betaMC: Staging

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1 Standardized Slopes

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
mvn <- BetaMC(object, type = "mvn")
adf <- BetaMC(object, type = "adf")
hc3 <- BetaMC(object, type = "hc3")
summary(mvn)
summary(adf)
summary(hc3)
coef(mvn)
coef(adf)
coef(hc3)
vcov(mvn)
vcov(adf)
vcov(hc3)
confint(mvn)
confint(adf)
confint(hc3)
```

2 Multiple Correlation

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
std_mvn <- BetaMC(object, type = "mvn")
std_adf <- BetaMC(object, type = "adf")
std_hc3 <- BetaMC(object, type = "hc3")
mvn <- RSqBetaMC(std_mvn)
adf <- RSqBetaMC(std_adf)
hc3 <- RSqBetaMC(std_hc3)
summary(mvn)

#> Multiple correlation
#> 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(adf)

#> Multiple correlation
#> type = "adf"
#>        est     se     R 0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8045 0.0545 20000 0.552 0.6168 0.6672 0.8796 0.9018 0.9285
#> adj 0.7906 0.0583 20000 0.520 0.5894 0.6434 0.8709 0.8948 0.9234

summary(hc3)

#> Multiple correlation
#> type = "hc3"
#>        est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> rsq 0.8045 0.0627 20000 0.4816 0.5770 0.6414 0.8879 0.9116 0.9320
#> adj 0.7906 0.0672 20000 0.4446 0.5468 0.6158 0.8799 0.9053 0.9271

coef(mvn)

#>       rsq       adj
#> 0.8045263 0.7905638

coef(adf)

#>       rsq       adj
#> 0.8045263 0.7905638

coef(hc3)

#>       rsq       adj
#> 0.8045263 0.7905638

vcov(mvn)

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

vcov(adf)

#>             rsq         adj
#> rsq 0.002965697 0.003177533
#> adj 0.003177533 0.003404499

vcov(hc3)
```

```
#>             rsq         adj
#> rsq 0.003937405 0.004218648
#> adj 0.004218648 0.004519980

confint(mvn)

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

confint(adf)

#>          2.5%     97.5%
#> rsq 0.6671984 0.8795506
#> adj 0.6434268 0.8709471

confint(hc3)

#>          2.5%     97.5%
#> rsq 0.6414308 0.8879357
#> adj 0.6158187 0.8799311
```

3 Differences of Standardized Slopes

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
std_mvn <- BetaMC(object, type = "mvn")
std_adf <- BetaMC(object, type = "adf")
std_hc3 <- BetaMC(object, type = "hc3")
mvn <- DiffBetaMC(std_mvn)
adf <- DiffBetaMC(std_adf)
hc3 <- DiffBetaMC(std_hc3)
summary(mvn)

#> Difference between standardized regression coefficients
#> type = "mvn"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1348 20000 -0.3394 -0.2553 -0.1664 0.3605 0.4309 0.5247
#> NARTIC-PCTSUPP 0.2319 0.1248 20000 -0.1975 -0.0955 -0.0222 0.4668 0.5421 0.6061
#> PCTGRT-PCTSUPP 0.1282 0.1221 20000 -0.2649 -0.1856 -0.1151 0.3637 0.4380 0.5154

summary(adf)

#> Difference between standardized regression coefficients
#> type = "adf"
```

```
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1217 20000 -0.2892 -0.2061 -0.1340 0.3393 0.4167 0.5086
#> NARTIC-PCTSUPP 0.2319 0.1184 20000 -0.1535 -0.0806 -0.0067 0.4575 0.5322 0.6061
#> PCTGRT-PCTSUPP 0.1282 0.1208 20000 -0.2702 -0.1877 -0.1096 0.3605 0.4320 0.5173

summary(hc3)

