Package: fect (via r-universe)

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Type Package

Title Fixed Effects Counterfactuals

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Maintainer Ziyi Liu <zyliu2020@uchicago.edu>

Description Estimates causal effects with panel data using the counterfactual methods. It is suitable for panel or time-series cross-sectional analysis with binary treatments under (hypothetically) baseline randomization.It allows a treatment to switch on and off and limited carryover effects. It supports linear factor models, a generalization of gsynth and the matrix completion method. Implementation details can be found in Liu, Wang and Xu (2022) <arXiv:2107.00856>.

URL https://yiqingxu.org/packages/fect/articles/tutorial.html

NeedsCompilation yes

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Imports Rcpp (>= 0.12.3), ggplot2 (>= 2.1.0), GGally (>= 1.0.1), doParallel (>= 1.0.10), foreach (>= 1.4.3), abind (>= 1.4-0), MASS, gridExtra, grid, fixest, doRNG, future, panelView, mvtnorm

SystemRequirements A C++11 compiler.

Depends R (>= 3.5.0)

LinkingTo Rcpp, RcppArmadillo

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Author Licheng Liu [aut], Ziyi Liu [aut, cre], Ye Wang [aut], Yiqing Xu [aut] (<https://orcid.org/0000-0003-2041-6671>)

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`fect-package` *Fixed Effects Counterfactual Estimators*

Description

The package implements counterfactual estimators in TSCS data analysis and statistical tools to test their identification assumptions.

Details

It implements counterfactual estimators in TSCS data analysis. These estimators first impute counterfactuals for each treated observation in a TSCS dataset by fitting an outcome model (fixed effects model, interactive fixed effects model, or matrix completion) using the untreated observations. They then estimate the individualistic treatment effect for each treated observatio n by subtracting the predicted counterfactual outcome from its observed outcome. Finally, the average treatment effect on the treated (ATT) or period-specific ATTs are calculated. A placebo test and an equivalence test are included to evaluate the validity of identification assumptions behind these estimators.

See `fect` for details.

Author(s)

Licheng Liu <liulch@mit.edu>, MIT

Ye Wang <yw1576@nyu.edu>, New York University

Yiqing Xu <yiqingxu@stanford.edu >, Stanford University

Ziyi Liu <zyliu2020@uchicago.edu>, University of Chicago

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

Licheng Liu, et al. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science.

`att.cumu` *Calculate Cumulative Treatment Effects*

Description

Calculate cumulative treatment effects

Usage

```
att.cumu(x, period = NULL, weighted = TRUE, alpha = 0.05, type = "on", plot = FALSE)
```

Arguments

`x`	a `fect` object.
`period`	a two-element numeric vector specifying the range of term during which treatment effects are to be accumulated. e.g. `period = c(-1,1)`.
`weighted`	a logical flag specifying whether to calculate weigthed cumulative treatment effects based on counts at each period. Default is `weighted = TRUE`.
`alpha`	a numerical value that specfies significant level.
`type`	a string that specifies the type. Must be one of the following: "on" (switch-on treatment effect); "off" (switch-off treatment effect). Default is `type = "on"`.
`plot`	A logical flag indicating whether to plot cumulative effects. Default is `plot = FALSE`.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

Licheng Liu, et al. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science.

For more details about the matrix completion method, see https://github.com/susanathey/MCPanel.

See Also

fect and plot.fect

---

fect *Fixed Effects Counterfactual Estimators*

Description

Implements counterfactual estimators in TSCS data analysis and statistical tools to test their identification assumptions.

Usage

```
fect(formula = NULL, data, Y, D, X = NULL, group = NULL,
            na.rm = FALSE,
            index, force = "two-way", r = 0, lambda = NULL, nlambda = 10,
            CV = NULL, k = 10, cv.prop = 0.1, cv.treat = FALSE,
            cv.nobs = 3, cv.donut = 0, criterion = "mspe",
            binary = FALSE, QR = FALSE,
            method = "fe",
            se = FALSE, vartype = "bootstrap", nboots = 200, alpha = 0.05,
            parallel = TRUE, cores = NULL, tol = 0.001, seed = NULL,
            min.T0 = NULL, max.missing = NULL,
            proportion = 0.3, pre.periods = NULL,
            f.threshold = 0.5, tost.threshold = NULL,
            knots = NULL, degree = 2,
            sfe = NULL, cfe = NULL,
            balance.period = NULL, fill.missing = FALSE,
            placeboTest = FALSE, placebo.period = NULL,
           carryoverTest = FALSE, carryover.period = NULL, carryover.rm = NULL,
            loo = FALSE, permute = FALSE, m = 2, normalize = FALSE)
```

Arguments

formula	an object of class "formula": a symbolic description of the model to be fitted, e.g, Y~D+X1+X2
data	a data frame, can be a balanced or unbalanced panel data.
Y	the outcome indicator.
D	the treatment indicator. The treatment should be binary (0 and 1).

