Power Analysis

Power Analysis

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

Running Code

When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

Imports

```
if (!require("pacman")) install.packages("pacman")
```

```
Loading required package: pacman
```

```
pacman::p_load("knitr","readr","tidyverse","lm.beta","BDEsize","foreign","lmtest","sandwic
```

Load Data

```
## load data
dataset_us <- read.dta(file = "dataset_us.dta")
dataset_ch <- read.dta(file = "dataset_ch.dta")
```

Models

```
## Vignette experiment, full factorial design (7 factors with two levels each: 2x2x2x2x2x2

## base models

reg_us <- lm(outcome ~ age + gender + family + nationality + education + benefits + permit
coeftest(reg_us, vcov = vcovCL, cluster = ~ResponseId)
```

```
t test of coefficients:

                   Estimate Std. Error t value  Pr(>|t|)
(Intercept)        5.859284   0.163195 35.9037 < 2.2e-16 ***
ageyoung          -0.028181   0.080188 -0.3514 0.7252745
genderwoman       -0.077652   0.081592 -0.9517 0.3412931
familysingle      -0.052363   0.083819 -0.6247 0.5321895
nationalityCanada  0.043405   0.080455  0.5395 0.5895735
educationhigh      0.887725   0.098715  8.9928 < 2.2e-16 ***
benefitsno         0.371886   0.098644  3.7700 0.0001652 ***
permittemporary    0.091460   0.091274  1.0020 0.3163777
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
reg_ch <- lm(outcome ~ age + gender + family + nationality + education + benefits + permit
coeftest(reg_ch, vcov = vcovCL, cluster = ~ResponseId)
```

```
t test of coefficients:

                    Estimate Std. Error t value  Pr(>|t|)
(Intercept)         5.740619   0.142199 40.3703 < 2.2e-16 ***
ageyoung            0.067611   0.079577  0.8496  0.395581
genderwoman         0.043811   0.075735  0.5785  0.562976
familysingle       -0.151091   0.076515 -1.9746  0.048373 *
nationalityGermany  0.251286   0.084465  2.9750  0.002946 **
educationhigh       0.942591   0.100204  9.4067 < 2.2e-16 ***
benefitsno          0.430369   0.083338  5.1642 2.527e-07 ***
permittemporary    -0.197713   0.076293 -2.5915  0.009589 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

STD noise

```
# calculate mean square of error of the noise (standard deviation of noise)
aov.model_us <- aov(outcome ~ age + gender + family + nationality + education + benefits +
(aov.model_us.std <- sqrt(summary(aov.model_us)[[1]]$`Mean Sq`[8]))
```

```
[1] 2.839875
```

```
# sqrt(8.1) = 2.8
aov.model_ch <- aov(outcome ~ age + gender + family + nationality + education + benefits +
(aov.model_ch.std <- sqrt(summary(aov.model_ch)[[1]]$`Mean Sq`[8]))
```

```
[1] 2.400373
```

```
# sqrt(5.8) = 2.4

# calculate standardised effect sizes (main effect)
(reg_us_beta<-lm.beta(reg_us)) #
```

```
Call:
lm(formula = outcome ~ age + gender + family + nationality +
    education + benefits + permit, data = dataset_us)

Standardized Coefficients::
      (Intercept)          ageyoung       genderwoman      familysingle
               NA      -0.004895875      -0.013490327      -0.009096869
nationalityCanada     educationhigh        benefitsno   permittemporary
      0.007540450       0.154210490       0.064607083       0.015888720
```

```
(reg_ch_beta<-lm.beta(reg_ch)) #
```

```
Call:
lm(formula = outcome ~ age + gender + family + nationality +
    education + benefits + permit, data = dataset_ch)
```

```
Standardized Coefficients::
       (Intercept)           ageyoung       genderwoman       familysingle
                NA        0.013749118        0.008908375       -0.030721126
nationalityGermany      educationhigh         benefitsno    permittemporary
       0.051101740        0.191681518        0.087519190       -0.040207021
```

Power Analysis

What is the statistical power to estimate the effects of benefits and permit?

Calculate optimal sample size and minimal detectable effect sizes

Conventional values for alpha (0.05) and beta (0.2)

Delta values from the model estimates above

CH Benefits

```
model.ch.benefits <- Size.Full(factor.lev=c(2,2,2,2,2,2,2),
                    interaction=F,
                    delta_type=1,
                    delta=c(abs(reg_ch_beta$standardized.coefficients["benefitsno"]),
                            0,
                            aov.model_ch.std),
                    alpha=0.05,
                    beta=0.2)
model.ch.benefits$model
```

```
[1] "A+B+C+D+E+F+G"
```

```
model.ch.benefits$n # optimal sample size
```

```
[1] 93
```

```
model.ch.benefits$Delta # minimal detectable standardised effect sizes
```

```
         A          B          C          D          E          F          G
0.03631674 0.03631674 0.03631674 0.03631674 0.03631674 0.03631674 0.03631674
```

CH Permit

```
model.ch.permits <- Size.Full(factor.lev=c(2,2,2,2,2,2,2),
                     interaction=F,
                     delta_type=1,
                     delta=c(abs(reg_ch_beta$standardized.coefficients["permittemporary"]),
                             0,
                             aov.model_ch.std),
                     alpha=0.05,
                     beta=0.2)
model.ch.permits$model
```

```
[1] "A+B+C+D+E+F+G"
```

```
model.ch.permits$n # optimal sample size
```

```
[1] 438
```

```
model.ch.permits$Delta # minimal detectable standardised effect sizes
```

```
         A          B          C          D          E          F          G
0.01673338 0.01673338 0.01673338 0.01673338 0.01673338 0.01673338 0.01673338
```

US Benefits

```
model.us.benefits <- Size.Full(factor.lev=c(2,2,2,2,2,2,2),
                     interaction=F,
                     delta_type=1,
                     delta=c(abs(reg_us_beta$standardized.coefficients["benefitsno"]),
                             0,
                             aov.model_us.std),
                     alpha=0.05,
                     beta=0.2)
model.us.benefits$model
```

```
[1] "A+B+C+D+E+F+G"
```

```
model.us.benefits$n # optimal sample size
```

```
[1] 237
```

```
model.us.benefits$Delta # minimal detectable standardised effect sizes
```

```
        A         B         C         D         E         F         G
0.0227485 0.0227485 0.0227485 0.0227485 0.0227485 0.0227485 0.0227485
```

US Permits

```
model.us.permits <- Size.Full(factor.lev=c(2,2,2,2,2,2,2),
                    interaction=F,
                    delta_type=1,
                    delta=c(abs(reg_us_beta$standardized.coefficients["permittemporary"]),
                            0,
                            aov.model_us.std),
                    alpha=0.05,
                    beta=0.2)
```

```
The optimal sample size will be greater than 1000.
You may increase the input argument 'maxsize'.
```

```
model.us.permits$model
```

```
NULL
```

```
model.us.permits$n # optimal sample size
```

```
NULL
```

```
model.us.permits$Delta # minimal detectable standardised effect sizes
```

```
NULL
```