Homework 8

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Research Question

Can a Bayesian regression method for censored data improve the internal and external validity of behavioral measures of risk taking?

Description of Variables

PAV: Primary Action Variable, number of times participants engaged in action during trial Pops: 1 = participant was penalized on that trial, 0 = participant was not penalized on that trial SubjectID: Factor variable with IDs of subject as levels BMRT: Factor variable with which behavioral measure of risk taking participant was taking Rep: Number of trials participant started for a given BMRT condition

Mathematical Expression of Model and Priors

$$PAV \mid \text{cens(Pops)} \sim \text{Poisson}(\lambda),$$

$$\log(\lambda) = \beta_0 + \beta_1 \cdot \text{BMRT} + \beta_2 \cdot \text{Rep} + u_{\text{SubjectID}},$$

$$u_{\text{SubjectID}} \sim \mathcal{N}(0, \sigma^2),$$

Code for Bayesian Analysis

Below is the code. We used 4 chains with 16,000 iterations (8,000 warm up) and 4 cores.

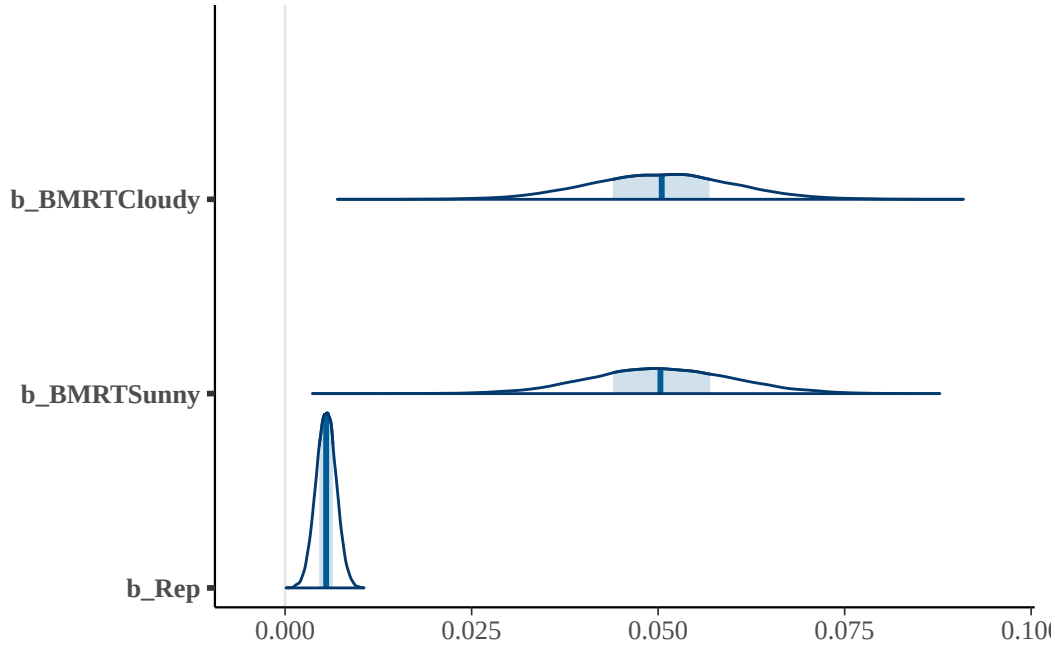
```r
censoredFit <- brm(
  PAV | cens(Pops) ~ BMRT + Rep + (1 | SubjectID),
  data = indvData,
  family = poisson(),
  prior = set_prior("student_t(3, 0, 2.5)", class = "b"),
  chains = 4,
  iter = 16000,
  warmup = 8000,
  cores = 4 ,
  control = list(adapt_delta = 0.99, max_treedepth = 15)
)
```

Convergence Check of MCMC

```
 Family: poisson
  Links: mu = log
Formula: PAV | cens(Pops) ~ BMRT + Rep + (1 | SubjectID)
   Data: indvData (Number of observations: 8960)
  Draws: 4 chains, each with iter = 16000; warmup = 8000; thin = 1;
         total post-warmup draws = 32000

Multilevel Hyperparameters:
~SubjectID (Number of levels: 296)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     0.53      0.02     0.49     0.57 1.00     1792     4067

Regression Coefficients:
           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept      2.11      0.03     2.05     2.17 1.01      734     1490
BMRTCloudy     0.05      0.01     0.03     0.07 1.00    32611    24582
BMRTSunny      0.05      0.01     0.03     0.07 1.00    32357    26069
Rep            0.01      0.00     0.00     0.01 1.00    57310    23308

Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
and Tail_ESS are effective sample size measures, and Rhat is the potential
scale reduction factor on split chains (at convergence, Rhat = 1).
```

The R hat values are close to 1 and all ESS values are above 400.

Posterior Distribution of Model Parameters



All posterior distributions are symmetric and bell shaped.

Interpretation of Results

Based on the results from the Bayesian censored regression we were successfully able to predict the number of actions participants would have taken if they had not been censored in their responses. This method shows participants increase their PAV across all 3 BMRT on average. Additionally, the transformed data correlate better with external measures of risk taking compared to the raw data.