betaDelta: Staging

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1 Standardized Slopes

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
mvn <- BetaDelta(object, type = "mvn")
adf <- BetaDelta(object, type = "adf")
summary(mvn)

#> Call:
#> BetaDelta(object = object, type = "mvn")
#>
#> Standardized regression slopes with MVN standard errors:
#>            est     se      t df     p   0.05%   0.5%   2.5%  97.5%  99.5%
#> NARTIC  0.4951 0.0759 6.5272 42 0.000  0.2268 0.2905 0.3421 0.6482 0.6998
#> PCTGRT  0.3915 0.0770 5.0824 42 0.000  0.1190 0.1837 0.2360 0.5469 0.5993
#> PCTSUPP 0.2632 0.0747 3.5224 42 0.001 -0.0011 0.0616 0.1124 0.4141 0.4649
#>         99.95%
#> NARTIC  0.7635
#> PCTGRT  0.6640
#> PCTSUPP 0.5276

summary(adf)

#> Call:
#> BetaDelta(object = object, type = "adf")
#>
#> Standardized regression slopes with ADF standard errors:
#>            est     se      t df      p   0.05%   0.5%   2.5%  97.5%  99.5%
#> NARTIC  0.4951 0.0674 7.3490 42 0.0000  0.2568 0.3134 0.3592 0.6311 0.6769
#> PCTGRT  0.3915 0.0710 5.5164 42 0.0000  0.1404 0.2000 0.2483 0.5347 0.5830
#> PCTSUPP 0.2632 0.0769 3.4231 42 0.0014 -0.0088 0.0558 0.1081 0.4184 0.4707
#>         99.95%
#> NARTIC  0.7335
#> PCTGRT  0.6426
#> PCTSUPP 0.5353

coef(mvn)
```

```
#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4951451 0.3914887 0.2632477

coef(adf)

#>    NARTIC    PCTGRT   PCTSUPP
#> 0.4951451 0.3914887 0.2632477

vcov(mvn)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.005754524 -0.003360334 -0.002166127
#> PCTGRT  -0.003360334  0.005933462 -0.001769723
#> PCTSUPP -0.002166127 -0.001769723  0.005585256

vcov(adf)

#>               NARTIC       PCTGRT      PCTSUPP
#> NARTIC   0.004539472 -0.002552698 -0.001742698
#> PCTGRT  -0.002552698  0.005036538 -0.001906216
#> PCTSUPP -0.001742698 -0.001906216  0.005914088

confint(mvn)

#>             2.5 %    97.5 %
#> NARTIC  0.3420563 0.6482339
#> PCTGRT  0.2360380 0.5469395
#> PCTSUPP 0.1124272 0.4140682

confint(adf)

#>             2.5 %    97.5 %
#> NARTIC  0.3591757 0.6311146
#> PCTGRT  0.2482683 0.5347091
#> PCTSUPP 0.1080509 0.4184444
```

2 Differences of Standardized Slopes

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

```
#> Call:
#> DiffBetaDelta(object = std_mvn)
#>
#> Difference between standardized regression coefficients with MVN standard errors:
#>                   est     se      z      p   0.05%    0.5%    2.5%  97.5%
#> NARTIC-PCTGRT  0.1037 0.1357 0.7640 0.4449 -0.3428 -0.2458 -0.1623 0.3696
#> NARTIC-PCTSUPP 0.2319 0.1252 1.8524 0.0640 -0.1800 -0.0906 -0.0135 0.4773
#> PCTGRT-PCTSUPP 0.1282 0.1227 1.0451 0.2960 -0.2755 -0.1878 -0.1123 0.3688
#>                 99.5% 99.95%
#> NARTIC-PCTGRT  0.4531 0.5501
#> NARTIC-PCTSUPP 0.5544 0.6438
#> PCTGRT-PCTSUPP 0.4443 0.5320

summary(adf)

#> Call:
#> DiffBetaDelta(object = std_adf)
#>
#> Difference between standardized regression coefficients with ADF standard errors:
#>                   est     se      z      p   0.05%    0.5%    2.5%  97.5%
#> NARTIC-PCTGRT  0.1037 0.1212 0.8555 0.3923 -0.2950 -0.2084 -0.1338 0.3411
#> NARTIC-PCTSUPP 0.2319 0.1181 1.9642 0.0495 -0.1566 -0.0722  0.0005 0.4633
#> PCTGRT-PCTSUPP 0.1282 0.1215 1.0555 0.2912 -0.2716 -0.1847 -0.1099 0.3664
#>                 99.5% 99.95%
#> NARTIC-PCTGRT  0.4158 0.5024
#> NARTIC-PCTSUPP 0.5360 0.6204
#> PCTGRT-PCTSUPP 0.4412 0.5281

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

vcov(mvn)

#>                NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.018408653    0.009511262   -0.008897391
#> NARTIC-PCTSUPP   0.009511262    0.015672035    0.006160773
#> PCTGRT-PCTSUPP  -0.008897391    0.006160773    0.015058164

vcov(adf)
```

```
#>                 NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.014681407    0.006928651   -0.007752755
#> NARTIC-PCTSUPP   0.006928651    0.013938955    0.007010303
#> PCTGRT-PCTSUPP  -0.007752755    0.007010303    0.014763058

confint(mvn)

#>                       2.5 %    97.5 %
#> NARTIC-PCTGRT  -0.16226855 0.3695814
#> NARTIC-PCTSUPP -0.01346652 0.4772614
#> PCTGRT-PCTSUPP -0.11226950 0.3687516

confint(adf)

#>                         2.5 %    97.5 %
#> NARTIC-PCTGRT  -0.1338262589 0.3411391
#> NARTIC-PCTSUPP  0.0004975295 0.4632974
#> PCTGRT-PCTSUPP -0.1099011119 0.3663832
```

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/