X	time-varying covariates. Covariates that have perfect collinearity with specified fixed effects are dropped automatically.
group	the group indicator. If specified, the group-wise ATT will be estimated.
na.rm	a logical flag indicating whether to list-wise delete missing observations. Default to FALSE. If na.rm = FALSE, it allows the situation when Y is missing but D is not missing for some observations. If na.rm = TRUE, it will list-wise delete observations whose Y, D, or X is missing.
index	a two-element string vector specifying the unit and time indicators. Must be of length 2. Every observation should be uniquely defined by the pair of the unit and time indicator.
force	a string indicating whether unit or time or both fixed effects will be imposed. Must be one of the following, "none", "unit", "time", or "two-way". The default is "two-way".
r	an integer specifying the number of factors. If CV = TRUE, the cross validation procedure will select the optimal number of factors from r to 5.
lambda	a single or sequence of positive numbers specifying the hyper-parameter sequence for matrix completion method. If lambda is a sequence and CV = 1, cross-validation will be performed.
nlambda	an integer specifying the length of hyper-parameter sequence for matrix completion method. Default is nlambda = 10.
CV	a logical flag indicating whether cross-validation will be performed to select the optimal number of factors or hyper-parameter in matrix completion algorithm. If r is not specified, the procedure will search through r = 0 to 5.
k	an integer specifying number of cross-validation rounds. Default is k = 10.
cv.prop	a numerical value specifying the proportion of testing set compared to sample size during the cross-validation procedure.
cv.treat	a logical flag speficying whether to only use observations of treated units as testing set.
cv.nobs	an integer specifying the length of continuous observations within a unit in the testing set. Default is cv.nobs = 3.
cv.donut	an integer specifying the length of removed observations at the head and tail of the continuous observations specified by cv.nobs. These removed observations will not be used to fit the data nor be in the validation set for the cross-validation, e.g, if cv.nobs=3 and cv.donut = 1, the first and the last observation in each triplet will not be included in the test set. Default is cv.donut = 0.
criterion	criterion used for model selection. Default is "mspe". "mspe" for the mean squared prediction error, "gmspe" for the geometric-mean squared prediction errors, if criterion="moment", we average the residuals in test sets by their relative periods to treatments and then average the squares of these period-wise deviations weighted by the number of observations at each period, it yields a better pre-trend fitting on test sets rather than a better prediction ability. "pc" for the information criterion of interactive fixed effects or generalized synthetic control model.
binary	This version doesn't support this option. a logical flag indicating whether a probit link function will be used.

QR	This version doesn't support this option. a logical flag indicating whether QR decomposition will be used for factor analysis in probit model.
method	a string specifying which imputation algorithm will be used. "fe" for fixed effects model, "ife" for interactive fixed effects model, "mc" for matrix copletion method, "polynomial" for polynomial trend terms, "bspline" for regression splines, "gsynth" for generalized synthetic control method, and "cfe" for complex fixed effects method Default is method = "fe".
se	a logical flag indicating whether uncertainty estimates will be produced.
vartype	a string specifying the type of variance estimator. Choose from vartype = c("bootstrap", "jackknife", "parametric"). Default value is "bootstrap".
nboots	an integer specifying the number of bootstrap runs. Ignored if se = FALSE.
alpha	significant level for hypothesis test and CIs. Default value is alpha = 0.05.
parallel	a logical flag indicating whether parallel computing will be used in bootstrapping and/or cross-validation. Ignored if se = FALSE.
cores	an integer indicating the number of cores to be used in parallel computing. If not specified, the algorithm will use the maximum number of logical cores of your computer (warning: this could prevent you from multi-tasking on your computer).
tol	a positive number indicating the tolerance level.
seed	an integer that sets the seed in random number generation. Ignored if se = FALSE and r is specified.
min.T0	an integer specifying the minimum value of observed periods that a unit is under control.
max.missing	an integer. Units with number of missing values greater than it will be removed. Ignored if this parameter is set "NULL"(i.e. max.missing = NULL, the default setting).
proportion	a numeric value specifying pre-treatment periods that have observations larger than the proportion of observations at period 0. These pre-treatment periods are used used for goodness-of-fit test. Ignore if se = FALSE. Deafult is proportion = 0.3.
pre.periods	a vector specifying the range of pre-treatment period used for goodness-of-fit test. If left blank, all pre-treatment periods specified by proportion will be used. Ignore if se = FALSE.
f.threshold	a numeric value specifying the threshold for the F-statistic in the equivalent test. Ignore if se = FALSE. Deafult is f.threshold = 0.5.
tost.threshold	a numeric value specifying the threshold for the two-one-sided t-test. If alpha=0.05, TOST checks whether the 90 The default value is 0.36 times the standard deviation of the outcome variable after two-way fixed effects are partialed out.
knots	a numeric vector speicfying the knots for b-spline curve trend term.
degree	an integer speifcying the order of either the b-spline or the polynomial trend term.
sfe	a vector specifying other fixed effects in addition to unit or time fixed effects that is used when method="cfe".