#> Difference between standardized regression coefficients
#> type = "hc3"
#>                    est     se     R   0.05%    0.5%    2.5%  97.5%  99.5% 99.95%
#> NARTIC-PCTGRT  0.1037 0.1410 20000 -0.3408 -0.2609 -0.1764 0.3767 0.4649 0.5697
#> NARTIC-PCTSUPP 0.2319 0.1318 20000 -0.2054 -0.1191 -0.0367 0.4816 0.5588 0.6615
#> PCTGRT-PCTSUPP 0.1282 0.1363 20000 -0.3207 -0.2303 -0.1475 0.3878 0.4757 0.5592

coef(mvn)

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

coef(adf)

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

coef(hc3)

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

vcov(mvn)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018176173    0.009414899   -0.008761273
#> NARTIC-PCTSUPP   0.009414899    0.015565443    0.006150544
#> PCTGRT-PCTSUPP  -0.008761273    0.006150544    0.014911817

vcov(adf)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.014798908    0.007107739   -0.007691169
#> NARTIC-PCTSUPP   0.007107739    0.014008854    0.006901115
#> PCTGRT-PCTSUPP  -0.007691169    0.006901115    0.014592284

vcov(hc3)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.019893072    0.009333186   -0.010559887
#> NARTIC-PCTSUPP   0.009333186    0.017364424    0.008031238
#> PCTGRT-PCTSUPP  -0.010559887    0.008031238    0.018591125
```

```
confint(mvn)

#>                          2.5%     97.5%
#> NARTIC-PCTGRT  -0.16643898 0.3605034
#> NARTIC-PCTSUPP -0.02216683 0.4668334
#> PCTGRT-PCTSUPP -0.11511211 0.3636570

confint(adf)

#>                           2.5%     97.5%
#> NARTIC-PCTGRT  -0.134021679 0.3393289
#> NARTIC-PCTSUPP -0.006726061 0.4575467
#> PCTGRT-PCTSUPP -0.109611792 0.3605397

confint(hc3)

