

# Package ‘mixedbiastest’

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**Type** Package

**Title** Bias Diagnostic for Linear Mixed Models

**Version** 0.4.1

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**Description** Provides a function to perform bias diagnostics on linear mixed models fitted with `lmer()` from the 'lme4' package. Implements permutation tests for assessing the bias of fixed effects, as described in Karl and Zimmerman (2021) <[doi:10.1016/j.jspi.2020.06.004](https://doi.org/10.1016/j.jspi.2020.06.004)>. Karl and Zimmerman (2020) <[doi:10.17632/tmynggddfm.1](https://doi.org/10.17632/tmynggddfm.1)> provide R code for implementing the test using 'mvgllmmRank' output. Development of this package was assisted by 'GPT o1-preview' for code structure and documentation.

**Depends** R (>= 3.5.0)

**Imports** lme4, Matrix, ggplot2, rlang

**Suggests** plm

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.3.2

**NeedsCompilation** no

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**Repository** CRAN

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mixedbiastest-package    *mixedbiastest: Bias Diagnostics for Linear Mixed Models*

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**Description**

The ‘mixedbiastest’ package provides a function to perform bias diagnostics on linear mixed models fitted with ‘lmer’ from the ‘lme4’ package. It implements permutation tests for assessing the bias of fixed effects, as described in Karl and Zimmerman (2021).

**Functions**

- `mixedbiastest` Performs the bias diagnostic test.
- `print.mixedbiastest` Prints the results of the bias diagnostic.
- `plot.mixedbiastest` Plots the permutation distributions and observed test statistics for each fixed effect.
- `list_fixed_effects` List Fixed Effects from an merMod Object.

**Acknowledgments**

Development of this package was assisted by GPT o1-preview, which helped in constructing the structure of much of the code and the roxygen documentation. The code is based on the R code provided by Karl and Zimmerman (2020).

**Author(s)**

**Maintainer:** Andrew T. Karl <akar1@asu.edu> ([ORCID](#))

**References**

Karl, A. T., & Zimmerman, D. L. (2021). A diagnostic for bias in linear mixed model estimators induced by dependence between the random effects and the corresponding model matrix. *Journal of Statistical Planning and Inference*, 212, 70–80. doi:10.1016/j.jspi.2020.06.004

Karl, A., & Zimmerman, D. (2020). Data and Code Supplement for ‘A Diagnostic for Bias in Linear Mixed Model Estimators Induced by Dependence Between the Random Effects and the Corresponding Model Matrix’. Mendeley Data, V1. doi:10.17632/tmynggddfm.1

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`example_data`*Example Dataset for the mixedbiastest Package*

---

**Description**

A dataset containing 97 observations of three variables: `y`, `x`, and `group`.

**Usage**

```
example_data
```

**Format**

A data frame with 97 rows and 3 variables:

**y** Numeric response variable.

**x** Numeric predictor variable.

**group** Integer indicating group membership.

---

`list_fixed_effects`*List Fixed Effects from a merMod Object*

---

**Description**

This function lists the fixed effects coefficients from an ‘lmerMod’/‘merMod’ object, providing the index and name of each coefficient. This can help users construct contrast vectors (‘k\_list’) for use with the ‘mixedbiastest’ function.

**Usage**

```
list_fixed_effects(model)
```

**Arguments**

`model`

An object of class ‘merMod’ fitted using ‘lmer’ from the ‘lme4’ package.

**Value**

A data frame with two columns:

**Index** The index of each fixed effect coefficient.

**Coefficient** The name of each fixed effect coefficient.

## Acknowledgments

Development of this package was assisted by GPT o1-preview, which helped in constructing the structure of much of the code and the roxygen documentation. The code is based on the R code provided by Karl and Zimmerman (2020).

## Examples

```
if (requireNamespace("plm", quietly = TRUE) && requireNamespace("lme4", quietly = TRUE)) {
  library(lme4)
  data("Gasoline", package = "plm")
  # Fit a random effects model using lme4
  mixed_model <- lmer(lgaspcar ~ lincomep + lrpmpg + lcarpcap + (1 | country),
    data = Gasoline, REML = FALSE)

  # List fixed effects
  fixed_effects <- list_fixed_effects(mixed_model)
  print(fixed_effects)
}
```

---

mixedbiastest

*Bias Diagnostic for Linear Mixed Models*


---

## Description

Performs a permutation test to assess the bias of fixed effects in a linear mixed model fitted with ‘lmer’. This function computes the test statistic and performs the permutation test, returning an object of class “mixedbiastest”.

