betaMC: Staging

Ivan Jacob Agaloos Pesigan

Staging...

1 Monte Carlo Simulation

```
# Fit the regression model
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
# Generate the sampling distribution of parameter estimates
mc <- MC(object, R = 20000, type = "mvn", seed = 42)
mc

#> Call:
#> MC(object = object, R = 20000, type = "mvn", seed = 42)
#> The first set of simulated parameter estimates
#> and model-implied covariance matrix.
#>
#> $coef
#> [1] 0.07870029 0.29032215 0.08937812
#>
#> $sigmasq
#> [1] 23.24249
#>
#> $vechsigmacapx
#> [1] 2532.6545  246.2173  270.4276  317.0434  138.1482  447.0203
#>
#> $sigmacapx
#>           [,1]     [,2]     [,3]
#> [1,] 2532.6545 246.2173 270.4276
#> [2,]  246.2173 317.0434 138.1482
#> [3,]  270.4276 138.1482 447.0203
#>
#> $sigmaysq
#> [1] 91.44796
#>
#> $sigmayx
#> [1] 294.9733 123.7695 101.3440
#>
```

```
#> $sigmacap
#>           [,1]      [,2]     [,3]     [,4]
#> [1,]  91.44796  294.9733 123.7695 101.3440
#> [2,] 294.97330 2532.6545 246.2173 270.4276
#> [3,] 123.76953  246.2173 317.0434 138.1482
#> [4,] 101.34404  270.4276 138.1482 447.0203
#>
#> $pd
#> [1] TRUE
```

2 Standardized Regression Slopes

```
out <- BetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4951 0.0765 20000 0.2361 0.2875 0.3368 0.6354 0.6813 0.7353
#> PCTGRT  0.3915 0.0761 20000 0.1416 0.1937 0.2379 0.5368 0.5819 0.6398
#> PCTSUPP 0.2632 0.0747 20000 0.0267 0.0779 0.1178 0.4093 0.4589 0.5320

summary(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4951 0.0765 20000 0.2361 0.2875 0.3368 0.6354 0.6813 0.7353
#> PCTGRT  0.3915 0.0761 20000 0.1416 0.1937 0.2379 0.5368 0.5819 0.6398
#> PCTSUPP 0.2632 0.0747 20000 0.0267 0.0779 0.1178 0.4093 0.4589 0.5320

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4951451 0.3914887 0.2632477

vcov(out)
```

```
#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.005849298 -0.003297148 -0.002165995
#> PCTGRT  -0.003297148  0.005796229 -0.001703916
#> PCTSUPP -0.002165995 -0.001703916  0.005574450

confint(out)

#>              2.5%     97.5%
#> NARTIC  0.3368306 0.6354279
#> PCTGRT  0.2378812 0.5368376
#> PCTSUPP 0.1177538 0.4092548
```

3 Multiple Correlation

```
out <- RSqMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8045 0.0560 20000 0.5397 0.6006 0.6623 0.8789 0.9038 0.9266
#> adj 0.7906 0.0601 20000 0.5069 0.5721 0.6382 0.8702 0.8969 0.9214

summary(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8045 0.0560 20000 0.5397 0.6006 0.6623 0.8789 0.9038 0.9266
#> adj 0.7906 0.0601 20000 0.5069 0.5721 0.6382 0.8702 0.8969 0.9214

coef(out)

#>       rsq       adj
#> 0.8045263 0.7905638

vcov(out)
```

```
#>             rsq         adj
#> rsq 0.003141591 0.003365990
#> adj 0.003365990 0.003606418

confint(out)

#>          2.5%     97.5%
#> rsq 0.6623081 0.8788682
#> adj 0.6381872 0.8702159
```

4 Semipartial Correlation

```
out <- SCorMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4312 0.0783 20000 0.1758 0.2242 0.2678 0.5736 0.6241 0.6966
#> PCTGRT  0.3430 0.0731 20000 0.1104 0.1577 0.1948 0.4805 0.5356 0.5935
#> PCTSUPP 0.2385 0.0699 20000 0.0228 0.0675 0.1016 0.3748 0.4250 0.4978

summary(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4312 0.0783 20000 0.1758 0.2242 0.2678 0.5736 0.6241 0.6966
#> PCTGRT  0.3430 0.0731 20000 0.1104 0.1577 0.1948 0.4805 0.5356 0.5935
#> PCTSUPP 0.2385 0.0699 20000 0.0228 0.0675 0.1016 0.3748 0.4250 0.4978

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4311525 0.3430075 0.2384789

vcov(out)
```

```
#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0061321623 -0.0012528441 -0.0009082182
#> PCTGRT  -0.0012528441  0.0053483029 -0.0007484783
#> PCTSUPP -0.0009082182 -0.0007484783  0.0048837434

confint(out)

#>              2.5%     97.5%
#> NARTIC  0.2677757 0.5736470
#> PCTGRT  0.1947635 0.4804929
#> PCTSUPP 0.1015873 0.3747518
```

