Package 'xtfifevd'

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Type Package

Title Panel Fixed Effects Filtered and Variance Decomposition Estimation

Version 1.0.2

Description Implements fixed effects estimators for time-invariant variables in panel data models. Provides three estimation methods: FEVD (Fixed Effects Vector Decomposition) from Plumper and Troeger (2007) <doi:10.1093/pan/mpm002>, and FEF (Fixed Effects Filtered) and FEF-IV (instrumental variables variant) from Pesaran and Zhou (2018) <doi:10.1080/07474938.2016.1222225>. All methods use the correct Pesaran-Zhou variance estimators that account for generated regressor uncertainty, avoiding the size distortions documented in the literature.

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URL https://github.com/muhammedalkhalaf/xtfifevd

BugReports https://github.com/muhammedalkhalaf/xtfifevd/issues

Encoding UTF-8

RoxygenNote 7.3.3

Depends R (>= 4.1.0)

Imports stats, MASS

Suggests plm, lmtest, sandwich, testthat (>= 3.0.0), knitr, rmarkdown

Config/testthat/edition 3

NeedsCompilation no

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`bw_ratio` *Between/Within Variance Ratio for Time-Invariant Variables*

Description

Computes the between-panel and within-panel standard deviations for specified variables, along with their ratio. This diagnostic helps assess whether FEVD/FEF methods may improve upon standard FE estimation.

Usage

```
bw_ratio(data, variables, id)
```

Arguments

`data`	A data frame containing the panel data.
`variables`	A character vector of variable names to analyze.
`id`	Character string naming the panel identifier variable.

Details

For truly time-invariant variables, the within-panel SD should be zero (or near-zero due to numerical precision), giving an infinite ratio.

According to Plümper and Troeger (2007), FEVD/FEF methods tend to improve upon standard FE when:

- The between/within ratio exceeds approximately 1.7
- The correlation between z and the unobserved unit effect is not too high

Value

A data frame with columns:

variable Variable name

sd_between Between-panel standard deviation

sd_within Within-panel standard deviation

bw_ratio Ratio of between to within SD

References

Plumper, T., & Troeger, V. E. (2007). Efficient Estimation of Time-Invariant and Rarely Changing Variables in Finite Sample Panel Analyses with Unit Fixed Effects. *Political Analysis*, 15(2), 124-139. doi:10.1093/pan/mpm002

Examples

```
# Create example data
set.seed(42)
N <- 50
T <- 5
id <- rep(1:N, each = T)
z_invariant <- rep(rnorm(N), each = T)  # Truly time-invariant
z_slow <- rep(rnorm(N), each = T) + rnorm(N * T, sd = 0.1)  # Slowly varying
x_varying <- rnorm(N * T)  # Time-varying

data <- data.frame(id = id, z_inv = z_invariant,
                   z_slow = z_slow, x = x_varying)

bw_ratio(data, c("z_inv", "z_slow", "x"), id = "id")
```

`xtfifevd` *Panel Fixed Effects Estimation for Time-Invariant Variables*

Description

Estimates panel models with time-invariant regressors using FEVD, FEF, or FEF-IV methods. Standard fixed effects estimation cannot identify coefficients on time-invariant variables; these methods decompose or filter the unit effects to recover these coefficients.

Usage

```
xtfifevd(
  formula,
  data,
  id,
  time,
  method = c("fevd", "fef", "fef_iv"),
  instruments = NULL,
  na.action = na.omit
)

fevd(formula, data, id, time, na.action = na.omit)

fef(formula, data, id, time, na.action = na.omit)

fef_iv(formula, data, id, time, instruments, na.action = na.omit)
```

Arguments

`formula`	A formula of the form `y ~ x1 + x2 | z1 + z2` where variables before `|` are time-varying and variables after `|` are time-invariant.
`data`	A data frame containing the variables.
`id`	Character string naming the panel (individual) identifier variable.
`time`	Character string naming the time identifier variable.
`method`	Estimation method: `"fevd"` (default), `"fef"`, or `"fef_iv"`.
`instruments`	For `method = "fef_iv"`, a one-sided formula specifying instrumental variables, e.g., `~ iv1 + iv2`.
`na.action`	How to handle missing values. Default is `na.omit`.

Details

Model:

The panel model is:

$$y_{it} = \alpha_i + x'_{it}\beta + z'_i\gamma + \varepsilon_{it}$$

where x_{it} are time-varying regressors, z_i are time-invariant regressors, and α_i are individual fixed effects.

Stage 1 (All Methods):

Fixed effects regression of y_{it} on x_{it} yields consistent $\hat{\beta}$ and combined residuals $\hat{u}_{it} = \hat{\alpha}_i + \hat{\varepsilon}_{it}$.

Stage 2:

Time-averaged residuals $\bar{u}_i$ are regressed on z_i:

- **FEF**: OLS of $\bar{u}_i$ on z_i with intercept
- **FEF-IV**: 2SLS using instruments r_i
- **FEVD**: Same as FEF, then Stage 3 pooled OLS (point estimates identical)

Variance Estimation:

Uses Pesaran-Zhou (2016) Equation 17/51 which properly accounts for estimation uncertainty from Stage 1. The naive pooled OLS standard errors from FEVD Stage 3 are **inconsistent** and can understate true SEs by factors of 2-5x or more.

Value

An object of class `"xtfifevd"` containing:

coefficients Named vector of all coefficients (beta, gamma, intercept)

vcov Variance-covariance matrix using Pesaran-Zhou estimator

beta Coefficients on time-varying variables (from FE stage)

gamma Coefficients on time-invariant variables

intercept Overall intercept

residuals Idiosyncratic residuals from FE stage

fitted.values Fitted values

sigma2_e Variance of idiosyncratic error

sigma2_u Variance of unit effects

N Total number of observations

N_g Number of groups (panels)

T_bar Average time periods per panel

method Estimation method used

call The matched call

Functions

- `fevd`: FEVD estimation (3-stage, Plümper-Troeger)
- `fef`: FEF estimation (2-stage, Pesaran-Zhou)
- `fef_iv`: FEF-IV estimation with instruments

References

Plumper, T., & Troeger, V. E. (2007). Efficient Estimation of Time-Invariant and Rarely Changing Variables in Finite Sample Panel Analyses with Unit Fixed Effects. *Political Analysis*, 15(2), 124-139. doi:10.1093/pan/mpm002

Pesaran, M. H., & Zhou, Q. (2018). Estimation of time-invariant effects in static panel data models. *Econometric Reviews*, 37(10), 1137-1171. doi:10.1080/07474938.2016.1222225

See Also

`fevd`, `fef`, `fef_iv`, `bw_ratio`

Examples

```
# Simulate panel data
set.seed(123)
N <- 100  # panels
T <- 10   # time periods
n <- N * T

# Generate data
id <- rep(1:N, each = T)
time <- rep(1:T, N)
alpha_i <- rep(rnorm(N), each = T)  # Fixed effects
z <- rep(rnorm(N), each = T)        # Time-invariant
x <- rnorm(n)                        # Time-varying
y <- 1 + 2 * x + 0.5 * z + alpha_i + rnorm(n, sd = 0.5)

data <- data.frame(id = id, time = time, y = y, x = x, z = z)

# Estimate with different methods
fit_fevd <- xtfifevd(y ~ x | z, data = data, id = "id", time = "time")
summary(fit_fevd)
```

```
fit_fef <- xtfifevd(y ~ x | z, data = data, id = "id", time = "time",
                    method = "fef")
summary(fit_fef)
```

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