**: the vector of the "detrended" response variable.
- **fitted.values**: the vector of fitted values (computed from the "detrended" data).
- **id**: a vector containing the unique person identifier.
- **weights**: a vector containing weights used in fitting, or integer 1 if not specified in call.
- **call**: the matched call.
- **assign**: assign attributes of the formula.
- **na.omit**: (where relevant) a vector of the omitted observations. The only handling method of NAs is "omit".
- **contrasts**: (only where relevant) the contrasts used.
- **arg**: a list containing the used methods. Only "feis" and "individual" effects available.
- **slopevars**: a character vector containing the names of the slope variables.
- **r2**: R squared of the "detrended" model.
- **adj.r2**: adjusted R squared of the "detrended" model.
- **vcov_arg**: a character containing the method used to compute the variance-covariance matrix.
- **tol**: the tolerance parameter (for use in bsfeistest).

References


**See Also**

`summary.feis, plm, pvcm, pmg, feistest`

**Examples**

```r
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry + enrol + as.factor(yeargr) | exp + I(exp^2),
                   data = mwp, id = "id", robust = TRUE)
summary(feis.mod)
```

---

**feistest**  
*Artificial Regression Test*

**Description**

Estimates a regression-based Hausman test for fixed effects individual slope models.

**Usage**

```r
feistest(
  model = NA,  
  robust = FALSE,  
  type = c("all", "art1", "art2", "art3"),  
  terms = NULL,  
  ...
)
```

**Arguments**

- `model`  
  an object of class "feis".
- `robust`  
  logical. If TRUE uses cluster robust standard errors (Default is FALSE).
- `type`  
  one of "all" (the Default), "art1" for test of FEIS against FE only, "art2" for test of FE against RE only, and "art3" for test of FEIS against RE only (see also Details).
- `terms`  
  An optional character vector specifying which coefficients should be jointly tested. By default, all covariates are included in the Wchi-squared test. For "type=art2", the slope variable is always included in "terms".
- `...`  
  further arguments.
Details

The Hausman test can be computed by estimating a correlated random effects model (see Wooldridge 2010, pp. 328-334, Ruettenauer and Ludwig 2020). This is achieved by estimating a Mundlak (Mundlak 1978) specification using random effects models with \texttt{plm}. Subsequently, \texttt{feistest} tests whether the time-constant variables / slope variables are correlated with the unobserved heterogeneity by using a Wald chi-squared test with \texttt{wald.test}.

\texttt{type=}``art1`` estimates an extended regression-based Hausman test comparing fixed effects individual slope models and conventional fixed effects models. For \texttt{art1} the Mundlak-specification (Mundlak 1978) includes the person-specific averages, but additionally the person-specific slope estimates used for "detrending" in \texttt{feis}. This allows to test whether we can omit the estimated values based on the slopes and reduce the model to a conventional FE model. The Wald test of \texttt{type=}``art1`` is applied to the slope variables only. \texttt{type=}``art2`` estimates the conventional regression-based Hausman test (as described in Wooldridge 2010, pp. 328-334) comparing conventional fixed effects models against random effects models. \texttt{type=}``art3`` estimates a regression-based Hausman test comparing FEIS directly against RE, thereby testing for inconsistency of the RE model due to either heterogeneous slopes or time-constant omitted heterogeneity. For \texttt{art3} the Mundlak-specification includes only the person-specific slopes, and no averages. This allows to test whether we can omit the estimated values based on the slopes and reduce the model to a conventional RE model. (for a formal description please see Ruettenauer and Ludwig 2020).

Currently, the \texttt{tol} option in \texttt{feis()} is only forwarded in \texttt{bsfeistest}, but not in \texttt{feistest}. If specified (\texttt{robust=TRUE}), \texttt{feistest} uses panel-robust standard errors.

Value

An object of class "feistest", containing the following elements:

- \texttt{wald_feis} an object of class "wald.test" (see \texttt{wald.test}) testing the fixed effects individual slopes model against the conventional fixed effects model (\texttt{type=}``art1``).
- \texttt{wald_fe} an object of class "wald.test" (see \texttt{wald.test}) testing the fixed effects model against the random effects model (\texttt{type=}``art2``).
- \texttt{wald_re} an object of class "wald.test" (see \texttt{wald.test}) testing the fixed effects individual slopes model against the random effects model (\texttt{type=}``art3``).
- \texttt{vcov1} the variance-covariance matrix of CREIS (\texttt{type=}``art1``).
- \texttt{vcov2} the variance-covariance matrix of CRE (\texttt{type=}``art2``).
- \texttt{vcov3} the variance-covariance matrix of CREIS without the means (\texttt{type=}``art3``).
- \texttt{CREIS} an object of class "plm" (see \texttt{plm}) estimating a Correlated Random Effect Individual Slope model (\texttt{type=}``art1``).
- \texttt{CRE} an object of class "plm" (see \texttt{plm}) estimating a Correlated Random Effect model (\texttt{type=}``art2``).
- \texttt{CREIS2} an object of class "plm" (see \texttt{plm}) estimating a Correlated Random Effect Individual Slope model without including the covariates' means (\texttt{type=}``art3``).
- \texttt{call} the matched call.
- \texttt{robust} logical. If \texttt{TRUE} cluster robust standard errors were used (Default is \texttt{FALSE}).
- \texttt{formula} an object of class "Formula" describing the model.
- \texttt{type} the type of performed test(s).
- \texttt{terms} character vector of covariates are included in the Wchi-squared test.
References