5 Improvement in R-Squared

```
out <- DeltaRSqMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1859 0.0665 20000 0.0309 0.0502 0.0717 0.3291 0.3895 0.4852
#> PCTGRT  0.1177 0.0501 20000 0.0122 0.0249 0.0379 0.2309 0.2869 0.3522
#> PCTSUPP 0.0569 0.0341 20000 0.0005 0.0046 0.0103 0.1404 0.1807 0.2478

summary(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.1859 0.0665 20000 0.0309 0.0502 0.0717 0.3291 0.3895 0.4852
#> PCTGRT  0.1177 0.0501 20000 0.0122 0.0249 0.0379 0.2309 0.2869 0.3522
#> PCTSUPP 0.0569 0.0341 20000 0.0005 0.0046 0.0103 0.1404 0.1807 0.2478

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.1858925 0.1176542 0.0568722
```

```
vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0044289021 -0.0007116463 -0.0003586200
#> PCTGRT  -0.0007116463  0.0025137273 -0.0002249326
#> PCTSUPP -0.0003586200 -0.0002249326  0.0011662150

confint(out)

#>                2.5%     97.5%
#> NARTIC  0.07170384 0.3290709
#> PCTGRT  0.03793281 0.2308734
#> PCTSUPP 0.01031999 0.1404389
```

6 Squared Partial Correlation

```
out <- PCorMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4874 0.1057 20000 0.1107 0.1774 0.2463 0.6536 0.7115 0.7651
#> PCTGRT  0.3757 0.1070 20000 0.0506 0.1029 0.1466 0.5626 0.6249 0.6973
#> PCTSUPP 0.2254 0.0989 20000 0.0029 0.0192 0.0459 0.4256 0.5040 0.6004

summary(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4874 0.1057 20000 0.1107 0.1774 0.2463 0.6536 0.7115 0.7651
#> PCTGRT  0.3757 0.1070 20000 0.0506 0.1029 0.1466 0.5626 0.6249 0.6973
#> PCTSUPP 0.2254 0.0989 20000 0.0029 0.0192 0.0459 0.4256 0.5040 0.6004

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4874382 0.3757383 0.2253739
```

```
vcov(out)

#>                NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0111704616 6.346398e-04 2.324141e-04
#> PCTGRT  0.0006346398 1.144963e-02 6.321237e-05
#> PCTSUPP 0.0002324141 6.321237e-05 9.771910e-03

confint(out)

#>                2.5%     97.5%
#> NARTIC  0.24631873 0.6535594
#> PCTGRT  0.14663732 0.5625980
#> PCTSUPP 0.04591214 0.4255732
```

7 Differences of Standardized Slopes

```
out <- DiffBetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1351 20000 -0.3222 -0.2492 -0.1646 0.3636 0.4396 0.5234
#> NARTIC-PCTSUPP 0.2319 0.1255 20000 -0.2169 -0.1058 -0.0219 0.4673 0.5376 0.6141
#> PCTGRT-PCTSUPP 0.1282 0.1216 20000 -0.2715 -0.1853 -0.1120 0.3615 0.4424 0.5251

summary(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1351 20000 -0.3222 -0.2492 -0.1646 0.3636 0.4396 0.5234
#> NARTIC-PCTSUPP 0.2319 0.1255 20000 -0.2169 -0.1058 -0.0219 0.4673 0.5376 0.6141
#> PCTGRT-PCTSUPP 0.1282 0.1216 20000 -0.2715 -0.1853 -0.1120 0.3615 0.4424 0.5251

coef(out)

#>  NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#>      0.1036564      0.2318974      0.1282410
```

```r
vcov(out)

#>                 NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018239823    0.009608525   -0.008631298
#> NARTIC-PCTSUPP   0.009608525    0.015755737    0.006147212
#> PCTGRT-PCTSUPP  -0.008631298    0.006147212    0.014778510

confint(out)

#>                         2.5%     97.5%
#> NARTIC-PCTGRT  -0.16461689 0.3636014
#> NARTIC-PCTSUPP -0.02186839 0.4672556
#> PCTGRT-PCTSUPP -0.11203309 0.3615385
```