cfe	a vector of lists specifying interactive fixed effects when method="cfe". For each list, the value of the first element is the name of the group variable for which fixed effects are to be estimated. The value of the second element is the name of a regressor (e.g., a time trend).
balance.period	a vector of length 2 specifying the range of periods for a balanced sample which has no missing observation in the specified range.
fill.missing	a logical flag indicating whether to allow missing observations in this balanced sample. The default is FALSE.
placeboTest	a logic flag indicating whether to perform placebo test.
placebo.period	an integer or a two-element numeric vector specifying the range of pre-treatment periods that will be assigned as pseudo treatment periods.
carryoverTest	a logic flag indicating whether to perform (no) carryover test.
carryover.period	an integer or a two-element numeric vector specifying the range of post-treatment periods that will be assigned as pseudo treatment periods.
carryover.rm	an integer specifying the range of post-treatment periods that will be assigned as pseudo treatment periods.
loo	a logic flag indicating whether to perform the leave-one-period-out goodness-of-fit test, which is very time-consuming.
permute	a logic flag indicating whether to perform permutation test.
m	an integer specifying the block length in permutation test. Default value is m = 2.
normalize	a logic flag indicating whether to scale outcome and covariates. Useful for accelerating computing speed when magnitude of data is large. The default is normalize=FALSE.

Details

fect implements counterfactual estimators in TSCS data analysis. These estimators first impute counterfactuals for each treated observation in a TSCS dataset by fitting an outcome model (fixed effects model, interactive fixed effects model, or matrix completion) using the untreated observations. They then estimate the individualistic treatment effect for each treated observation by subtracting the predicted counterfactual outcome from its observed outcome. Finally, the average treatment effect on the treated (ATT) or period-specific ATTs are calculated. A placebo test and an equivalence test are included to evaluate the validity of identification assumptions behind these estimators. Data must be with a dichotomous treatment.

Value

Y.dat	a T-by-N matrix storing data of the outcome variable.
D.dat	a T-by-N matrix storing data of the treatment variable.
I.dat	a T-by-N matrix storing data of the indicator for whether is observed or missing.
Y	name of the outcome variable.
D	name of the treatment variable.

X	name of the time-varying control variables.
index	name of the unit and time indicators.
force	user specified force option.
T	the number of time periods.
N	the total number of units.
p	the number of time-varying observables.
r.cv	the number of factors included in the model – either supplied by users or automatically chosen via cross-validation.
lambda.cv	the optimal hyper-parameter in matrix completion method chosen via cross-validation.
beta	coefficients of time-varying observables from the interactive fixed effect model.
sigma2	the mean squared error of interactive fixed effect model.
IC	the information criterion.
est	result of the interactive fixed effect model based on observed values.
MSPE	mean squared prediction error of the cross-validated model.
CV.out	result of the cross-validation procedure.
niter	the number of iterations in the estimation of the interactive fixed effect model.
factor	estimated time-varying factors.
lambda	estimated loadings.
lambda.tr	estimated loadings for treated units.
lambda.co	estimated loadings for control units.
mu	estimated ground mean.
xi	estimated time fixed effects.
alpha	estimated unit fixed effects.
alpha.tr	estimated unit fixed effects for treated units.
alpha.co	estimated unit fixed effects for control units.
validX	a logic value indicating if multicollinearity exists.
validF	a logic value indicating if factor exists.
id	a vector of unit IDs.
rawtime	a vector of time periods.
obs.missing	a matrix stroing status of each unit at each time point.
Y.ct	a T-by-N matrix storing the predicted Y(0).
eff	a T-by-N matrix storing the difference between actual outcome and predicted Y(0).
res	residuals for observed values.
eff.pre	difference between actual outcome and predicted Y(0) for observations of treated units under control.
eff.pre.equiv	difference between actual outcome and predicted Y(0) for observations of treated units under control based on baseline (two-way fixed effects) model.

