

# Package ‘betaDelta’

October 21, 2023

**Title** Confidence Intervals for Standardized Regression Coefficients

**Version** 1.0.3.9000

**Description** Generates confidence intervals for standardized regression coefficients using delta method standard errors for models fitted by `lm()` as described in Yuan and Chan (2011) <[doi:10.1007/s11336-011-9224-6](https://doi.org/10.1007/s11336-011-9224-6)> and Jones and Waller (2015) <[doi:10.1007/s11336-013-9380-y](https://doi.org/10.1007/s11336-013-9380-y)>. A description of the package and code examples are presented in Pesigan, Sun, and Cheung (2023) <[doi:10.1080/00273171.2023.2201277](https://doi.org/10.1080/00273171.2023.2201277)>.

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

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

**License** MIT + file LICENSE

**Encoding** UTF-8

**LazyData** true

**Roxygen** list(markdown = TRUE)

**Depends** R (>= 3.5.0)

**Imports** numDeriv

**Suggests** knitr, rmarkdown, testthat, betaSandwich

**RoxygenNote** 7.2.3

**NeedsCompilation** no

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BetaDelta	<i>Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix</i>
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**Description**

Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix

**Usage**

```
BetaDelta(object, type = "mvn", alpha = c(0.05, 0.01, 0.001))
```

**Arguments**

object	Object of class lm.
type	Character string. If type = "mvn", use the multivariate normal-theory approach. If type = "adf", use the asymptotic distribution-free approach.
alpha	Numeric vector. Significance level $\alpha$ .

**Value**

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

- call** Function call.
- args** Function arguments.
- lm\_process** Processed lm object.
- 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

Jones, J. A., & Waller, N. G. (2015). The normal-theory and asymptotic distribution-free (ADF) covariance matrix of standardized regression coefficients: Theoretical extensions and finite sample behavior. *Psychometrika*, 80(2), 365–378. doi:10.1007/s113360139380y

Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*. doi:10.1080/00273171.2023.2201277

Yuan, K.-H., & Chan, W. (2011). Biases and standard errors of standardized regression coefficients. *Psychometrika*, 76(4), 670–690. doi:10.1007/s1133601192246

See Also

Other Beta Delta Functions: [DiffBetaDelta\(\)](#)

Examples

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

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coef.betadelta	Standardized Regression Slopes
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Description

Standardized Regression Slopes

Usage

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

Arguments

object            Object of class betadelta.  
...               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 <- BetaDelta(object)
coef(std)
```

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coef.diffbetadelta	<i>Differences of Standardized Regression Slopes</i>
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**Description**

Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class diffbetadelta.
...	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 <- BetaDelta(object)
diff <- DiffBetaDelta(std)
coef(diff)
```

---

confint.betadelta	<i>Confidence Intervals for Standardized Regression Slopes</i>
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## Description

Confidence Intervals for Standardized Regression Slopes

## Usage

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

## Arguments

object	Object of class betadelta.
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 <- BetaDelta(object)  
confint(std, level = 0.95)
```

---

confint.diffbetadelta *Confidence Intervals for Differences of Standardized Regression Slopes*

---

## Description

Confidence Intervals for Differences of Standardized Regression Slopes

## Usage

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

## Arguments

object	Object of class diffbetadelta.
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 <- BetaDelta(object)  
diff <- DiffBetaDelta(std)  
confint(diff)
```

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DeltaGeneric*Delta Method Confidence Intervals (Generic)*

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**Description**

Calculates delta method confidence intervals for a function of parameters using a numerical Jacobian.

**Usage**

```
DeltaGeneric(  
  object,  
  def,  
  theta = 0,  
  alpha = c(0.05, 0.01, 0.001),  
  z = TRUE,  
  df  
)
```

**Arguments**

object	R object. Fitted model object with coef and vcov methods that return a named vector of estimated parameters and sampling variance-covariance matrix, respectively.
def	List of character strings. A list of defined functions of parameters. The string should be a valid R expression when parsed and should result a single value when evaluated.
theta	Numeric vector. Parameter values when the null hypothesis is true.
alpha	Numeric vector. Significance level/s.
z	Logical. If z = TRUE, use the standard normal distribution. If z = FALSE, use the t distribution.
df	Numeric. Degrees of freedom if z = FALSE.