See Also

- summary.feistest, bsfeistest, feis, plm, wald.test, phtest

Examples

```r
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry + enrol | year, 
                     data = mwp, id = "id", robust = TRUE)
ht <- feistest(feis.mod, robust = TRUE, type = "all")
summary(ht)
# Only for marry coefficient
ht2 <- feistest(feis.mod, robust = TRUE, type = "all", terms = c("marry"))
summary(ht2)
```

model.matrix.feis  

*model.matrix for feis objects*

Description

Methods to extract transformed model matrix for "feis" objects.

Usage

```r
## S3 method for class 'feis'
model.matrix(object, ...)
```

Arguments

- object: an object of class "feis".
- ...: further arguments.

Details

*model.matrix for feis objects* returns the model or design matrix of the respective FEIS model. This is the transformed (de-trended) data, which is used for estimation of the model in `lm()`.
model.response.feis

Value

An object of class "matrix" for model.matrix.

See Also

feis, model.matrix

Examples

data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry + as.factor(yeargr) | exp,
data = mwp, id = "id")
mm <- model.matrix(feis.mod)

model.response.feis(x, ...)

Arguments

x an object of class feis.
... further arguments.

Details

The function provides a convenient way to return the model.response of a feis object. This is the transformed (de-trended) variable which is used for estimation of the final model.

Value

A "numeric" of the transformed response variable of the estimation model.

Examples

data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry + enrol | year,
data = mwp, id = "id")
y_tilde <- model.response.feis(feis.mod)
Panel data including wages and family status

Description
A random sample from the National Longitudinal Survey of Youth (Bureau of Labor Statistics 2014). It contains information on wages, family status, and work experience for a random sample of men. For a description of the original dataset and variable construction see Ludwig and Bruederl (2018).

Usage

mwp

Format
A data frame with 3100 observations and 17 variables:

- **id**: unique person identifier
- **year**: survey year
- **lnw**: natural log of hourly wage rate
- **exp**: work experience in current job, in years
- **expq**: work experience in current job squared
- **marry**: family status (=0 if not married, =1 if married)
- **evermarry**: indicator if ever married (=0 if never married, =1 if married at some point)
- **enrol**: current enrollment in education (=0 not enrolled, =1 enrolled)
- **yeduc**: years of formal education
- **age**: respondents current age
- **cohort**: respondents birth cohort
- **yeargr1**: dummy indicating grouped year=1
- **yeargr2**: dummy indicating grouped year=2
- **yeargr3**: dummy indicating grouped year=3
- **yeargr4**: dummy indicating grouped year=4
- **yeargr5**: dummy indicating grouped year=5

Source
Ludwig and Bruederl (2018)
References


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**predict.feis**

*Predict method for feis models*

**Description**

Predicted values based on linear model object.

**Usage**

```r
## S3 method for class 'feis'
predict(
  object,
  newdata = NULL,
  se.fit = FALSE,
  vcov = NULL,
  interval = c("none", "confidence", "prediction"),
  level = 0.95,
  pred.var = sigma_sq,
  ...,
)
```

**Arguments**

- `object`: an object of class "feis", fitted model.
- `newdata`: an optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
- `se.fit`: a switch indicating if standard errors are required.
- `vcov`: optional variance-covariance matrix for std.err. calculation.
- `interval`: type of interval calculation.
- `level`: tolerance/confidence level.
- `pred.var`: the variance for future observations to be assumed for prediction intervals. By default, equals the residual variance.
- `...`: further arguments.
slopes

Details

predict.lm produces predicted values, obtained by evaluating the regression function in the frame newdata (which defaults to model.matrix(object)). If the logical se.fit is TRUE, standard errors of the predictions are calculated. If the vcov is not provided, the object$vcov is used, thus allowing for robust variance-covariance matrices. Setting intervals specifies computation of confidence or prediction (tolerance) intervals at the specified level.

Note: Currently, predictions are based on the transformed (de-trended) data.

Value

A vector of predictions or a matrix of predictions and bounds with column names fit, lwr, and upr if interval is set.