8 Monte Carlo Simulation with Multiple Imputation

```r
set.seed(42)
nas1982_missing <- mice::ampute(nas1982)$amp
nas1982_missing

#>    QUALITY NFACUL NGRADS PCTSUPP PCTGRT NARTIC PCTPUB
#> 1       12     13     19      16      8     14     39
#> 2       23     29     72      67      3     61     66
#> 3       29     38    111      NA     13     68     68
#> 4       36     16     28      52     63     49     75
#> 5       44     40    104      64     53     NA     83
#> 6       21     14     28      59     29     65     79
#> 7       40     44     16      81     35     79     82
#> 8       42     NA     57      65     40    187     82
#> 9       24     16     18      87     19     NA     75
#> 10      30     37     41      43      8     NA     54
#> 11      20     20     45      26     25     49     50
#> 12       8     11     27       7      0      9     27
#> 13      NA     29    112      64     35     65     69
#> 14      14     14     57      10      0     11     43
#> 15      27     38    167      28     NA    196     84
#> 16      46     27    113      62     52    173     85
#> 17      NA     32    122      51     19     79     69
#> 18      42     NA    116      56     32    208     73
#> 19      33     32     54      49     19    120     69
#> 20      31     42     79      41     NA    114     71
#> 21      23     30     76      22     20     87     67
#> 22      18     NA     62      39      6     10     39
#> 23      29     41     98      41     12    101     66
```

```
#> 24      21     23     52      33      4     59     78
#> 25      45     NA    222      64     32    274     70
#> 26      25     26     63      39     NA    160     89
#> 27      18     16     24       4     31     39     63
#> 28      NA     38    154      55     34     84     63
#> 29      21     19     40       7      5     60     84
#> 30      24     16     18      25     63     31     63
#> 31      15     13     29      23     15     62     85
#> 32      15     23     41      51      4     24     NA
#> 33      36     32     69      65     16    122     75
#> 34      38     21     38      28     48     92     91
#> 35      32     28     90      70     36    117     61
#> 36      27     22     52      10     27    114     86
#> 37      16     20     80      46     10     19     40
#> 38      26     32     41      13      6     64     56
#> 39      NA     26     81      70     58    155    100
#> 40      26     40     81      42     10     70     68
#> 41      14     19     87      15      5     72     79
#> 42      12     17     26       9      6     15     59
#> 43      29     29     71      74     17     85     76
#> 44      34     27     20       0     29     79     57
#> 45      28     26     70      68     27     84     73
#> 46      NA     36     59      57     67    172     83
```

```
# Fit the regression model
## Note that this does not deal with missing values.
## The fitted model (`object`) is updated with each imputed data.
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982_missing)
# Generate the sampling distribution of parameter estimates
# using multiple imputation estimates and sampling covariance matrix
mc <- MCMI(object, R = 20000, type = "mvn", seed = 42,
           data = nas1982_missing, m = 100)
mc

#> Call:
#> MCMI(object = object, R = 20000, type = "mvn", seed = 42, data = nas1982_missing,
#>     m = 100)
#> The first set of simulated parameter estimates
#> and model-implied covariance matrix.
#>
#> $coef
#> [1] 0.08398719 0.29238900 0.07455049
#>
#> $sigmasq
#> [1] 18.11836
```

```
#>
#> $vechsigmacapx
#> [1] 2522.0829  399.7604  454.5402  316.4199  125.3370  607.1978
#>
#> $sigmacapx
#>           [,1]     [,2]     [,3]
#> [1,] 2522.0829 399.7604 454.5402
#> [2,]  399.7604 316.4199 125.3370
#> [3,]  454.5402 125.3370 607.1978
#>
#> $sigmaysq
#> [1] 97.12449
#>
#> $sigmayx
#> [1] 362.5944 135.4364 120.0896
#>
#> $sigmacap
#>           [,1]      [,2]     [,3]     [,4]
#> [1,]  97.12449  362.5944 135.4364 120.0896
#> [2,] 362.59438 2522.0829 399.7604 454.5402
#> [3,] 135.43638  399.7604 316.4199 125.3370
#> [4,] 120.08960  454.5402 125.3370 607.1978
#>
#> $pd
#> [1] TRUE
```

