

Comparison of single region models with school variable

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Data

```
regions <- c('Lazio', 'Lombardia', 'Abruzzo', 'Veneto', 'Emilia-Romagna', 'Toscana', 'Campania', 'Friuli Venezia Giulia', 'Sicilia', 'Calabria')

regions

## [1] "Lazio"           "Lombardia"        "Abruzzo"
## [4] "Veneto"          "Emilia-Romagna"   "Toscana"
## [7] "Campania"        "Friuli Venezia Giulia" "Sicilia"
## [10] "Calabria"

grouped_data <- get_hier_data(data_it, regions, initial_date = as.Date('2020-08-30') )

p_delay <- get_delay_distribution()

## school effect

school_opening <- as.Date('2020-09-14')
school <- rep(0, length(grouped_data$dates))
school[which(grouped_data$dates > school_opening +10)] <- 1
grow_school <- which(grouped_data$dates>=school_opening &grouped_data$dates <= school_opening +10)
school[grow_school] <- (grow_school - which(grouped_data$dates ==school_opening))^2 /100

## mask effect

masks_obligation <- as.Date('2020-10-13')
masks <- rep(0, length(grouped_data$dates))
masks[which(grouped_data$dates > masks_obligation +10)] <- 1
grow_masks <- which(grouped_data$dates>=masks_obligation &grouped_data$dates <=masks_obligation +10)
masks[grow_masks] <- (grow_masks - which(grouped_data$dates ==masks_obligation))^2 /100

stan_data_grouped <- list(J = length(regions),
                           N = nrow(grouped_data$exposures),
                           N_nonzero = length(grouped_data$nonzero_days),
                           nonzero_days = grouped_data$nonzero_days,
                           conv_gt = get_gt_convolution_ln2(nrow(grouped_data$exposures)),
                           length_delay = length(p_delay),
                           p_delay = p_delay,
                           exposures = grouped_data$exposures,
                           nonzero_positives = grouped_data$positives[grouped_data$nonzero_days ,],
                           school= school)
```

```

)

stan_data_grouped_2 <- list(J = length(regions),
                           N = nrow(grouped_data$exposures),
                           N_nonzero = length(grouped_data$nonzero_days),
                           nonzero_days = grouped_data$nonzero_days,
                           conv_gt = get_gt_convolution_ln2(nrow(grouped_data$exposures)),
                           length_delay = length(p_delay),
                           p_delay = p_delay,
                           exposures = grouped_data$exposures,
                           nonzero_positives = grouped_data$positives[grouped_data$nonzero_days ,],
                           school= school[grouped_data$nonzero_days]

)

compiled_grouped <- stan_model('..../stan/grouped_model_school.stan')

## Trying to compile a simple C file
## Running /Library/Frameworks/R.framework/Resources/bin/R CMD SHLIB foo.c
## clang -mmacosx-version-min=10.13 -I"/Library/Frameworks/R.framework/Resources/include" -DNDEBUG -I
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/include
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util
## namespace Eigen {
## ^
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util
## namespace Eigen {
## ^
## ;
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/include
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/Core:96:10: f
## #include <complex>
## ^
## 3 errors generated.
## make: *** [foo.o] Error 1
fit_grouped <- sampling(compiled_grouped, data= stan_data_grouped, iter=2000, cores=getOption("mc.cores"

##
## SAMPLING FOR MODEL 'grouped_model_school' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.021569 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 215.69 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 1: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 1: Iteration: 400 / 2000 [ 20%] (Warmup)
```

```

## Chain 1: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 1: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 1673.93 seconds (Warm-up)
## Chain 1:           1403.52 seconds (Sampling)
## Chain 1:           3077.45 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'grouped_model_school' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.008276 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 82.76 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 2: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 2: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 2: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 2: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 2:
## Chain 2: Elapsed Time: 1559.64 seconds (Warm-up)
## Chain 2:           1091.89 seconds (Sampling)
## Chain 2:           2651.53 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'grouped_model_school' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.009322 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 93.22 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 3: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 3: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 3: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 3: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%] (Sampling)

