# Package 'feisr'

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**Title** Estimating Fixed Effects Individual Slope Models

**Version** 0.0.0.9100

**URL** https://github.com/ruettenauer/feisr

**BugReports** https://github.com/ruettenauer/feisr/issues

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**Description** Provides a function to estimate fixed effects individual slope models.

**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** 6.0.1

## 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, Gelbach, and Miller 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, doi: 10.2307/1913827.

## See Also

feis, feistest, plm, wald.test, phtest

## Examples

```
data("Produc", package = "plm")
feis.mod <- feis(log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp | year,
                 data = Produc, id = "state", robust = TRUE)
bsht <- bsfeistest(feis.mod, type = "all", rep = 10, seed = 1234)
summary(bsht)
```

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# extract.feis *Extract method for* feis*-class*

---

## Description

Provides an extract method for usage of texreg with feis-class.

## Usage

```
extract.feis(model, include.rsquared = TRUE, include.adjrs = TRUE,
  include.nobs = TRUE, include.groups = TRUE, include.rmse = TRUE, ...)
```

### Arguments

| | |
|---|---|
| model | an object of class feis |
| include.rsquared | logical. If TRUE (default) R squared is reported. |
| include.adjrs | logical. If TRUE (default) adjusted R squared is reported. |
| include.nobs | logical. If TRUE number of observations is reported. |
| include.groups | logical. If TRUE number of groups is reported. |
| include.rmse | logical. If TRUE RMSE is reported. |
| ... | further arguments. |

### See Also

texreg, screenreg

### Examples

```
library(texreg)

setMethod("extract", signature = className("feis", "feisr"),
definition = extract.feis)

data("Produc", package = "plm")
feis1.mod <- feis("log(gsp) ~ log(pcap) | year",
                  data = Produc, id = "state", robust = TRUE)
feis2.mod <- feis("log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp | year",
                  data = Produc, id = "state", robust = TRUE)
screenreg(list(feis1.mod, feis2.mod))
```

---

## 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 indivdiual 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("Produc", package = "plm")
feis.mod <- feis("log(gsp) ~ log(pcap) + log(pc) + log(emp) + unemp | year",
                 data = Produc, id = "state", 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, doi: 10.2307/1913646.

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

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`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. |

# Index