9 Standardized Regression Slopes

```
out <- BetaMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.5163 0.0774 20000  0.2620 0.3125 0.3589 0.6604 0.7028 0.7572
#> PCTGRT  0.3992 0.0786 20000  0.1583 0.1985 0.2441 0.5530 0.5999 0.6629
#> PCTSUPP 0.2312 0.0766 20000 -0.0074 0.0418 0.0844 0.3849 0.4366 0.5044

summary(out)
```

```
#> Call:
#> BetaMC(object = mc)
#>
#> Standardized regression slopes
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.5163 0.0774 20000  0.2620 0.3125 0.3589 0.6604 0.7028 0.7572
#> PCTGRT  0.3992 0.0786 20000  0.1583 0.1985 0.2441 0.5530 0.5999 0.6629
#> PCTSUPP 0.2312 0.0766 20000 -0.0074 0.0418 0.0844 0.3849 0.4366 0.5044

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.5162754 0.3991985 0.2312159

vcov(out)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.005990897 -0.003204737 -0.002518760
#> PCTGRT  -0.003204737  0.006179803 -0.001636130
#> PCTSUPP -0.002518760 -0.001636130  0.005871284

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.35894967 0.6604213
#> PCTGRT  0.24412867 0.5529630
#> PCTSUPP 0.08443888 0.3848915
```

10 Multiple Correlation

```
out <- RSqMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8049 0.0564 20000 0.5222 0.6150 0.6725 0.8935 0.9180 0.9413
#> adj 0.7910 0.0604 20000 0.4881 0.5875 0.6492 0.8859 0.9122 0.9371

summary(out)
```

```
#> Call:
#> RSqMC(object = mc)
#>
#> R-squared and adjusted R-squared
#> type = "mvn"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8049 0.0564 20000 0.5222 0.6150 0.6725 0.8935 0.9180 0.9413
#> adj 0.7910 0.0604 20000 0.4881 0.5875 0.6492 0.8859 0.9122 0.9371

coef(out)

#>       rsq       adj
#> 0.8048971 0.7909611

vcov(out)

#>              rsq         adj
#> rsq 0.003178407 0.003405436
#> adj 0.003405436 0.003648681

confint(out)

#>          2.5%     97.5%
#> rsq 0.6725408 0.8935486
#> adj 0.6491508 0.8859449
```

11 Semipartial Correlation

```
out <- SCorMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4526 0.0805 20000  0.1816 0.2431 0.2870 0.6012 0.6530 0.7130
#> PCTGRT  0.3543 0.0779 20000  0.1156 0.1626 0.2010 0.5045 0.5604 0.6300
#> PCTSUPP 0.2072 0.0702 20000 -0.0069 0.0355 0.0722 0.3470 0.4010 0.4662

summary(out)

#> Call:
```

```
#> SCorMC(object = mc)
#>
#> Semipartial correlations
#> type = "mvn"
#>            est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4526 0.0805 20000  0.1816 0.2431 0.2870 0.6012 0.6530 0.7130
#> PCTGRT  0.3543 0.0779 20000  0.1156 0.1626 0.2010 0.5045 0.5604 0.6300
#> PCTSUPP 0.2072 0.0702 20000 -0.0069 0.0355 0.0722 0.3470 0.4010 0.4662

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4526060 0.3543134 0.2071623

vcov(out)

#>               NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.006482871 -0.0009679920 -0.0012089669
#> PCTGRT  -0.000967992  0.0060634932 -0.0007671747
#> PCTSUPP -0.001208967 -0.0007671747  0.0049311174

confint(out)

#>               2.5%     97.5%
#> NARTIC  0.28704629 0.6012321
#> PCTGRT  0.20103711 0.5044822
#> PCTSUPP 0.07217763 0.3469582
```

