

# betaSandwich: Staging

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Staging...

## References

- Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*, 58(6), 1183–1186. <https://doi.org/10.1080/00273171.2023.2201277>
- R Core Team. (2024). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. <https://www.R-project.org/>

## 1 Standardized Slopes

```
df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
mvn <- BetaN(object)
adf <- BetaADF(object)
hc3 <- BetaHC(object, type = "hc3")
summary(mvn)
```

#>		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)
```

#>		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

summary(hc3)

#>      est      se      t df      p  0.05%   0.5%   2.5%  97.5%  99.5%
#> NARTIC 0.4951 0.0786 6.3025 42 0.0000 0.2172 0.2832 0.3366 0.6537 0.7071
#> PCTGRT 0.3915 0.0818 4.7831 42 0.0000 0.1019 0.1707 0.2263 0.5567 0.6123
#> PCTSUPP 0.2632 0.0855 3.0786 42 0.0037 -0.0393 0.0325 0.0907 0.4358 0.4940
#>      99.95%
#> NARTIC 0.7731
#> PCTGRT 0.6810
#> PCTSUPP 0.5658

coef(mvn)

#>      NARTIC      PCTGRT      PCTSUPP
#> 0.4951451 0.3914887 0.2632477

coef(adf)

#>      NARTIC      PCTGRT      PCTSUPP
#> 0.4951451 0.3914887 0.2632477

coef(hc3)

#>      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

vcov(hc3)

#>      NARTIC      PCTGRT      PCTSUPP
#> NARTIC 0.006172168 -0.003602529 -0.001943469
#> PCTGRT -0.003602529 0.006699155 -0.002443584
#> PCTSUPP -0.001943469 -0.002443584 0.007311625

```

```

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

confint(hc3)

#>           2.5 %    97.5 %
#> NARTIC  0.33659828 0.6536920
#> PCTGRT  0.22631203 0.5566654
#> PCTSUPP 0.09068548 0.4358099

```

## 2 Multiple Correlation

```

df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
std_mvn <- BetaN(object)
std_adf <- BetaADF(object)
std_hc3 <- BetaHC(object, type = "hc3")
mvn <- RSqBetaSandwich(std_mvn)
adf <- RSqBetaSandwich(std_adf)
hc3 <- RSqBetaSandwich(std_hc3)
summary(mvn)

#>      est      se      t df      p    0.05%    0.5%    2.5%  97.5%  99.5%
#> rsq 0.8045 4.1345 0.1946 42 0.8467 -13.8224 -10.3507 -7.5393 9.1483 11.9598
#> adj 0.7906 4.4299 0.1785 42 0.8592 -14.8811 -11.1615 -8.1492 9.7304 12.7426
#>      99.95%
#> rsq 15.4314
#> adj 16.4622

summary(adf)

#>      est      se      t df      p    0.05%    0.5%    2.5%  97.5%  99.5%
#> rsq 0.8045 3.6172 0.2224 42 0.8251 -11.9923 -8.9550 -6.4953 8.1044 10.5640
#> adj 0.7906 3.8756 0.2040 42 0.8394 -12.9203 -9.6661 -7.0307 8.6118 11.2472

```

```

#>      99.95%
#> rsq 13.6014
#> adj 14.5015

summary(hc3)

#>      est      se      t df      p    0.05%    0.5%    2.5% 97.5% 99.5%
#> rsq 0.8045 3.9483 0.2038 42 0.8395 -13.1636 -9.8483 -7.1635 8.7725 11.4573
#> adj 0.7906 4.2303 0.1869 42 0.8527 -14.1753 -10.6231 -7.7466 9.3277 12.2043
#>      99.95%
#> rsq 14.7726
#> adj 15.7564

coef(mvn)

#>   rsq.rsq   adj.adj
#> 0.8045263 0.7905638

coef(adf)

#>   rsq.rsq   adj.adj
#> 0.8045263 0.7905638

coef(hc3)

#>   rsq.rsq   adj.adj
#> 0.8045263 0.7905638

vcov(mvn)

#>      rsq      adj
#> rsq 17.09432 18.31534
#> adj 18.31534 19.62358

vcov(adf)

#>      rsq      adj
#> rsq 13.08433 14.01893
#> adj 14.01893 15.02028

vcov(hc3)

#>      rsq      adj
#> rsq 15.58911 16.70262
#> adj 16.70262 17.89567

confint(mvn)

```

```

#>          2.5 %    97.5 %
#> rsq -7.539288  9.148341
#> adj -8.149238  9.730365

confint(adf)

#>          2.5 %    97.5 %
#> rsq -6.495334  8.104386
#> adj -7.030715  8.611842

confint(hc3)

#>          2.5 %    97.5 %
#> rsq -7.163476  8.772529
#> adj -7.746582  9.327709

```

### 3 Differences of Standardized Slopes

```

df <- nas1982
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = df)
std_mvn <- BetaN(object)
std_adf <- BetaADF(object)
std_hc3 <- BetaHC(object, type = "hc3")
mvn <- DiffBetaSandwich(std_mvn)
adf <- DiffBetaSandwich(std_adf)
hc3 <- DiffBetaSandwich(std_hc3)
summary(mvn)

#>          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)

#>          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

summary(hc3)

#>               est      se      z      p    0.05%    0.5%    2.5%  97.5%
#> NARTIC-PCTGRT  0.1037 0.1417 0.7316 0.4644 -0.3626 -0.2613 -0.1741 0.3814
#> NARTIC-PCTSUPP 0.2319 0.1318 1.7595 0.0785 -0.2018 -0.1076 -0.0264 0.4902
#> PCTGRT-PCTSUPP 0.1282 0.1375 0.9329 0.3509 -0.3241 -0.2259 -0.1412 0.3977
#>               99.5% 99.95%
#> NARTIC-PCTGRT  0.4686 0.5699
#> NARTIC-PCTSUPP 0.5714 0.6656
#> PCTGRT-PCTSUPP 0.4823 0.5806

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    0.018408653    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

vcov(hc3)

#>               NARTIC-PCTGRT NARTIC-PCTSUPP PCTGRT-PCTSUPP
#> NARTIC-PCTGRT    0.020076382    0.009274583   -0.010801799
#> NARTIC-PCTSUPP    0.009274583    0.017370731    0.008096148
#> PCTGRT-PCTSUPP   -0.010801799    0.008096148    0.018897947

```

```

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

confint(hc3)

#>                2.5 %    97.5 %
#> NARTIC-PCTGRT  -0.17405314 0.3813660
#> NARTIC-PCTSUPP -0.02642203 0.4902169
#> PCTGRT-PCTSUPP -0.14119483 0.3976769

```

## References

- Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*, 58(6), 1183–1186. <https://doi.org/10.1080/00273171.2023.2201277>
- R Core Team. (2024). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. <https://www.R-project.org/>