See Also

predict.lm, predict

Examples

feis.mod <- feis(lnw ~ age | exp,
data = mwp, id = "id", robust = TRUE)

new <- data.frame(age = seq(-10, 10, 1))
feis.pred <- predict(feis.mod, newdata = new,
                     se.fit = TRUE, interval = "confidence")

## Not run:
mtextplot(new$age, feis.pred$fit, lty = c(1,2,2),
           type = "l", ylab = "predicted y")

## End(Not run)

c________________________c
slopes Extract individual slopes
c________________________c

Description

Extracts the individual slopes (alpha_i) from a feis object created by feis.

Usage

slopes(model = NA, ...)

Arguments

model an object of class "feis".
... further arguments.
Details

The function extracts a matrix containing the individual slope parameters ($\alpha_i$), which equals the coefficient(s) of regressing the dependent variable on the slope parameter(s).

If slope variables are perfectly collinear within a cluster, one variable is dropped and the function returns 0 for the respective slope and cluster.

Value

An $N \times J$ matrix containing the individual slopes for each cluster unit $N$ and slope variable $J$. Row-names indicate the cluster id.

Examples

data("Produc", package = "plm")
feis.mod <- feis("log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp | year",
                 data = Produc, id = "state", robust = TRUE)
slps <- slopes(feis.mod)

summary.feis

Summary for feis objects

Description

The summary method for feis objects generates some additional information about estimated feis models.

Usage

## S3 method for class 'feis'
summary(object, vcov = NULL, ...)

## S3 method for class 'summary.feis'
print(
  x,
  digits = max(3,getOption("digits") - 2),
  width = getOption("width"),
  subset = NULL,
  ...
)

Arguments

- **object**: an object of class "feis".
- **vcov**: a variance-covariance matrix furnished by the user or a function to calculate one.
- **...**: further arguments.
x an object of class "summary.feis".
digits number of digits for printed output.
width the maximum length of the lines in the printed output.
subset a character or numeric vector indicating a subset of the table of coefficients to be printed.

Value
An object of class "summary.feis", containing the elements of the feis object (see `feis`). The object is forwarded to print method. The following objects are modified:

coefficients a matrix with the estimated coefficients, standard errors, t-values, and p-values, if argument vcov is NULL the standard errors are calculated by the vcov in the input object.
r.squared a vector containing R squared and adjusted R squared.

See Also
feis

Examples
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry | exp, data = mwp, id = "id")
summary(feis.mod)
## S3 method for class 'bsfeistest'
summary(object, ...)

## S3 method for class 'summary.bsfeistest'
print(
  x,
  digits = max(3,getOption("digits") - 2),
  width = getOption("width"),
  ...
)

### Arguments

- **object**: an object of class "feistest" or "bsfeistest".
- **...**: further arguments.
- **x**: an object of class "summary.feistest" or "summary.bsfeistest".
- **digits**: number of digits for printed output.
- **width**: the maximum length of the lines in the printed output.

### Value

An object of class "summary.feistest" or "summary.bsfeistest", equal to the original input object (see `feistest` and `bsfeistest`). The object is forwarded to print method.

### See Also

- `feistest`, `bsfeistest`

### Examples

```r
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry | exp,
  data = mwp, id = "id")
ht <- feistest(feis.mod, robust = TRUE, type = "all")
summary(ht)
```

---

### vcov.feis

**Calculate Variance-Covariance Matrix for feis models**

### Description

Returns the variance-covariance matrix of the main parameters of an object of class "feis". By default, this is the unscaled variance-covariance matrix.
Usage

```r
## S3 method for class 'feis'
vcov(object, ..., scale = FALSE)
```

Arguments

- `object`: an object of class "feis", fitted model.
- `...`: further arguments.
- `scale`: logical. If TRUE returns scaled vcov by sigma^2 (default is FALSE).

Details

By default, `vcov()` return the unscaled variance-covariance matrix of the fitted FEIS model. If set to `scale = TRUE`, the vcov is scaled by the nuisance parameter sigma^2 (as is `object$vcov`). Note that corrections for clustering (i.e. robust = TRUE in the fitted model) are ignored in `vcov()`. In this case, `object$vcov` will return the vcov with corrections for clustering.

Value

A matrix of the estimated covariances between the parameter estimates in the fitted FEIS model.

See Also

- `feis`
- `vcov`
- `sigma`

Examples

```r
data("mwp", package = "feis")
feis.mod <- feis(lnw ~ marry + enrol | exp,
    data = mwp, id = "id")
vcov(feis.mod)
all.equal(vcov(feis.mod), feis.mod$vcov) # FALSE: not equal, because vcov() unscaled
all.equal(vcov(feis.mod, scale = TRUE), feis.mod$vcov) # equal
```
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