#>                          2.5%     97.5%
#> NARTIC-PCTGRT  -0.17641218 0.3767087
#> NARTIC-PCTSUPP -0.03669939 0.4815911
#> PCTGRT-PCTSUPP -0.14751144 0.3878389
```

4 Partial Correlations

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
std_mvn <- BetaMC(object, type = "mvn")
std_adf <- BetaMC(object, type = "adf")
std_hc3 <- BetaMC(object, type = "hc3")
mvn <- PCorBetaMC(std_mvn)
adf <- PCorBetaMC(std_adf)
hc3 <- PCorBetaMC(std_hc3)
summary(mvn)

#> Semipartial correlation (*)
#> Squared semipartial correlation (^)
#> Squared partial correlation (+)
#> type = "mvn"
#>             est     se     R  0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC*  0.4312 0.0769 20000 0.1725 0.2271 0.2704 0.5721 0.6236 0.6754
#> PCTGRT*  0.3430 0.0744 20000 0.1115 0.1549 0.1950 0.4870 0.5377 0.6034
#> PCTSUPP* 0.2385 0.0702 20000 0.0246 0.0646 0.1013 0.3773 0.4292 0.4951
#> NARTIC^  0.1859 0.0653 20000 0.0297 0.0516 0.0731 0.3273 0.3888 0.4562
#> PCTGRT^  0.1177 0.0513 20000 0.0124 0.0240 0.0380 0.2372 0.2891 0.3641
#> PCTSUPP^ 0.0569 0.0344 20000 0.0006 0.0042 0.0103 0.1423 0.1842 0.2451
```

```
#> NARTIC+  0.4874 0.1050 20000 0.1190 0.1810 0.2443 0.6561 0.7118 0.7788
#> PCTGRT+  0.3757 0.1086 20000 0.0561 0.0982 0.1464 0.5687 0.6338 0.7007
#> PCTSUPP+ 0.2254 0.1001 20000 0.0026 0.0184 0.0454 0.4289 0.5004 0.6071

summary(adf)

#> Semipartial correlation (*)
#> Squared semipartial correlation (^)
#> Squared partial correlation (+)
#> type = "adf"
#>             est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC*  0.4312 0.0709 20000  0.1137 0.2116 0.2721 0.5494 0.5937 0.6434
#> PCTGRT*  0.3430 0.0707 20000  0.0886 0.1495 0.1923 0.4670 0.5144 0.5748
#> PCTSUPP* 0.2385 0.0699 20000 -0.0069 0.0487 0.0962 0.3710 0.4199 0.4856
#> NARTIC^  0.1859 0.0583 20000  0.0129 0.0448 0.0740 0.3019 0.3525 0.4139
#> PCTGRT^  0.1177 0.0471 20000  0.0079 0.0224 0.0370 0.2181 0.2646 0.3304
#> PCTSUPP^ 0.0569 0.0334 20000  0.0001 0.0024 0.0093 0.1376 0.1763 0.2358
#> NARTIC+  0.4874 0.0987 20000  0.0520 0.1722 0.2449 0.6324 0.6830 0.7417
#> PCTGRT+  0.3757 0.1005 20000  0.0342 0.0939 0.1470 0.5356 0.5925 0.6478
#> PCTSUPP+ 0.2254 0.1040 20000  0.0003 0.0092 0.0381 0.4353 0.5170 0.6131

summary(hc3)

#> Semipartial correlation (*)
#> Squared semipartial correlation (^)
#> Squared partial correlation (+)
#> type = "hc3"
#>             est     se     R   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC*  0.4312 0.0862 20000  0.0630 0.1386 0.2238 0.5663 0.6186 0.6673
#> PCTGRT*  0.3430 0.0833 20000  0.0406 0.1056 0.1566 0.4894 0.5448 0.6017
#> PCTSUPP* 0.2385 0.0783 20000 -0.0242 0.0318 0.0793 0.3885 0.4442 0.5201
#> NARTIC^  0.1859 0.0686 20000  0.0040 0.0192 0.0501 0.3207 0.3827 0.4453
#> PCTGRT^  0.1177 0.0548 20000  0.0016 0.0112 0.0245 0.2395 0.2968 0.3621
#> PCTSUPP^ 0.0569 0.0379 20000  0.0000 0.0011 0.0063 0.1509 0.1973 0.2705
#> NARTIC+  0.4874 0.1188 20000  0.0166 0.0807 0.1776 0.6496 0.7081 0.7719
#> PCTGRT+  0.3757 0.1158 20000  0.0071 0.0489 0.1031 0.5568 0.6200 0.6828
#> PCTSUPP+ 0.2254 0.1136 20000  0.0000 0.0045 0.0264 0.4573 0.5433 0.6433

coef(mvn)