`pre.sd` by period residual standard deviation for estimated pre-treatment average treatment effects.

`att.avg` average treatment effect on the treated.

`att.avg.unit` by unit average treatment effect on the treated.

`time` term for switch-on treatment effect.

`count` count of each term for switch-on treatment effect.

`att` switch-on treatment effect.

`time.off` term for switch-off treatment effect.

`att.off` switch-off treatment effect.

`count.off` count of each term for switch-off treatment effect.

`att.placebo` average treatment effect for placebo period.

`att.carryover` average treatment effect for carryover period.

`eff.calendar` average treatment effect for each calendar period.

`eff.calendar.fit` loess fitted values of average treatment effect for each calendar period.

`N.calandar` number of treated observations at each calendar period.

`balance.avg.att` average treatment effect for the balance sample.

`balance.att` switch-on treatment effect for the balance sample.

`balance.time` term of switch-on treatment effect for the balance sample.

`balance.count` count of each term for switch-on treatment effect for the balance sample.

`balance.att.placebo` average treatment effect for placebo period of the balance sample.

`group.att` average treatment effect for different groups.

`group.output` a list saving the switch-on treatment effects for different groups.

`est.att.avg` inference for `att.avg`.

`est.att.avg.unit` inference for `att.avg.unit`.

`est.att` inference for `att.on`.

`est.att.off` inference for `att.off`.

`est.placebo` inference for `att.placebo`.

`est.carryover` inference for `att.carryover`.

`est.eff.calendar` inference for `eff.calendar`.

`est.eff.calendar.fit` inference for `eff.calendar.fit`.

`est.balance.att` inference for `balance.att`.

`est.balance.avg` inference for `balance.avg.att`.

`est.balance.placebo`
: inference for `balance.att.placebo`.

`est.beta`
: inference for `beta`.

`est.group.att`
: inference for `group.att`.

`est.group.output`
: inference for `group.output`.

`att.avg.boot`
: bootstrap results for `att.avg`.

`att.avg.unit.boot`
: bootstrap results for `att.avg.unit`.

`att.count.boot`
: bootstrap results for `count`.

`att.off.boot`
: bootstrap results for `att.avg.off`.

`att.off.count.boot`
: bootstrap results for `count.off`.

`att.placebo.boot`
: bootstrap results for `att.placebo`.

`att.carryover.boot`
: bootstrap results for `att.carryover`.

`balance.att.boot`
: bootstrap results for `balance.att`.

`att.bound`
: equivalence confidence interval for equivalence test.

`att.off.bound`
: equivalence confidence interval for equivalence test for switch-off effect.

`beta.boot`
: bootstrap results for `beta`.

`test.out`
: goodness-of-fit test and equivalent test results for pre-treatment fitting check.

`loo.test.out`
: leave-one-period-out goodness-of-fit test and equivalent test results for pre-treatment fitting check.

`permute`
: permutation test results for sharp null hypothesis.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu; Ziyi Liu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

Licheng Liu, et al. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science.

For more details about the matrix completion method, see https://github.com/susanathey/MCPanel.

See Also

plot.fect and print.fect

Examples

```
library(fect)
data(fect)
out <- fect(Y ~ D + X1 + X2, data = simdata1,
            index = c("id","time"), force = "two-way",
            CV = TRUE, r = c(0, 5), se = 0, parallel = FALSE)
```

---

fect-internal *Internal FEct Functions*

Description

Internal fect functions

Details

These are not to be called by the user (or in some cases are just waiting for proper documentation to be written :).

---

get.cohort *Get the Cohort Index*

Description

Gets the cohort index given a panel data.

