Package ‘ebci’

October 13, 2022

Title Robust Empirical Bayes Confidence Intervals
Version 1.0.0
Description Computes empirical Bayes confidence estimators and confidence intervals in a normal means model. The intervals are robust in the sense that they achieve correct coverage regardless of the distribution of the means. If the means are treated as fixed, the intervals have an average coverage guarantee. The implementation is based on Armstrong, Kolesár and Plagborg-Møller (2020) <arXiv:2004.03448>.
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The text describes the function `cva` which computes the critical value for constructing average coverage confidence intervals under moment constraints. The function is based on the work of Armstrong, Kolesár, and Plagborg-Møller (2020).

**Description**

Computes the critical value $c_{v a}(m_2, \kappa)$ from Armstrong, Kolesár, and Plagborg-Møller (2020).

**Usage**

```r
cva(m2, kappa = Inf, alpha = 0.05, check = TRUE)
```

**Arguments**

- `m2` Bound on second moment of the normalized bias, $m_2$
- `kappa` Bound on the kurtosis of the normalized bias, $\kappa$
- `alpha` Determines confidence level, $1 - \alpha$.
- `check` If `TRUE`, verify accuracy of the solution by checking that the implied least favorable distribution satisfies the $m_2$ and $kappa$ constraints and yields the same non-coverage rate. If this fails (perhaps due to numerical accuracy issues), solve a finite-grid approximation (by discretizing the support of the normalized bias) to the primal linear programming problem, and check that it agrees with the dual solution.

**Value**

Returns a list with 4 components:

- `cv` Critical value for constructing two-sided confidence intervals.
- `alpha` The argument `alpha`.
- `x` Support points for the least favorable distribution for the squared normalized bias, $b^2$.
- `p` Probabilities associated with the support points.

**References**


**Examples**

```r
# Usual critical value
cva(m2=0, kappa=Inf, alpha=0.05)
# Larger critical value that takes bias into account. Only uses second moment
# constraint on normalized bias.
cva(m2=4, kappa=Inf, alpha=0.05)
# Add a constraint on kurtosis. This tightens the critical value.
cva(m2=4, kappa=3, alpha=0.05)
```
Neighborhood effects data from Chetty and Hendren (2018)

Description

This dataset contains a subset of the publicly available data from Chetty and Hendren (2018). It contains raw estimates and standard errors of neighborhood effects at the commuting zone level.

Usage

cz

Format

A data frame with 741 rows corresponding to commuting zones (CZ) and 10 columns corresponding to the variables:

- **cz** Commuting zone ID
- **czname** Name of CZ
- **state** 2-digit state code
- **pop** Population according to the year 2000 Census
- **theta25** Fixed-effect estimate of the causal effect of living in the CZ for one year on children’s percentile rank in the national distribution of household earnings at age 26 relative to others in the same birth cohort for children growing up with parents at the 25th percentile of national income distribution
- **theta75** Fixed-effect estimate of the causal effect of living in the CZ for one year on children’s percentile rank in the national distribution of household earnings at age 26 relative to others in the same birth cohort for children growing up with parents at the 75th percentile of national income distribution
- **se25** Standard error of theta25
- **se75** Standard error of theta75
- **stayer25** Average percentile rank in the national distribution of household earnings at age 26 relative to others in the same birth cohort for stayers (children who grew up in the CZ and did not move) with parents at the 25th percentile of national income distribution.
- **stayer75** Average percentile rank in the national distribution of household earnings at age 26 relative to others in the same birth cohort for stayers (children who grew up in the CZ and did not move) with parents at the 75th percentile of national income distribution.

Source

https://opportunityinsights.org/data/?paper_id=599
References


**ebci**

*Compute empirical Bayes confidence intervals by shrinking toward regression*

**Description**

Computes empirical Bayes estimators based on shrinking towards a regression, and associated robust empirical Bayes confidence intervals (EBCIs), as well as length-optimal robust EBCIs.