#>   NARTIC*   PCTGRT*  PCTSUPP*   NARTIC^   PCTGRT^  PCTSUPP^   NARTIC+   PCTGRT+
#> 0.4311525 0.3430075 0.2384789 0.1858925 0.1176542 0.0568722 0.4874382 0.3757383
#>  PCTSUPP+
#> 0.2253739

coef(adf)
```

```
#>   NARTIC*   PCTGRT*  PCTSUPP*   NARTIC^   PCTGRT^  PCTSUPP^   NARTIC+   PCTGRT+
#> 0.4311525 0.3430075 0.2384789 0.1858925 0.1176542 0.0568722 0.4874382 0.3757383
#>  PCTSUPP+
#> 0.2253739

coef(hc3)

#>   NARTIC*   PCTGRT*  PCTSUPP*   NARTIC^   PCTGRT^  PCTSUPP^   NARTIC+   PCTGRT+
#> 0.4311525 0.3430075 0.2384789 0.1858925 0.1176542 0.0568722 0.4874382 0.3757383
#>  PCTSUPP+
#> 0.2253739

vcov(mvn)

#>                NARTIC*       PCTGRT*      PCTSUPP*       NARTIC^       PCTGRT^
#> NARTIC*   0.0059161388 -0.0012263563 -0.0009278841  0.0049799442 -0.0008356455
#> PCTGRT*  -0.0012263563  0.0055358333 -0.0007933958 -0.0010399841  0.0037705586
#> PCTSUPP* -0.0009278841 -0.0007933958  0.0049346035 -0.0007748720 -0.0005318032
#> NARTIC^   0.0049799442 -0.0010399841 -0.0007748720  0.0042619315 -0.0007045054
#> PCTGRT^  -0.0008356455  0.0037705586 -0.0005318032 -0.0007045054  0.0026303544
#> PCTSUPP^ -0.0004355140 -0.0003614701  0.0023599249 -0.0003614984 -0.0002398980
#> NARTIC+   0.0064447242 -0.0018639922 -0.0014861388  0.0053367412 -0.0012886734
#> PCTGRT+  -0.0019579748  0.0068093849 -0.0014138810 -0.0016700430  0.0045715616
#> PCTSUPP+ -0.0015043814 -0.0013558583  0.0062957952 -0.0012641652 -0.0009193071
#>                PCTSUPP^       NARTIC+       PCTGRT+      PCTSUPP+
#> NARTIC*  -0.0004355140  0.0064447242 -0.0019579748 -0.0015043814
#> PCTGRT*  -0.0003614701 -0.0018639922  0.0068093849 -0.0013558583
#> PCTSUPP*  0.0023599249 -0.0014861388 -0.0014138810  0.0062957952
#> NARTIC^  -0.0003614984  0.0053367412 -0.0016700430 -0.0012641652
#> PCTGRT^  -0.0002398980 -0.0012886734  0.0045715616 -0.0009193071
#> PCTSUPP^  0.0011803405 -0.0007259279 -0.0006741267  0.0030063719
#> NARTIC+  -0.0007259279  0.0110247789  0.0007676880  0.0003465792
#> PCTGRT+  -0.0006741267  0.0007676880  0.0117882002  0.0001459964
#> PCTSUPP+  0.0030063719  0.0003465792  0.0001459964  0.0100156710

vcov(adf)

#>                NARTIC*       PCTGRT*      PCTSUPP*       NARTIC^       PCTGRT^
#> NARTIC*   5.028634e-03  0.0002658118 -0.0004205940  4.094629e-03  1.157608e-04
#> PCTGRT*   2.658118e-04  0.0049916523 -0.0005972769  1.248823e-04  3.288950e-03
#> PCTSUPP* -4.205940e-04 -0.0005972769  0.0048893563 -3.872846e-04 -4.084194e-04
#> NARTIC^   4.094629e-03  0.0001248823 -0.0003872846  3.394463e-03  4.432194e-05
#> PCTGRT^   1.157608e-04  0.0032889504 -0.0004084194  4.432194e-05  2.218059e-03
#> PCTSUPP^ -1.876976e-04 -0.0002793178  0.0022800680 -1.715467e-04 -1.881497e-04
#> NARTIC+   5.415814e-03 -0.0003987451 -0.0001659118  4.335206e-03 -3.561790e-04
#> PCTGRT+  -9.533291e-05  0.0058796846 -0.0005254089 -2.160941e-04  3.818595e-03
#> PCTSUPP+ -8.736019e-04 -0.0013241036  0.0065514198 -7.789682e-04 -8.976828e-04
```

```
#>                PCTSUPP^       NARTIC+       PCTGRT+      PCTSUPP+
#> NARTIC*  -0.0001876976  0.0054158142 -9.533291e-05 -0.0008736019
#> PCTGRT*  -0.0002793178 -0.0003987451  5.879685e-03 -0.0013241036
