

# Package ‘betaMC’

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**Title** Monte Carlo Confidence Intervals for Standardized Regression Coefficients

**Version** 1.0.0.9000

**Description** Generates Monte Carlo confidence intervals for standardized regression coefficients for models fitted by `lm()`.  
'betaMC' combines ideas from Monte Carlo confidence intervals for the indirect effect (Preacher and Selig, 2012 <[doi:10.1080/19312458.2012.679848](https://doi.org/10.1080/19312458.2012.679848)>) and the sampling covariance matrix of regression coefficients (Dudgeon, 2017 <[doi:10.1007/s11336-017-9563-z](https://doi.org/10.1007/s11336-017-9563-z)>) to generate confidence intervals for standardized regression coefficients.

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

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

**License** MIT + file LICENSE

**Encoding** UTF-8

**LazyData** true

**Roxygen** list(markdown = TRUE)

**Depends** R (>= 3.5.0)

**Imports** stats, methods

**Suggests** knitr, rmarkdown, testthat

**RoxygenNote** 7.2.3

**NeedsCompilation** no

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BetaMC	<i>Estimate Standardized Regression Coefficients and Generate Sampling Distributions Using the Monte Carlo Method</i>
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## Description

Estimate Standardized Regression Coefficients and Generate Sampling Distributions Using the Monte Carlo Method

## Usage

```
BetaMC(
  object,
  R = 20000L,
  type = "hc3",
  g1 = 1,
  g2 = 1.5,
  k = 0.7,
  decomposition = "eigen",
  pd = TRUE,
  tol = 1e-06
)
```

## Arguments

object	Object of class <code>lm</code> .
R	Positive integer. Number of Monte Carlo replications.

type	Character string. Sampling covariance matrix type. Possible values are "mvn", "adf", "hc0", "hc1", "hc2", "hc3", "hc4", "hc4m", and "hc5". type = "mvn" uses the normal-theory sampling covariance matrix. type = "adf" uses the asymptotic distribution-free sampling covariance matrix. type = "hc0" through "hc5" uses different versions of heteroskedasticity-consistent sampling covariance matrix.
g1	Numeric. g1 value for type = "hc4m" or type = "hc5".
g2	Numeric. g2 value for type = "hc4m".
k	Numeric. Constant for type = "hc5"
decomposition	Character string. Matrix decomposition of the sampling variance-covariance matrix for the data generation. If decomposition = "chol", use Cholesky decomposition. If decomposition = "eigen", use eigenvalue decomposition. If decomposition = "svd", use singular value decomposition.
pd	Logical. If pd = TRUE, check if the sampling variance-covariance matrix is positive definite using tol.
tol	Numeric. Tolerance used for pd.

### Details

The empirical sampling distribution of parameter estimates for the unstandardized regression model is generated using the Monte Carlo method, that is, random values of parameter estimates are sampled from the multivariate normal distribution using the estimated parameter vector as the mean vector and the specified sampling covariance matrix using the type argument as the covariance matrix. The standardized regression coefficients are derived from each randomly generated vector of parameters to generate the empirical sampling distribution of estimates of standardized slopes. Confidence intervals are generated by obtaining percentiles corresponding to  $100(1 - \alpha)\%$  from the generated sampling distribution of standardized slopes, where  $\alpha$  is the significance level.

### Value

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

**call** Function call.

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

**lm\_process** Pre-processed object of class `lm`.

**type** Standard error type.

**thetahatstar** Sampling distribution of standardized estimates.

**vcov** Sampling distribution of standardized estimates.

**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
- Preacher, K. J., & Selig, J. P. (2012). Advantages of Monte Carlo confidence intervals for indirect effects. *Communication Methods and Measures*, 6(2), 77-98. doi:10.1080/19312458.2012.679848

## See Also

Other Beta Monte Carlo Functions: [DiffBetaMC\(\)](#), [RSqBetaMC\(\)](#)

## Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

---

coef.betamc

*Standardized Regression Slopes*

---

## Description

Standardized Regression Slopes

## Usage

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

## Arguments

object	Object of class betamc.
...	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)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
coef(out)
```

coef.diffbetamc

*Differences of Standardized Regression Slopes***Description**

Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class diffbetamc.
...	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 <- BetaMC(object)
diff <- DiffBetaMC(std)
coef(diff)
```

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

Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class rsqbetamc.
...	additional arguments.

