

# Package ‘betaSandwich’

March 10, 2023

**Title** Robust Confidence Intervals for Standardized Regression Coefficients

**Version** 1.0.3.9000

**Description** Generates robust confidence intervals for standardized regression coefficients using heteroskedasticity-consistent standard errors for models fitted by `lm()` as described in Dudgeon (2017) <[doi:10.1007/s11336-017-9563-z](https://doi.org/10.1007/s11336-017-9563-z)>.

**URL** <https://github.com/jeksterslab/betaSandwich>,  
<https://jeksterslab.github.io/betaSandwich/>

**BugReports** <https://github.com/jeksterslab/betaSandwich/issues>

**License** MIT + file LICENSE

**Encoding** UTF-8

**LazyData** true

**Roxygen** list(markdown = TRUE)

**Depends** R (>= 3.5.0)

**Imports** methods

**Suggests** knitr, rmarkdown, testthat

**RoxygenNote** 7.2.3

**NeedsCompilation** no

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BetaADF	<i>Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Using the Asymptotic Distribution-Free Approach</i>
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**Description**

Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Using the Asymptotic Distribution-Free Approach

**Usage**

BetaADF(object)

**Arguments**

object                      Object of class lm.

**Details**

Note that while the calculation in BetaADF() is different from betaDelta::BetaDelta() with type = "adf", the results are numerically equivalent. BetaADF() is appropriate when sample sizes are moderate to large (n > 250). BetaHC() is recommended in most situations.

**Value**

Returns an object of class betasandwich which is a list with the following elements:

**call**    Function call.

**args**    Function arguments.

**lm\_process** Processed lm object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

### Author(s)

Ivan Jacob Agaloos Pesigan

### References

Browne, M. W. (1984). Asymptotically distribution-free methods for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology*, 37(1), 62–83. doi:[10.1111/j.20448317.1984.tb00789.x](https://doi.org/10.1111/j.20448317.1984.tb00789.x)

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:[10.1007/s113360179563z](https://doi.org/10.1007/s113360179563z)

### See Also

Other Beta Sandwich Functions: [BetaHC\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

### Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaADF(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

---

BetaHC	<i>Estimate Standardized Regression Coefficients and the Corresponding Robust Sampling Covariance Matrix Using the Heteroskedasticity Consistent Approach</i>
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### Description

Estimate Standardized Regression Coefficients and the Corresponding Robust Sampling Covariance Matrix Using the Heteroskedasticity Consistent Approach

**Usage**

```
BetaHC(object, type = "hc3", g1 = 1, g2 = 1.5, k = 0.7)
```

**Arguments**

<code>object</code>	Object of class <code>lm</code> .
<code>type</code>	Character string. Correction type. Possible values are "hc0", "hc1", "hc2", "hc3", "hc4", "hc4m", and "hc5".
<code>g1</code>	Numeric. g1 value for type = "hc4m" or type = "hc5".
<code>g2</code>	Numeric. g2 value for type = "hc4m".
<code>k</code>	Numeric. Constant for type = "hc5"

**Value**

Returns an object of class `betasandwich` which is a list with the following elements:

**call** Function call.

**args** Function arguments.

**lm\_process** Processed `lm` object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**References**

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:[10.1007/s113360179563z](https://doi.org/10.1007/s113360179563z)

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

## Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

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BetaN	<i>Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Assuming Multivariate Normality</i>
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---

## Description

Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Assuming Multivariate Normality

## Usage

```
BetaN(object)
```

## Arguments

**object**                      Object of class `lm`.

## Details

Note that while the calculation in `BetaN()` is different from `betaDelta::BetaDelta()` with `type = "mvn"`, the results are numerically equivalent. `BetaN()` assumes multivariate normality. `BetaHC()` is recommended in most situations.