12 Improvement in R-Squared

```
out <- DeltaRSqMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.2049 0.0721 20000 0.0330 0.0591 0.0824 0.3615 0.4264 0.5084
#> PCTGRT  0.1255 0.0557 20000 0.0134 0.0264 0.0404 0.2545 0.3140 0.3968
#> PCTSUPP 0.0429 0.0303 20000 0.0000 0.0013 0.0052 0.1204 0.1608 0.2173

summary(out)
```

```
#> Call:
#> DeltaRSqMC(object = mc)
#>
#> Improvement in R-squared
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.2049 0.0721 20000 0.0330 0.0591 0.0824 0.3615 0.4264 0.5084
#> PCTGRT  0.1255 0.0557 20000 0.0134 0.0264 0.0404 0.2545 0.3140 0.3968
#> PCTSUPP 0.0429 0.0303 20000 0.0000 0.0013 0.0052 0.1204 0.1608 0.2173

coef(out)

#>     NARTIC     PCTGRT    PCTSUPP
#> 0.20485223 0.12553801 0.04291623

vcov(out)

#>                NARTIC        PCTGRT       PCTSUPP
#> NARTIC   0.0051971294 -0.0006153904 -0.0004330051
#> PCTGRT  -0.0006153904  0.0031044773 -0.0002054364
#> PCTSUPP -0.0004330051 -0.0002054364  0.0009202412

confint(out)

#>                2.5%     97.5%
#> NARTIC  0.082395574 0.3614800
#> PCTGRT  0.040415918 0.2545023
#> PCTSUPP 0.005209611 0.1203800
```

13 Squared Partial Correlation

```
out <- PCorMC(mc)
# Methods ------------------------------------------------------------
print(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.5672 0.1094 20000 0.1318 0.2080 0.2753 0.6987 0.7579 0.8157
#> PCTGRT  0.4454 0.1160 20000 0.0594 0.1082 0.1601 0.6090 0.6827 0.7620
#> PCTSUPP 0.2154 0.0996 20000 0.0001 0.0063 0.0251 0.4034 0.4839 0.5747
```

```
summary(out)

#> Call:
#> PCorMC(object = mc)
#>
#> Squared partial correlations
#> type = "mvn"
#>            est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.5672 0.1094 20000 0.1318 0.2080 0.2753 0.6987 0.7579 0.8157
#> PCTGRT  0.4454 0.1160 20000 0.0594 0.1082 0.1601 0.6090 0.6827 0.7620
#> PCTSUPP 0.2154 0.0996 20000 0.0001 0.0063 0.0251 0.4034 0.4839 0.5747

coef(out)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.5671748 0.4453821 0.2153953

vcov(out)

#>                NARTIC       PCTGRT      PCTSUPP
#> NARTIC  0.0119592796 0.0021232467 0.0001310655
#> PCTGRT  0.0021232467 0.0134581169 0.0003391276
#> PCTSUPP 0.0001310655 0.0003391276 0.0099271853

confint(out)

#>                2.5%     97.5%
#> NARTIC  0.27530649 0.6987267
#> PCTGRT  0.16011013 0.6089794
#> PCTSUPP 0.02508113 0.4034065
```

14 Differences of Standardized Slopes

```
out <- DiffBetaMC(mc)
# Methods ------------------------------------------------------
print(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1171 0.1363 20000 -0.3254 -0.2351 -0.1532 0.3805 0.4577 0.5422
#> NARTIC-PCTSUPP 0.2851 0.1300 20000 -0.1577 -0.0631  0.0203 0.5302 0.6005 0.6868
```

```
#> PCTGRT-PCTSUPP 0.1680 0.1238 20000 -0.2350 -0.1571 -0.0775 0.4073 0.4822 0.5610

summary(out)

#> Call:
#> DiffBetaMC(object = mc)
#>
#> Differences of standardized regression slopes
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1171 0.1363 20000 -0.3254 -0.2351 -0.1532 0.3805 0.4577 0.5422
#> NARTIC-PCTSUPP 0.2851 0.1300 20000 -0.1577 -0.0631  0.0203 0.5302 0.6005 0.6868
#> PCTGRT-PCTSUPP 0.1680 0.1238 20000 -0.2350 -0.1571 -0.0775 0.4073 0.4822 0.5610

coef(out)

#>  NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#>      0.1170769      0.2850595      0.1679825

vcov(out)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018580174    0.010078263   -0.008501911
#> NARTIC-PCTSUPP   0.010078263    0.016899700    0.006821437
#> PCTGRT-PCTSUPP  -0.008501911    0.006821437    0.015323348

confint(out)

#>                         2.5%     97.5%
#> NARTIC-PCTGRT  -0.15317974 0.3804541
#> NARTIC-PCTSUPP  0.02025922 0.5302107
#> PCTGRT-PCTSUPP -0.07750909 0.4073345
```

References

R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/