# Package ‘GMMSensitivity’

July 28, 2020

**Title** Confidence intervals for sensitivity analysis in GMM

**Version** 0.1.1

**Description** Construct confidence intervals in generalized method of moments (GMM) models that are valid under local misspecification.

**Depends** R (>= 4.0.0)

**License** GPL-3

**Encoding** UTF-8

**Suggests** spelling,
testthat,
knitr,
CVXR,
rmarkdown

**Imports** stats

**RoxygenNote** 7.1.1

**VignetteBuilder** knitr

**LazyData** true

**Language** en-US

**URL** https://github.com/kolesarm/GMMSensitivity/

**BugReports** https://github.com/kolesarm/GMMSensitivity/issues

## R topics documented:

blp *Estimates from Berry, Levinsohn, and Pakes (1995)*

## Description

This dataset contains estimates of the model in Berry, Levinsohn, and Pakes (1995), as implemented by Andrews, Gentzkow, and Shapiro (2017). It is used to illustrate the confidence intervals implemented in this package.

## Usage

```
blp
```

## Format

A list, consisting 11 objects:

**G** Matrix with 31 rows and 17 columns, estimate of derivative of the moment condition evaluated at initial estimate of $\theta$ from Berry, Levinsohn, and Pakes (1995), $\hat{\theta}$.

**H** Vector of length 17, estimate of derivative of average markup $h(\theta)$ with respect to model parameters $\theta$, evaluated at $\hat{\theta}$.

**W** Weight matrix used to obtain the estimate $\hat{\theta}$, preliminary estimate of variance of moment conditions.

**g_init** Average moment condition, evaluated at $\hat{\theta}$.

**h_init** Estimate of the average markup, $h(\hat{\theta})$.

**names** Two lists, one for names of the moment conditions, and one for elements of $\theta$.

**ZZ** Gram matrix $Z'Z$ of the instruments, used to specify the misspecification set $\mathcal{C}$.

**Sig** Estimate of variance of moment condition.

**sdZ** Vector of standard deviations of the instruments.

**perturb** scaling parameters to give interpretable meaning to violations of supply-side conditions. See vignette `vignette("GMMSensitivity",package="GMMSensitivity")` for details.

**n** Sample size, number of car models.

See Armstrong and Kolesár (2020) for a detailed description of these objects.

## Source

Replication files for Andrews, Gentzkow, and Shapiro (2017), available at https://doi.org/10.7910/DVN/LLARSN

### References

*Andrews, I., M. Gentzkow, and J. M. Shapiro (2017): Measuring the Sensitivity of Parameter Estimates to Sample Statistics, Quarterly Journal of Economics, 132, 1553–1592.*

*Armstrong, T. B., and M. Kolesár (2020): Sensitivity Analysis Using Approximate Moment Condition Models,* https://arxiv.org/abs/1808.07387

*Berry, S. T., J. Levinsohn, and A. Pakes (1995): Automobile Prices in Market Equilibrium, Econometrica, 63, 841–890.*

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`EffBounds` *Efficiency bounds under $\ell$_p constraints*

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### Description

Computes the asymptotic efficiency of two-sided fixed-length confidence intervals at $c = 0$, as well as the efficiency of one-sided confidence intervals that optimize a given `beta` quantile of excess length, when the set $\mathcal{C}$ is characterized by $\ell_p$ constraints.

### Usage

```
EffBounds(eo, B, M, p = 2, beta = 0.5, alpha = 0.05)
```

### Arguments

| | |
|---|---|
| `eo` | List containing initial estimates with the following components:<br>**Sig** Estimate of variance of the moment condition, matrix with dimension $d_g$ by $d_g$, where $d_g$ is the number of moments<br>**G** Estimate of derivative of the moment condition, matrix with dimension $d_g$ by $d_\theta$, where $d_\theta$ is the dimension of $\theta$<br>**H** Estimate of derivative of $h(\theta)$. A vector of length $d_\theta$<br>**n** sample size<br>**h_init** Estimate of $h(\theta)$<br>**k_init** Initial sensitivity<br>**g_init** Moment condition evaluated at initial estimate |
| `B` | matrix $B$ with full rank and dimension $d_g$ by $d_\gamma$ that determines the set $\mathcal{C}$, where $d_\gamma$ is the number of invalid moments, and $d_g$ is the number of moments |
| `M` | Bound on the norm of $\gamma$ |
| `p` | Parameter determining which $\ell_p$ norm to use, must equal `1`, `2`, or `Inf`. |
| `beta` | Quantile of excess length that a one-sided confidence interval is optimizing. |
| `alpha` | determines confidence level, `1-alpha`, for constructing/optimizing confidence intervals. |

### Details

The set $\mathcal{C}$ takes the form $B\gamma$ where the $\ell_p$ norm of $\gamma$ is bounded by $M$.

## Value

A list with two elements, `"onesided"` for efficiency of one-sided CIs and `"twosided"` for efficiency of two-sided CIs

## References

*Armstrong, T. B., and M. Kolesár (2018): Sensitivity Analysis Using Approximate Moment Condition Models, Unpublished manuscript*

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`Jtest` *J-test of overidentifying restrictions under local misspecification*

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## Description

Computes J-test of overidentifying restrictions with critical value adjusted to allow for local misspecification, when the parameter $c$ takes the form $c = B\gamma$ with the $\ell_p$ norm of $\gamma$ bounded by $M$. Assumes initial estimator in `eo` is optimal under correct specification.