#> PCTSUPP*  0.0022800680 -0.0001659118 -5.254089e-04  0.0065514198
#> NARTIC^  -0.0001715467  0.0043352062 -2.160941e-04 -0.0007789682
#> PCTGRT^  -0.0001881497 -0.0003561790  3.818595e-03 -0.0008976828
#> PCTSUPP^  0.0011161618 -0.0001129437 -2.878173e-04  0.0030710959
#> NARTIC+  -0.0001129437  0.0097404442  2.454887e-03  0.0020006587
#> PCTGRT+  -0.0002878173  0.0024548870  1.009022e-02  0.0009317532
#> PCTSUPP+  0.0030710959  0.0020006587  9.317532e-04  0.0108103290

vcov(hc3)

#>                NARTIC*       PCTGRT*      PCTSUPP*       NARTIC^       PCTGRT^
#> NARTIC*   7.423956e-03  7.438224e-04 -4.279778e-05  5.825960e-03  0.0003379422
#> PCTGRT*   7.438224e-04  6.932795e-03 -5.609526e-04  3.550374e-04  0.0044866780
#> PCTSUPP* -4.279778e-05 -5.609526e-04  6.130689e-03 -1.225772e-04 -0.0004047363
#> NARTIC^   5.825960e-03  3.550374e-04 -1.225772e-04  4.706501e-03  0.0001441210
#> PCTGRT^   3.379422e-04  4.486678e-03 -4.047363e-04  1.441210e-04  0.0030083194
#> PCTSUPP^ -2.782215e-05 -2.690089e-04  2.875299e-03 -5.674647e-05 -0.0001870319
#> NARTIC+   8.320235e-03  6.719206e-05  2.426903e-04  6.371971e-03 -0.0001825980
#> PCTGRT+   5.721479e-04  8.139442e-03 -5.194384e-04  1.007423e-04  0.0051660330
#> PCTSUPP+ -3.372136e-04 -1.385889e-03  7.965035e-03 -4.106309e-04 -0.0009686970
#>                PCTSUPP^       NARTIC+       PCTGRT+      PCTSUPP+
#> NARTIC*  -2.782215e-05  8.320235e-03  0.0005721479 -0.0003372136
#> PCTGRT*  -2.690089e-04  6.719206e-05  0.0081394416 -0.0013858888
#> PCTSUPP*  2.875299e-03  2.426903e-04 -0.0005194384  0.0079650352
#> NARTIC^  -5.674647e-05  6.371971e-03  0.0001007423 -0.0004106309
#> PCTGRT^  -1.870319e-04 -1.825980e-04  0.0051660330 -0.0009686970
#> PCTSUPP^  1.432631e-03  3.172889e-05 -0.0003159322  0.0037503313
#> NARTIC+   3.172889e-05  1.411378e-02  0.0038281168  0.0031245868
#> PCTGRT+  -3.159322e-04  3.828117e-03  0.0134026471  0.0012744845
#> PCTSUPP+  3.750331e-03  3.124587e-03  0.0012744845  0.0129117964

confint(mvn)

#>                2.5%     97.5%
#> NARTIC*  0.27038508 0.5720578
#> PCTGRT*  0.19497167 0.4870015
#> PCTSUPP* 0.10126654 0.3772624
#> NARTIC^  0.07310809 0.3272501
#> PCTGRT^  0.03801395 0.2371704
#> PCTSUPP^ 0.01025491 0.1423269
#> NARTIC+  0.24429526 0.6560683
#> PCTGRT+  0.14640408 0.5687141
#> PCTSUPP+ 0.04539652 0.4288631
```

```r
confint(adf)

#>                  2.5%     97.5%
#> NARTIC*  0.272078447 0.5494239
#> PCTGRT*  0.192256455 0.4669597
#> PCTSUPP* 0.096235759 0.3709863
#> NARTIC^  0.074026683 0.3018666
#> PCTGRT^  0.036962545 0.2180513
#> PCTSUPP^ 0.009261321 0.1376308
#> NARTIC+  0.244860438 0.6324089
#> PCTGRT+  0.147043243 0.5356481
#> PCTSUPP+ 0.038143896 0.4353191

confint(hc3)

#>                  2.5%     97.5%
#> NARTIC*  0.223832034 0.5663042
#> PCTGRT*  0.156592577 0.4893858
#> PCTSUPP* 0.079340595 0.3884854
#> NARTIC^  0.050100782 0.3207004
#> PCTGRT^  0.024521235 0.2394984
#> PCTSUPP^ 0.006308955 0.1509209
#> NARTIC+  0.177598245 0.6495872
#> PCTGRT+  0.103062726 0.5568203
#> PCTSUPP+ 0.026375149 0.4573436
```

References

R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/