Usage

```
get.cohort(data, D, index,
                  varname = NULL, entry.time = NULL)
```

Arguments

data	a data frame, can be a balanced or unbalanced panel data.
D	the treatment indicator. The treatment should be binary (0 and 1).
index	a two-element string vector specifying the unit and time indicators. Must be of length 2. Every observation should be uniquely defined by the pair of the unit and time indicator.
varname	a string specifying the name for the generated cohort index.
entry.time	a list of intervals for first get-treated time.

Details

`get.cohort` pre-processes the data and generates the index for different cohorts..

Value

`data`	a new data frame containing the cohort index.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu, Ziyi Liu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

Licheng Liu, et al. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science.

For more details about the matrix completion method, see https://github.com/susanathey/MCPanel.

See Also

`fect` and `print.fect`

Examples

```
library(fect)
data(fect)
simdata.cohort <- get.cohort(data = simdata,D = 'D',index = c("id","time"))
```

`interFE` *Interactive Fixed Effects Models*

Description

Estimating interactive fixed effect models.

Usage

```
interFE(formula = NULL, data, Y, X, index, r = 0, force = "none",
         se = TRUE, nboots = 500, seed = NULL,
         tol = 1e-3, binary = FALSE, QR = FALSE, normalize = FALSE)
```

Arguments

formula	an object of class "formula": a symbolic description of the model to be fitted.
data	a data frame (must be with a dichotomous treatment but balanced is not required).
Y	outcome.
X	time-varying covariates.
index	a two-element string vector specifying the unit (group) and time indicators. Must be of length 2.
r	an integer specifying the number of factors.
force	a string indicating whether unit or time fixed effects will be imposed. Must be one of the following, "none", "unit", "time", or "two-way". The default is "unit".
se	a logical flag indicating whether uncertainty estimates will be produced via bootstrapping.
nboots	an integer specifying the number of bootstrap runs. Ignored if se = FALSE.
seed	an integer that sets the seed in random number generation. Ignored if se = FALSE and r is specified.
tol	a numeric value that specifies tolerate level.
binary	a logical flag indicating whether a probit link function will be used.
QR	a logical flag indicating whether QR decomposition will be used for factor analysis in probit model.
normalize	a logic flag indicating whether to scale outcome and covariates. Useful for accelerating computing speed when magnitude of data is large.The default is normalize=FALSE.

Details

interFE estimates interactive fixed effect models proposed by Bai (2009).

Value

beta	estimated coefficients.
mu	estimated grand mean.
factor	estimated factors.
lambda	estimated factor loadings.
VNT	a diagonal matrix that consists of the r eigenvalues.
niter	the number of iteration before convergence.
alpha	estimated unit fixed effect (if force is "unit" or "two-way").
xi	estimated time fixed effect (if force is "time" or "two-way").
residuals	residuals of the estimated interactive fixed effect model.
sigma2	mean squared error of the residuals.
IC	the information criterion.

ValidX	a logical flag specifying whether there are valid covariates.
dat.Y	a matrix storing data of the outcome variable.
dat.X	an array storing data of the independent variables.
Y	name of the outcome variable.
X	name of the time-varying control variables.
index	name of the unit and time indicators.
est.table	a table of the estimation results.
est.boot	a matrix storing results from bootstraps.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica 77:1229–1279.

See Also

print.interFE and fect

Examples

```
library(fect)
data(fect)
d <- simdata1[-(1:150),] # remove the treated units
out <- interFE(Y ~ X1 + X2, data = d, index=c("id","time"),
               r = 2, force = "two-way", nboots = 50)
```

---

plot.fect *Plotting*

Description

Visualizes estimation results of the matrix completion method.

Usage

```
## S3 method for class 'fect'
plot(x, type = NULL, loo = "FALSE",
            highlight = NULL, plot.ci = NULL, show.points = NULL,
            show.group = NULL, bound = NULL, vis = NULL,
            count = TRUE, proportion = 0.3, pre.periods = NULL,
            f.threshold = NULL, tost.threshold = NULL,
            effect.bound.ratio = FALSE,
```

```
    stats = NULL, stats.labs = NULL,
    main = NULL,
    xlim = NULL, ylim = NULL, xlab = NULL, ylab = NULL,
  gridOff = FALSE, legendOff = FALSE, legend.pos = NULL, legend.nrow = NULL,
    legend.labs = NULL, stats.pos = NULL, theme.bw = TRUE,
    nfactors = NULL, include.FE = TRUE,
    id = NULL,
    cex.main = NULL, cex.main.sub = NULL, cex.axis = NULL,
    cex.lab = NULL, cex.legend = NULL, cex.text = NULL,
    axis.adjust = FALSE, axis.lab = "both", axis.lab.gap = c(0, 0),
    start0 = FALSE,
    return.test = FALSE,
    balance = NULL,...)
```