## Usage

```
mixedbiastest(model, n_permutations = 10000, k_list = NULL, verbose = FALSE)
```

## Arguments

|                |                                                                                                                                                             |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| model          | An object of class ‘lmerMod’ (or more generally ‘merMod’) fitted using ‘lmer’ from the ‘lme4’ package.                                                      |
| n_permutations | Integer. Number of permutations to perform (default is 10000).                                                                                              |
| k_list         | Optional list of numeric vectors. Each vector specifies a linear combination of fixed effects to test. If ‘NULL’, each fixed effect is tested individually. |
| verbose        | Logical. If ‘TRUE’, prints detailed messages during execution.                                                                                              |

## Details

**\*\*Note:\*\*** This function currently supports only models with diagonal random effects covariance matrices (i.e., the G matrix is diagonal). The methodology for non-diagonal G matrices is described in Karl and Zimmerman (2021), but is not implemented in this version of the package.

See the [list\\_fixed\\_effects](#) function if you would like to estimate the bias of a contrast of fixed effects.

## Value

An object of class "mixedbiastest" containing:

`results_table` A data frame with the test results for each fixed effect or contrast, including bias estimates and p-values.

`permutation_values` A list of numeric vectors containing permutation values for each fixed effect or contrast.

`model` The original lmerMod model object provided as input.

## Acknowledgments

Development of this package was assisted by GPT o1-preview, which helped in constructing the structure of much of the code and the roxygen documentation. The code is based on the R code provided by Karl and Zimmerman (2020).

## References

Karl, A. T., & Zimmerman, D. L. (2021). A diagnostic for bias in linear mixed model estimators induced by dependence between the random effects and the corresponding model matrix. *Journal of Statistical Planning and Inference*, 212, 70–80. doi:10.1016/j.jspi.2020.06.004

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## Examples

```
if (requireNamespace("plm", quietly = TRUE) && requireNamespace("lme4", quietly = TRUE)) {
  library(lme4)
  data("Gasoline", package = "plm")
  mixed_model <- lmer(lgaspcar ~ lincomep + lrpmpg + lcarpcap + (1 | country),
    data = Gasoline)
  result <- mixedbiastest(mixed_model)
  print(result); plot(result)
}
if (requireNamespace("lme4", quietly = TRUE)) {
  library(lme4)
  example_model <- lmer(y ~ x + (1 | group), data = example_data)
  result2 <- mixedbiastest(example_model)
  print(result2); plot(result2)

  # Simulate data
  set.seed(123)
  n_groups <- 30
  n_obs_per_group <- 10
  group <- rep(1:n_groups, each = n_obs_per_group)
  x <- runif(n_groups * n_obs_per_group)
  beta0 <- 2; beta1 <- 5
  sigma_u <- 1; sigma_e <- 0.5
  u <- rnorm(n_groups, 0, sigma_u)
  e <- rnorm(n_groups * n_obs_per_group, 0, sigma_e)
```

```

y <- beta0 + beta1 * x + u[group] + e

data_sim <- data.frame(y = y, x = x, group = factor(group))
model3 <- lmer(y ~ x + (1 | group), data = data_sim)
result3 <- mixedbiastest(model3, verbose = TRUE)
plot(result3)
}

```

---

plot.mixedbiastest      *Plot Method for Bias Diagnostic Results*

---

### Description

Plots the permutation distributions and observed test statistics for each fixed effect.

### Usage

```

## S3 method for class 'mixedbiastest'
plot(x, bins = 30, ...)

```

### Arguments

|      |                                                          |
|------|----------------------------------------------------------|
| x    | An object of class "mixedbiastest".                      |
| bins | Integer, number of bins for the histograms (default 30). |
| ...  | Additional arguments (currently not used).               |

### Value

A ggplot object (returned invisibly) showing permutation distributions for all fixed effects.

---

print.mixedbiastest      *Print Method for Bias Diagnostic Results*

---

### Description

Prints the results of the bias diagnostic in a formatted table.

### Usage

```

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

```

### Arguments

|     |                                            |
|-----|--------------------------------------------|
| x   | An object of class "mixedbiastest".        |
| ... | Additional arguments (currently not used). |

**Value**

No return value. This function is called for its side effects (printing the results).

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