Package 'feisr'

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Title Estimating Fixed Effects Individual Slope Models

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Author Tobias Ruettenauer [aut, cre],
Volker Ludwig [aut]

Maintainer Tobias Ruettenauer <ruettenauer@sowi.uni-kl.de>

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>; 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)

License GPL (>= 2)

Encoding UTF-8

LazyData true

RdMacros Rdpack

Imports aod, Formula, plm, Rdpack, stats

Suggests texreg, testthat

RoxygenNote 6.1.1

NeedsCompilation no

R topics documented:

`bsfeistest` *Bootstrapped Regression Test*

Description

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

Usage

```
bsfeistest(model = NA, type = c("all", "bs1", "bs2", "bs3"),
  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).
`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) 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 Hausmann test comparing fixed effects individual slope models and conventional fixed effects models. In this case, `bsfeistest` tests for inconsistency of the convetional FE model due to heterogeneous slopes. `type="bs2"` estimates a bootstrapped version of the well-known Hausmann 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 perfomed 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").
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.

References

Cameron AC, Gelbach JB, Miller DL (2008). "Bootstrap-Based Improvements for Inference with Clustered Errors." *Review of Economics and Statistics*, **90**(3), 414–427. ISSN 0034-6535, doi: 10.1162/rest.90.3.414.

Hausman JA (1978). "Specification Tests in Econometrics." *Econometrica*, **46**(6), 1251–1271. ISSN 00129682.

See Also

feis, feistest, plm, wald.test, phtest

Examples

```
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry + enrol | year,
                 data = mwp, id = "id", robust = TRUE)
bsht <- bsfeistest(feis.mod, type = "bs1", rep = 5, seed = 1234, prog = FALSE)
summary(bsht)
```

feis *Fixed Effects Individual Slope Estimator*

Description

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

Usage

```
feis(formula, data, id, robust = FALSE, intercept = FALSE,
  dropgroups = FALSE, ...)
```

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).
`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`).
`...`	further arguments.

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; 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 ~ x1 + x2`, with the slope variables `x3` and `x4`, the model can be estimated with:

- `formula = y ~ x1 + x2 | x3 + x4`

If the second part is not specified (and individual "slopes" are estimated only by an intercept), the model reduces to a conventional fixed effects (within) model. In this case please use the well-established `plm` (`model="within"`) function instead of `feis`.

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).

Value

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

coefficients	the vector of coefficients.
vcov	the variance-covariance matrix of the coefficients.
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 and the untransformed slope variables.
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.
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.

References

Bruederl J, Ludwig V (2015). "Fixed-Effects Panel Regression." In Best H, Wolf C (eds.), *The Sage Handbook of Regression Analysis and Causal Inference*, 327–357. Sage, Los Angeles. ISBN 1446252442.

Wooldridge JM (2010). *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, Mass. ISBN 0262294354.

See Also

plm, feistest

Examples

```
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 Hausmann test for fixed effects individual slope models.

Usage

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

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).
`...`	further arguments.

Details

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

`type="art1"` estimates an extended regression-based Hausmann test comparing fixed effects individual slope models and conventional fixed effects models. For `art1` the Mundlak-specification (Mundlak 1978) includes the person-specific averages, but additionally the person-specific slope estimates used for "detrending" in `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 `type="art1"` is applied to the slope variables only. `type="art2"` estimates the conventional regression-based Hausmann test (as described in Wooldridge 2010, pp. 328-334) comparing conventional fixed effects models against random effects models. `type="art3"` estimates a regression-based Hausmann 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 `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.

If specified (`robust=TRUE`), `feistest` uses panel-robust standard errors.

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="art1"`).

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

References

Mundlak Y (1978). "On the Pooling of Time Series and Cross Section Data." *Econometrica*, **46**(1), 69. ISSN 00129682.

Wooldridge JM (2010). *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, Mass. ISBN 0262294354.

See Also

feis, bsfeistest, plm, wald.test, phtest

Examples

```
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)
```

---

mwp — *Panel data including wages and family status*

Description

A random sample from the National Longitudinal Survey of Youth (NLSY79 2012). 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 erolment in education (=0 not enroled, =1 enroled)

yeduc years of formal education

age respondents current age

cohort respondents birth cohort

yeargr grouped year (1=1979-1980, 2=1981-1985, 3=1986-1990, 4=1991-1995, 5=1996-2000)

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

Ludwig V, Bruederl J (2018). "Is There a Male Marital Wage Premium? New Evidence from the United States." *American Sociological Review*, **83**(4), 744–770. ISSN 0003-1224, doi: 10.1177/0003122418784909.

NLSY79 (2012). *National Longitudinal Survey of Youth 1979 Cohort, 19792012*. Bureau of Labor Statistics, U.S. Department of Labor.

`slopes` *Extract individual slopes*

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 depenent 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 x J matrix containing the individual slopes for each cluster unit N and slope variable J. Rownames 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, ...)
```

Arguments

object	an object of class "plm".
vcov	a variance-covariance matrix furnished by the user or a function to calculate one.
...	further arguments.

Value

An object of class "summary.feis", containing the elements of the feis object (see feis). 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.

Examples

```
data("mwp", package = "feisr")
feis.mod <- feis(lnw ~ marry | exp,
                 data = mwp, id = "id")
summary(feis.mod)
```

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