## Usage

```
Jtest(eo, B, M, p = 2, alpha = 0.05)
```

## Arguments

`eo` List containing initial estimates with the following components:

- **Sig** Estimate of variance of the moment condition, matrix with dimension $d_g$ by $d_g$, where $d_g$ is the number of moments
- **G** Estimate of derivative of the moment condition, matrix with dimension $d_g$ by $d_\theta$, where $d_\theta$ is the dimension of $\theta$
- **H** Estimate of derivative of $h(\theta)$. A vector of length $d_\theta$
- **n** sample size
- **h_init** Estimate of $h(\theta)$
- **k_init** Initial sensitivity
- **g_init** Moment condition evaluated at initial estimate

`B` matrix $B$ with full rank and dimension $d_g$ by $d_\gamma$ that determines the set $\mathcal{C}$, where $d_\gamma$ is the number of invalid moments, and $d_g$ is the number of moments

`M` Bound on the norm of $\gamma$

`p` Parameter determining which $\ell_p$ norm to use, must equal `1`, `2`, or `Inf`.

`alpha` determines confidence level, `1-alpha`, for constructing/optimizing confidence intervals.

## Value

List with three elements:

**J** Value of J statistic

**p0** P-value of usual J test

**pC** P-value for J-test that allows for local misspecification

**Mmin** Minimum value of $M$ for which the J-test does not reject

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`lph` *Compute solution path for $\ell\_\infty$ or $\ell\_1$ constraints*

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## Description

Computes the vector of optimal sensitivities at each knot of the solution path that traces out the optimal bias-variance frontier when the set $C$ takes the form $c = B\gamma$ with the $\ell_p$ norm of $\gamma$ is bounded by a constant, for $p = 1$, or $p = \infty$. This path is used as an input to `OptEstimator`.

## Usage

```
lph(eo, B, p = Inf)
```

## Arguments

`eo` List containing initial estimates with the following components:

- **Sig** Estimate of variance of the moment condition, matrix with dimension $d_g$ by $d_g$, where $d_g$ is the number of moments
- **G** Estimate of derivative of the moment condition, matrix with dimension $d_g$ by $d_\theta$, where $d_\theta$ is the dimension of $\theta$
- **H** Estimate of derivative of $h(\theta)$. A vector of length $d_\theta$
- **n** sample size
- **h_init** Estimate of $h(\theta)$
- **k_init** Initial sensitivity
- **g_init** Moment condition evaluated at initial estimate

`B` matrix $B$ with full rank and dimension $d_g$ by $d_\gamma$ that determines the set $\mathcal{C}$, where $d_\gamma$ is the number of invalid moments, and $d_g$ is the number of moments

`p` Parameter determining which $\ell_p$ norm to use, one of `1`, or `Inf`.

## Details

The algorithm is described in Appendix A of Armstrong and Kolesár (2020)

## Value

Matrix of optimal sensitivites. Each row corresponds to the vector of optimal sensitivity at each step in the solution path.

## References

*Armstrong, T. B., and M. Kolesár (2020): Sensitivity Analysis Using Approximate Moment Condition Models,* https://arxiv.org/abs/1808.07387v4

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OptEstimator *One-step estimator based on optimal sensitivity under ℓ_p constraints*

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## Description

Computes the optimal sensitivity and the optimal estimator when the set $\mathcal{C}$ takes the form $c = B\gamma$ with the $\ell_p$ norm of $\gamma$ bounded by $M$.

## Usage

```
OptEstimator(
  eo,
  B,
  M,
  p = 2,
  spath = NULL,
  alpha = 0.05,
  opt.criterion = "FLCI"
)
```

## Arguments

| | |
|---|---|
| eo | List containing initial estimates with the following components:<br>**Sig** Estimate of variance of the moment condition, matrix with dimension $d_g$ by $d_g$, where $d_g$ is the number of moments<br>**G** Estimate of derivative of the moment condition, matrix with dimension $d_g$ by $d_\theta$, where $d_\theta$ is the dimension of $\theta$<br>**H** Estimate of derivative of $h(\theta)$. A vector of length $d_\theta$<br>**n** sample size<br>**h_init** Estimate of $h(\theta)$<br>**k_init** Initial sensitivity<br>**g_init** Moment condition evaluated at initial estimate |
| B | matrix $B$ with full rank and dimension $d_g$ by $d_\gamma$ that determines the set $\mathcal{C}$, where $d_\gamma$ is the number of invalid moments, and $d_g$ is the number of moments |
| M | Bound on the norm of $\gamma$ |
| p | Parameter determining which $\ell_p$ norm to use, must equal `1`, `2`, or `Inf`. |
| spath | Optionally, the solution path, output of `lph` to speed up computation. For `p==1` and `p==Inf` only. |
| alpha | determines confidence level, `1-alpha`, for constructing/optimizing confidence intervals. |

`opt.criterion` Optimality criterion for choosing optimal bias-variance tradeoff. The options are:

- `"MSE"` Minimize worst-case mean squared error of the estimator.
- `"FLCI"` Length of (fixed-length) two-sided confidence intervals.
- `"Valid"` Optimal estimator under valid moments. This returns the original estimator, with confidence intervals adjusted for possible misspecification

## Value

Object of class `"GMMEstimate"`, which is a list with at least the following components:

**h** Point estimate

**bias** Worst-case bias of estimator

**se** Standard error of estimator

**hl** Half-length of confidence interval, so that the confidence interval takes the form $h + -hl$

# Index