## Value

Returns an object of class `betasandwich` which is a list with the following elements:

**call** Function call.

**args** Function arguments.

**lm\_process** Processed `lm` object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**References**

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:[10.1007/s113360179563z](https://doi.org/10.1007/s113360179563z)

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaN(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

---

coef.betasandwich	<i>Standardized Regression Slopes</i>
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**Description**

Standardized Regression Slopes

**Usage**

```
## S3 method for class 'betasandwich'
coef(object, ...)
```

**Arguments**

object	Object of class betasandwich.
...	additional arguments.

**Value**

Returns a vector of standardized regression slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
coef(std)
```

---

coef.diffbetasandwich *Differences of Standardized Regression Slopes*

---

**Description**

Differences of Standardized Regression Slopes

**Usage**

```
## S3 method for class 'diffbetasandwich'
coef(object, ...)
```

**Arguments**

object	Object of class diffbetasandwich.
...	additional arguments.

**Value**

Returns a vector of differences of standardized regression slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
coef(diff)
```

---

coef.rsqbetasandwich	<i>Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)</i>
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---

**Description**

Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

**Usage**

```
## S3 method for class 'rsqbetasandwich'
coef(object, ...)
```

**Arguments**

object	Object of class rsqbetasandwich.
...	additional arguments.

**Value**

Returns a vector of multiple correlation coefficients (R-squared and adjusted R-squared)

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
coef(rsq)
```

---

confint.betasandwich	<i>Confidence Intervals for Standardized Regression Slopes</i>
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---

**Description**

Confidence Intervals for Standardized Regression Slopes

**Usage**

```
## S3 method for class 'betasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```



**Arguments**

object	Object of class betasandwich.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

**Value**

Returns a matrix of confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
confint(std, level = 0.95)
```

---

confint.diffbetasandwich

*Confidence Intervals for Differences of Standardized Regression Slopes*

---

**Description**

Confidence Intervals for Differences of Standardized Regression Slopes

**Usage**

```
## S3 method for class 'diffbetasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```

**Arguments**

object	Object of class diffbetasandwich.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

**Value**

Returns a matrix of confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
confint(diff, level = 0.95)
```

---

confint.rsqbetasandwich

*Confidence Intervals for Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)*

---

**Description**

Confidence Intervals for Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

**Usage**

```
## S3 method for class 'rsqbetasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```

**Arguments**

object	Object of class rsqbetasandwich.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

**Value**

Returns a matrix of confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
confint(rsq, level = 0.95)
```

---

DiffBetaSandwich	<i>Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix</i>
------------------	---

---

**Description**

Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix

**Usage**

```
DiffBetaSandwich(object)
```

**Arguments**

object	Object of class betasandwich, that is, the output of the BetaHC(), BetaN(), or BetaADF() functions.
--------	---

**Value**

Returns an object of class diffbetasandwich which is a list with the following elements:

**fit** The argument object.

**vcov** Sampling covariance matrix of differences of standardized slopes.

**est** Vector of differences of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [BetaN\(\)](#), [RSqBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
# Methods -----
print(diff)
summary(diff)
coef(diff)
vcov(diff)
confint(diff, level = 0.95)
```

nas1982

*1982 National Academy of Sciences Doctoral Programs Data***Description**

1982 National Academy of Sciences Doctoral Programs Data

**Usage**

nas1982

**Format**

Ratings of 46 doctoral programs in psychology in the USA with the following variables:

**QUALITY** Program quality ratings.**NFACUL** Number of faculty members in the program.**NGRADS** Number of program graduates.**PCTSUPP** Percentage of program graduates who received support.**PCTGRT** Percent of faculty members holding research grants.**NARTIC** Number of published articles attributed to program faculty member.**PCTPUB** Percent of faculty with one or more published article.**References**

National Research Council. (1982). *An assessment of research-doctorate programs in the United States: Social and behavioral sciences*. doi:10.17226/9781. Reproduced with permission from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

print.betasandwich

*Print Method for an Object of Class betasandwich***Description**

Print Method for an Object of Class betasandwich

**Usage**

```
## S3 method for class 'betasandwich'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class betasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
print(std)
```