**Value**

Returns a vector of multiple correlation.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

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

**Description**

Confidence Intervals for Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class betamc.
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)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
confint(out, level = 0.95)
```

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confint.diffbetamc	<i>Confidence Intervals for Differences of Standardized Regression Slopes</i>
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**Description**

Confidence Intervals for Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class diffbetamc.
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 <- BetaMC(object)
diff <- DiffBetaMC(std)
confint(diff, level = 0.95)
```

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confint.rsqbetamc	<i>Confidence Intervals for Differences of Standardized Regression Slopes</i>
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---

**Description**

Confidence Intervals for Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class rsqbetamc.
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 <- BetaMC(object)
rsq <- RSqBetaMC(std)
confint(rsq, level = 0.95)
```

DiffBetaMC

*Estimate Differences of Standardized Slopes and Sampling Covariance Matrix*

**Description**

Estimate Differences of Standardized Slopes and Sampling Covariance Matrix

**Usage**

```
DiffBetaMC(object)
```

**Arguments**

**object**                      Object of class `betamc`, that is, the output of the `BetaMC()` function.

**Value**

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

**fit** The argument object.

**thetahatstar** Sampling distribution.

**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 Monte Carlo Functions: [BetaMC\(\)](#), [RSqBetaMC\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(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.betamc

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

Print Method for an Object of Class betamc

**Usage**

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

**Arguments**

x	Object of Class betamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
print(out)
```

---

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

---

**Description**

Print Method for an Object of Class diffbetamc

**Usage**

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

**Arguments**

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

**Value**

Returns a matrix of differences of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

---

print.rsqbetamc

*Print Method for an Object of Class rsqbetamc*

---

**Description**

Print Method for an Object of Class rsqbetamc

**Usage**

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

**Arguments**

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

**Value**

Returns a matrix of multiple correlation (R-squared and adjusted R-squared), standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

---

RSqBetaMC	<i>Estimate Differences of Standardized Slopes and Sampling Covariance Matrix</i>
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---

**Description**

Estimate Differences of Standardized Slopes and Sampling Covariance Matrix

**Usage**

```
RSqBetaMC(object)
```

**Arguments**

**object**                      Object of class `betamc`, that is, the output of the `BetaMC()` function.

**Value**

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

**fit** The argument object.

**thetahatstar** Sampling distribution.

**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 Monte Carlo Functions: [BetaMC\(\)](#), [DiffBetaMC\(\)](#)

**Examples**

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

---

summary.betamc	<i>Summary Method for an Object of Class betamc</i>
----------------	---

---

**Description**

Summary Method for an Object of Class betamc

**Usage**

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

**Arguments**

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

**Value**

Returns a matrix of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
summary(out)
```

---

summary.diffbetamc	<i>Summary Method for an Object of Class diffbetamc</i>
--------------------	---

---

**Description**

Summary Method for an Object of Class diffbetamc

**Usage**

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

**Arguments**

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

**Value**

Returns a matrix of differences of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

---

summary.rsqbetamc	<i>Summary Method for an Object of Class rsqbetamc</i>
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---

**Description**

Summary Method for an Object of Class rsqbetamc

**Usage**

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

**Arguments**

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

**Value**

Returns a matrix of multiple correlation (R-squared and adjusted R-squared), standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

---

vcov.betamc

*Sampling Covariance Matrix of the Standardized Regression Slopes*


---

**Description**

Sampling Covariance Matrix of the Standardized Regression Slopes

**Usage**

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

**Arguments**

object            Object of class betamc.  
...                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)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
vcov(out)
```



---

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

---

**Description**

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object            Object of class diffbetamc.  
...               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 <- BetaMC(object)
diff <- DiffBetaMC(std)
vcov(diff)
```

---

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

---

**Description**

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

**Usage**

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

**Arguments**

object	Object of class rsqbetamc.
...	additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of multiple correlation.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

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

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