Arguments

x	a fect object.
type	a string specifying the type of the plot. "gap" plots the estimated period-wise ATT (dynamic treatment effects), "equiv" shows the visualization of the equivalence test, "exit" plots the estimated period-wise switch-off effects, "status" shows the treatment status of all observations, "factors" plots the estimated factor and time fixed effects, "loadings" plots the estimated factor loadings and unit fixed effects, "calendar" plots the estimated treatment effects for each calendar period, and "box" visualizes the estimated individualistic treatment effects of observations.
loo	a logical flag indicating whether to use the leave-one-period-out pre-treatment effects for the visualization and tests.
highlight	a logical flag indicating whether to highlight the periods for the carryover and placebo test.
plot.ci	a string specifying the confidence interval. Choose from: "0.9", "0.95", or "none".
show.points	a logical flag indicating whether to represent treatment effects by points or point-ranges. Default to TRUE.
show.group	a string indicating the group to be visualized.
bound	a string that specifies the bounds to be plotted for equivalence test for pre-treatment fit checking. Choose from: "both", "equiv", "min" and "none".
vis	A string specifying whether to plot the dots for placebo plots.
count	a logical flag controlling whether to show the count of each term for gap plot.
proportion	a positive value specifying periods at which observations equal to or greater than the proporation of the largest number of observations at a certain period. Default to 0.3.
pre.periods	a vector specifying the range of pre-treatment period used for goodness-of-fit test. If left blank, all pre-treatment periods specified by proportion will be used. Ignore if se = FALSE.
f.threshold	a numeric value specifying the threshold for the F-statistic in the equivalent test. Ignore if se = FALSE. Deafult is f.threshold = 0.5.

`tost.threshold` a numeric value specifying the threshold for the two-one-sided t-test. If `alpha=0.05`, TOST checks whether the 90 The default value is 0.36 times the standard deviation of the outcome variable after two-way fixed effects are partialed out.

`effect.bound.ratio` a logical value specifiying whether to annotate the ratio of estimated average treatment effects / minimun bound.

`stats` a string that specifices what statistics to be shown. For `"gap"` plot, choose from `c("none", "F.p", "equiv.p", "F.equiv.p",)`, for `"placebo"` plot, choose from `c("none", "placebo.p", "equiv.placebo.p")`, and for "carryover" plot, choose from `c("none", "carryover.p")`.

`stats.labs` a string specifying the label for the statistics specified by `stats`.

`main` a string that controls the title of the plot. If not supplied, no title will be shown.

`xlim` a two-element numeric vector specifying the range of x-axis. When class of time varible is string, must specify not original value but a counting number e.g. `xlim=c(1,30)`.

`ylim` a two-element numeric vector specifying the range of y-axis.

`xlab` a string indicating the label of the x-axis.

`ylab` a string indicating the label of the y-axis.

`gridOff` a logical flag indicating whether to remove the grid lines for the status plot.

`legendOff` a logical flag controlling whether to show the legend.

`legend.pos` a string specifying the position of legend. If left blank, legend will be setted at the bottom.

`legend.nrow` an integer speficying rows of legend.

`legend.labs` a string vector for user-defined legends.

`stats.pos` a numeric vector of length 2 specifying the postion for labels of test statistic value.

`theme.bw` a logical flag specifying whether to use the black and white theme.

`nfactors` a integer controlling the number of factors to be shown when `type='factors'`.

`include.FE` a loical flag indicating whether to keep the fixed effects when `type='factors'` or `type='loadings'`.

`id` a string vector specifying a sub-group of units that are to be plotted for treatment status(`type = "status"`).

`cex.main` a numeric value (pt) specifying the fontsize of the main title.

`cex.main.sub` a numeric value (pt) specifying the fontsize of the subtitles.

`cex.axis` a numeric value (pt) specifying the fontsize of the texts on the axes.

`cex.lab` a numeric value (pt) specifying the fontsize of the axis titles.

`cex.legend` a numeric value (pt) specifying the fontsize of the legend.

`cex.text` a numeric value (pt) specifying the fontsize of the annotations.