---

```
print.diffbetasandwich
```

*Print Method for an Object of Class diffbetasandwich*

---

**Description**

Print Method for an Object of Class diffbetasandwich

**Usage**

```
## S3 method for class 'diffbetasandwich'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class diffbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of differences of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
print(diff)
```

---

print.rsqbetasandwich *Print Method for an Object of Class rsqbetasandwich*

---

**Description**

Print Method for an Object of Class rsqbetasandwich

**Usage**

```
## S3 method for class 'rsqbetasandwich'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class rsqbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of multiple correlation coefficients (R-squared and adjusted R-squared), standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
print(rsq)
```

---

RSqBetaSandwich	<i>Estimate Multiple Correlation Coefficients (R-squared and adjusted R-squared) and the Corresponding Sampling Covariance Matrix</i>
-----------------	---

---

**Description**

Estimate Multiple Correlation Coefficients (R-squared and adjusted R-squared) and the Corresponding Sampling Covariance Matrix

**Usage**

```
RSqBetaSandwich(object)
```

**Arguments**

**object** Object of class `betasandwich`, that is, the output of the `BetaHC()`, `BetaN()`, or `BetaADF()` functions.

**Value**

Returns an object of class `rsqbetasandwich` which is a list with the following elements:

**fit** The argument object.

**vcov** Sampling covariance matrix of multiple correlation coefficients (R-squared and adjusted R-squared).

**est** Vector of multiple correlation coefficients (R-squared and adjusted R-squared).

**Author(s)**

Ivan Jacob Agaloos Pesigan

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
# Methods -----
print(rsq)
summary(rsq)
coef(rsq)
vcov(rsq)
confint(rsq, level = 0.95)
```

---

summary.betasandwich    *Summary Method for an Object of Class betasandwich*

---

### Description

Summary Method for an Object of Class betasandwich

### Usage

```
## S3 method for class 'betasandwich'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

### Arguments

object	Object of class betasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

### Value

Returns a matrix of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

### Author(s)

Ivan Jacob Agaloos Pesigan

### Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
summary(std)
```

---

summary.diffbetasandwich  
                                   *Summary Method for an Object of Class diffbetasandwich*

---

### Description

Summary Method for an Object of Class diffbetasandwich

### Usage

```
## S3 method for class 'diffbetasandwich'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```



**Arguments**

object	Object of class diffbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of differences of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
summary(diff)
```

---

summary.rsqbetasandwich

*Summary Method for an Object of Class rsqbetasandwich*

---

**Description**

Summary Method for an Object of Class rsqbetasandwich

**Usage**

```
## S3 method for class 'rsqbetasandwich'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

object	Object of class rsqbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of multiple correlation coefficients (R-squared and adjusted R-squared), standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
summary(rsq)
```

---

vcov.betasandwich

*Sampling Covariance Matrix of the Standardized Regression Slopes*


---

**Description**

Sampling Covariance Matrix of the Standardized Regression Slopes

**Usage**

```
## S3 method for class 'betasandwich'
vcov(object, ...)
```

**Arguments**

object	Object of class betasandwich.
...	additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
vcov(std)
```

---

vcov.diffbetasandwich *Sampling Covariance Matrix of Differences of Standardized Regression Slopes*

---

### Description

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

### Usage

```
## S3 method for class 'diffbetasandwich'
vcov(object, ...)
```

### Arguments

object            Object of class diffbetasandwich.  
...               additional arguments.

### Value

Returns a matrix of the variance-covariance matrix of differences of standardized regression slopes.

### Author(s)

Ivan Jacob Agaloos Pesigan

### Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
vcov(diff)
```

---

vcov.rsqbetasandwich *Sampling Covariance Matrix of Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)*

---

### Description

Sampling Covariance Matrix of Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

### Usage

```
## S3 method for class 'rsqbetasandwich'
vcov(object, ...)
```

**Arguments**

<code>object</code>	Object of class <code>rsqbetasandwich</code> .
<code>...</code>	additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of multiple correlation coefficients (R-squared and adjusted R-squared).

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
vcov(rsq)
```

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