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     p   0.05%   0.5%   2.5%  97.5%  99.5% 99.95%
#> NARTIC  0.4951 0.0759 6.5272 0.000  0.2268 0.2905 0.3421 0.6482 0.6998 0.7635
#> PCTGRT  0.3915 0.0770 5.0824 0.000  0.1190 0.1837 0.2360 0.5469 0.5993 0.6640
#> PCTSUPP 0.2632 0.0747 3.5224 0.001 -0.0011 0.0616 0.1124 0.4141 0.4649 0.5276

summary(adf)

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

#> Difference between standardized regression coefficients with MVN standard errors:
#>                    est     se      t      p   0.05%    0.5%    2.5%  97.5%
#> NARTIC-PCTGRT  0.1037 0.1357 0.7640 0.4491 -0.3763 -0.2624 -0.1702 0.3775
#> NARTIC-PCTSUPP 0.2319 0.1252 1.8524 0.0710 -0.2110 -0.1059 -0.0207 0.4845
#> PCTGRT-PCTSUPP 0.1282 0.1227 1.0451 0.3020 -0.3059 -0.2028 -0.1194 0.3759
#>                  99.5% 99.95%
#> NARTIC-PCTGRT  0.4697 0.5837
```

```
#> NARTIC-PCTSUPP 0.5697 0.6748
#> PCTGRT-PCTSUPP 0.4593 0.5624
```

```
summary(adf)
```

```
#> Difference between standardized regression coefficients with ADF standard errors:
#>                    est     se      t      p   0.05%    0.5%    2.5%  97.5%
#> NARTIC-PCTGRT  0.1037 0.1212 0.8555 0.3971 -0.3250 -0.2233 -0.1409 0.3482
#> NARTIC-PCTSUPP 0.2319 0.1181 1.9642 0.0561 -0.1858 -0.0866 -0.0064 0.4702
#> PCTGRT-PCTSUPP 0.1282 0.1215 1.0555 0.2973 -0.3016 -0.1996 -0.1170 0.3734
#>                  99.5% 99.95%
#> NARTIC-PCTGRT  0.4306 0.5323
#> NARTIC-PCTSUPP 0.5504 0.6496
#> PCTGRT-PCTSUPP 0.4561 0.5581
```

```
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  -0.17015387 0.3774667
#> NARTIC-PCTSUPP -0.02074216 0.4845371
#> PCTGRT-PCTSUPP -0.11940123 0.3758833
```

```
confint(adf)
```

```
#>                        2.5%     97.5%
#> NARTIC-PCTGRT  -0.140868200 0.3481810
#> NARTIC-PCTSUPP -0.006364043 0.4701589
#> PCTGRT-PCTSUPP -0.116962608 0.3734447
```

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/