`axis.adjust` a logic flag indicating whether to adjust labels on x-axis. Useful when class of time variable is string and data magnitude is large.

axis.lab	a string indicating whether labels on the x- and y-axis will be shown. There are four options: "both" (default): labels on both axes will be shown; "unit": only labels on y-axis will be shown; "time": only labels on the x-axis will be shown; "none": no labels will be shown.
axis.lab.gap	a numeric vector setting the gaps between labels on the x- or y-axis for "missing" plot. Default is axis.lab.gap = c(0, 0), which means that all labels will be shown. Useful for datasets with large N or T.
start0	a logical flag indicating whether to index the start of the treatment as period 0 rather than period 1. Default to FALSE.
return.test	a logical flag indicating whether to return the results of statistical tests.
balance	a logical flag indicating whether to plot the dynamic treatment effects for the balance sample.
...	other argv.

Details

plot.fect visualizes the estimation results obtained by fect.

Value

p	a ggplot2 object saving the graph.
test.out	a list storing the results of statistical tests if return.test=TRUE.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu, Ziyi Liu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

Licheng Liu, et al. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science.

For more details about the matrix completion method, see https://github.com/susanathey/MCPanel.

See Also

fect and print.fect

Examples

```
library(fect)
data(fect)
out <- fect(Y ~ D + X1 + X2, data = simdata1,
            index = c("id","time"), force = "two-way",
            CV = TRUE, r = c(0, 5), se = 0, parallel = FALSE)
plot(out)
plot(out,type='status')
plot(out,show.points = FALSE)
```

`print.fect` *Print Results*

Description

Print results of the matrix completion method.

Usage

```
## S3 method for class 'fect'
print(x, switch.on = TRUE,
       switch.off = FALSE,time.on.lim = NULL, time.off.lim = NULL, ...)
```

Arguments

`x`	a `fect` object.
`switch.on`	a logical value that specifies whether to print switch.on effect.
`switch.off`	a logical value that specifies whether to print switch.off effect.
`time.on.lim`	a two-element numeric vector specifying the range of term of switch-on treatment effects. e.g. `time.on.lim = c(-1,1)`.
`time.off.lim`	a two-element numeric vector specifying the range of term of switch-off treatment effects. e.g. `time.off.lim = c(-1,1)`.
`...`	other argv.

Value

No return value.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu; Ziyi Liu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

Athey, Susan, et al. 2021 "Matrix completion methods for causal panel data models." Journal of the American Statistical Association.

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For more details about the matrix completion method, see https://github.com/susanathey/MCPanel.

See Also

fect and plot.fect

Examples

```
library(fect)
data(fect)
out <- fect(Y ~ D + X1 + X2, data = simdata1,
            index = c("id","time"), force = "two-way",
            CV = TRUE, r = c(0, 5), se = 0, parallel = FALSE)
print(out)
```

---

print.interFE *Print Results*

Description

Print results of interactive fixed effects estimation.

Usage

```
## S3 method for class 'interFE'
print(x, ...)
```

Arguments

x	an interFE object.
...	other argv.

Value

No return value.

Author(s)

Licheng Liu; Ye Wang; Yiqing Xu

References

Jushan Bai. 2009. "Panel Data Models with Interactive Fixed Effects." Econometrica 77:1229–1279.

See Also

interFE and fect

Examples

```
library(fect)
data(fect)
d <- simdata1[-(1:150),] # remove the treated units
out <- interFE(Y ~ X1 + X2, data = d, index=c("id","time"),
               r = 2, force = "two-way", nboots = 50)
print(out)
```

---

simdata *Simulated data*

Description

A simulated dataset with continuous outcomes.

Format

dataframe

References

Liu, Licheng, Ye Wang, and Yiqing Xu. 2022. “A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data.” American Journal of Political Science, forthcoming.

simdata1 *Simulated data*

Description

A simulated dataset with continuous outcomes.

Format

dataframe

References

Liu, Licheng, Ye Wang, and Yiqing Xu. 2022. "A Practical Guide to Counterfactual Estimators for Causal Inference with Time-Series Cross-Sectional Data." American Journal of Political Science, forthcoming.

turnout *EDR and voter turnout in the US*

Description

State-level voter turnout data.

Format

dataframe

References

Melanie Jean Springer. 2014. How the States Shaped the Nation: American Electoral Institutions and Voter Turnout, 1920-2000. University of Chicago Press.

Yiqing Xu. 2017. "Generalized Synthetic Control Method: Causal Inference with Interactive Fixed Effects Models." Political Analysis.

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