**Usage**

```r
ebci(
  formula,
  data,
  se,
  weights = NULL,
  alpha = 0.1,
  kappa = NULL,
  wopt = FALSE,
  fs_correction = "PMT"
)
```

**Arguments**

- **formula**: object of class "formula" (or one that can be coerced to that class) of the form \( Y \sim \text{predictors} \), where \( Y \) is a preliminary unbiased estimator, and the predictors are predictors \( X \) that guide the direction of shrinkage. For shrinking toward the grand mean, use \( Y \sim 1 \), and for shrinking toward \( 0 \) use \( Y \sim 0 \).

- **data**: optional data frame, list or environment (or object coercible by `as.data.frame` to a data frame) containing the preliminary estimator \( Y \) and the predictors. If not found in `data`, these variables are taken from `environment(formula)`, typically the environment from which the function is called.

- **se**: Standard errors \( \sigma \) associated with the preliminary estimates \( Y \).

- **weights**: An optional vector of weights to be used in the fitting process in computing \( \delta \), \( \mu_2 \) and \( \kappa \). Should be `NULL` or a numeric vector.

- **alpha**: Determines confidence level, \( 1 - \alpha \).

- **kappa**: If non-`NULL`, use pre-specified value for the kurtosis \( \kappa \) of \( \theta - X'\delta \) (such as \( \text{Inf} \)), instead of computing it.
If `TRUE`, also compute length-optimal robust EBCIs. These are robust EBCIs centered at estimates with the shrinkage factor \( w \), chosen to minimize the length of the resulting EBCI.

Finite-sample correction method used to compute \( \mu_2 \) and \( \kappa \). These corrections ensure that we do not shrink the preliminary estimates \( Y \) all the way to zero. If "PMT", use posterior mean truncation, if "FPLIB" use limited information Bayesian approach with a flat prior, and if "none", truncate the estimates at 0 for \( \mu_2 \) and 1 for \( \kappa \).

Returns a list with the following components:

- `mu2`: Estimated second moment of \( \theta - X'\delta \). Vector of length 2, the first element corresponds to the estimate after the finite-sample correction as specified by `fs_correction`, the second element is the uncorrected estimate.
- `kappa`: Estimated kurtosis \( \kappa \) of \( \theta - X'\delta \). Vector of length 2 with the same structure as `mu2`.
- `delta`: Estimated regression coefficients \( \delta \)
- `X`: Matrix of regressors
- `alpha`: Determines confidence level \( 1 - \alpha \) used.
- `df`: Data frame with components described below.

`df` has the following components:

- `w_eb`: EB shrinkage factors, \( \mu_2 / (\mu_2 + \sigma_i^2) \)
- `w_opt`: Length-optimal shrinkage factors
- `ncov_pa`: Maximal non-coverage of parametric EBCIs
- `len_eb`: Half-length of robust EBCIs based on EB shrinkage, so that the intervals take the form `cbind(th_eb-len_eb, th_eb+len_eb)`
- `len_op`: Half-length of robust EBCIs based on length-optimal shrinkage, so that the intervals take the form `cbind(th_op-len_op, th_op+len_op)`
- `len_pa`: Half-length of parametric EBCIs, which take the form `cbind(th_eb-len_pa, th_eb+len_a)`
- `len_us`: Half-length of unshrunk CIs, which take the form `cbind(th_us-len_us, th_us+len_us)`
- `th_us`: Unshrunk estimate \( Y \)
- `th_eb`: EB estimate.
- `th_op`: Estimate based on length-optimal shrinkage.
- `se`: Standard error \( \sigma \), as supplied by the argument `se`
- `weights`: Weights used
- `residuals`: The residuals \( Y_i - X_i\delta \)

References

Examples

```r
## Same specification as in empirical example in Armstrong, Kolesár
## and Plagborg-Møller (2020), but only use data on NY commuting zones
r <- ebcire(\texttt{theta25 ~ stayer25}, \texttt{data=cz[cz$state=="NY",]},
              \texttt{se=se25}, \texttt{weights=1/se25^2})
```
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