**Value**

Returns a numeric matrix with the following variables:

**est** Estimates  
**se** Standard errors  
**t or z** Test statistics  
**p** p value  
**ci** Confidence intervals

**Author(s)**

Ivan Jacob Agaloos Pesigan

## Examples

```
object <- glm(
  formula = vs ~ wt + disp,
  family = "binomial",
  data = mtcars
)
def <- list("exp(wt)", "exp(disp)")
DeltaGeneric(
  object = object,
  def = def,
  alpha = 0.05
)
```

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DiffBetaDelta	<i>Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix</i>
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## Description

Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix

## Usage

```
DiffBetaDelta(object, alpha = c(0.05, 0.01, 0.001))
```

## Arguments

<b>object</b>	Object of class <code>betadelta</code> , that is, the output of the <a href="#">BetaDelta()</a> function.
<b>alpha</b>	Numeric vector. Significance level $\alpha$ .

## Value

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

**call** Function call.

**fit** The argument object.

**args** Function arguments.

**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 Delta Functions: [BetaDelta\(\)](#)



## Examples

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

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nas1982

1982 National Academy of Sciences Doctoral Programs Data

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## 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.

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print.betadelta	<i>Print Method for an Object of Class betadelta</i>
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---

## Description

Print Method for an Object of Class betadelta

## Usage

```
## S3 method for class 'betadelta'  
print(x, alpha = NULL, digits = 4, ...)
```

## Arguments

x	Object of class betadelta.
alpha	Numeric vector. Significance level $\alpha$ . If alpha = NULL, use the argument alpha used in x.
digits	Digits to print.
...	additional arguments.

## Value

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

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

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

---

print.diffbetadelta	<i>Print Method for an Object of Class diffbetadelta</i>
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---

## Description

Print Method for an Object of Class diffbetadelta

## Usage

```
## S3 method for class 'diffbetadelta'  
print(x, alpha = NULL, digits = 4, ...)
```

## Arguments

x	Object of class diffbetadelta.
alpha	Numeric vector. Significance level $\alpha$ . If alpha = NULL, use the argument alpha used in x.
digits	Digits to print.
...	additional arguments.

## Value

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

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

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

---

summary.betadelta	<i>Summary Method for an Object of Class betadelta</i>
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**Description**

Summary Method for an Object of Class betadelta

**Usage**

```
## S3 method for class 'betadelta'  
summary(object, alpha = NULL, digits = 4, ...)
```

**Arguments**

object	Object of class betadelta.
alpha	Numeric vector. Significance level $\alpha$ . If alpha = NULL, use the argument alpha used in object.
digits	Digits to print.
...	additional arguments.

**Value**

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

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

---

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

---

## Description

Summary Method for an Object of Class diffbetadelta

## Usage

```
## S3 method for class 'diffbetadelta'  
summary(object, alpha = NULL, digits = 4, ...)
```

## Arguments

object	Object of class diffbetadelta.
alpha	Numeric vector. Significance level $\alpha$ . If alpha = NULL, use the argument alpha used in object.
digits	Digits to print.
...	additional arguments.

## Value

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

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

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

---

vcov.betadelta	<i>Sampling Covariance Matrix of the Standardized Regression Slopes</i>
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**Description**

Sampling Covariance Matrix of the Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class betadelta.
...	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 <- BetaDelta(object)
vcov(std)
```

---

vcov.diffbetadelta	<i>Sampling Covariance Matrix of Differences of Standardized Regression Slopes</i>
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---

**Description**

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

<code>object</code>	Object of class <code>diffbetadelta</code> .
<code>...</code>	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 <- BetaDelta(object)
diff <- DiffBetaDelta(std)
vcov(diff)
```

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