

# 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)
```

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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)
```

**Description**

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

**Usage**

```
DeltaGeneric(
  func,
  mu,
  sigmacap,
  n,
  theta = 0,
  alpha = c(0.05, 0.01, 0.001),
  z = TRUE,
  df,
  test = FALSE
)
```

**Arguments**

<code>func</code>	An R function the input of which is <code>mu</code> . The function should return a vector of any length.
<code>mu</code>	Numeric vector. Input of <code>func</code> .
<code>sigmacap</code>	Numeric vector or matrix. Asymptotic covariance matrix of <code>mu</code> .
<code>n</code>	Sample size.
<code>theta</code>	Numeric vector. Parameter values when the null hypothesis is true.
<code>alpha</code>	Numeric vector. Significance level/s.
<code>z</code>	Logical. If <code>z = TRUE</code> , use the standard normal distribution. If <code>z = FALSE</code> , use the <code>t</code> distribution.
<code>df</code>	Numeric. Degrees of freedom if <code>z = FALSE</code> .
<code>test</code>	Logical. If <code>TRUE</code> , return only the results of hypothesis tests. If <code>FALSE</code> , return both results of hypothesis tests and confidence intervals.

**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

Note that if `test = TRUE`, the ci columns are omitted.

### Author(s)

Ivan Jacob Agaloos Pesigan

### Examples

```
g <- function(x) {
  1 / x
}
mu <- 100
sigmasq <- 225
n <- 30
DeltaGeneric(
  func = g,
  mu = mu,
  sigmacap = sigmasq,
  n = n
)
```

---

DiffBetaDelta

*Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix*

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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 <code>BetaDelta()</code> 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

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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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