```

```

## Chain 3: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 3:
## Chain 3: Elapsed Time: 1578.05 seconds (Warm-up)
## Chain 3:           1295.37 seconds (Sampling)
## Chain 3:           2873.41 seconds (Total)
## Chain 3:
## 
## SAMPLING FOR MODEL 'grouped_model_school' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.008917 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 89.17 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 4: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 4: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 4: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 4: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 4:
## Chain 4: Elapsed Time: 1594.31 seconds (Warm-up)
## Chain 4:           1208.28 seconds (Sampling)
## Chain 4:           2802.59 seconds (Total)
## Chain 4:
compiled_grouped_2 <- stan_model('..../stan/grouped_model_school_2.stan')

## Trying to compile a simple C file

## Running /Library/Frameworks/R.framework/Resources/bin/R CMD SHLIB foo.c
## clang -mmacosx-version-min=10.13 -I"/Library/Frameworks/R.framework/Resources/include" -DNDEBUG -I
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/include
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util
## namespace Eigen {
## ^
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util
## namespace Eigen {
## ^
## ;
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/include
```

```

## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/Core:96:10: f
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/Core:96:10: f
## #include <complex>
## ~~~~~
## 3 errors generated.
## make: *** [foo.o] Error 1

fit_grouped_2 <- sampling(compiled_grouped_2, data= stan_data_grouped_2, iter=2000, cores=getOption("mc

##
## SAMPLING FOR MODEL 'grouped_model_school_2' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.016887 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 168.87 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 1: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 1: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 1: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 1: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 1327.39 seconds (Warm-up)
## Chain 1:           1206.7 seconds (Sampling)
## Chain 1:           2534.09 seconds (Total)
## Chain 1:
## 
## SAMPLING FOR MODEL 'grouped_model_school_2' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.008818 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 88.18 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration: 1 / 2000 [  0%] (Warmup)
## Chain 2: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 2: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 2: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 2: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 2:

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## Chain 2: Elapsed Time: 1426.42 seconds (Warm-up)
## Chain 2:           1153.69 seconds (Sampling)
## Chain 2:          2580.12 seconds (Total)
## Chain 2:
## 
## SAMPLING FOR MODEL 'grouped_model_school_2' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.009492 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 94.92 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration: 1 / 2000 [ 0%] (Warmup)
## Chain 3: Iteration: 200 / 2000 [ 10%] (Warmup)
## Chain 3: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 3: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 3: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 3:
## Chain 3: Elapsed Time: 1401.1 seconds (Warm-up)
## Chain 3:           1130.56 seconds (Sampling)
## Chain 3:          2531.66 seconds (Total)
## Chain 3:
## 
## SAMPLING FOR MODEL 'grouped_model_school_2' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.009031 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 90.31 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration: 1 / 2000 [ 0%] (Warmup)
## Chain 4: Exception: Exception: poisson_rng: Rate parameter is 0, but must be > 0! (in 'model654138a0899_grouped_model_school_2' at line 145)
## 
## Chain 4: Exception: Exception: poisson_rng: Rate parameter is 0, but must be > 0! (in 'model654138a0899_grouped_model_school_2' at line 145)
## 
## Chain 4: Exception: Exception: poisson_rng: Rate parameter is 0, but must be > 0! (in 'model654138a0899_grouped_model_school_2' at line 145)
## 
## Chain 4: Exception: Exception: poisson_rng: Rate parameter is 0, but must be > 0! (in 'model654138a0899_grouped_model_school_2' at line 145)
## 
## Chain 4: Iteration: 200 / 2000 [ 10%] (Warmup)

```

```

## Chain 4: Iteration: 400 / 2000 [ 20%] (Warmup)
## Chain 4: Iteration: 600 / 2000 [ 30%] (Warmup)
## Chain 4: Iteration: 800 / 2000 [ 40%] (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%] (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%] (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%] (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%] (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%] (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%] (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%] (Sampling)
## Chain 4:
## Chain 4: Elapsed Time: 1377.83 seconds (Warm-up)
## Chain 4:           1248.22 seconds (Sampling)
## Chain 4:           2626.05 seconds (Total)
## Chain 4:

## Warning in validityMethod(object): The following variables have undefined
## values: log_lik[1,1],The following variables have undefined values:
## log_lik[2,1],The following variables have undefined values: log_lik[3,1],The
## following variables have undefined values: log_lik[4,1],The following
## variables have undefined values: log_lik[5,1],The following variables have
## undefined values: log_lik[6,1],The following variables have undefined values:
## log_lik[7,1],The following variables have undefined values: log_lik[8,1],The
## following variables have undefined values: log_lik[9,1],The following
## variables have undefined values: log_lik[10,1],The following variables have
## undefined values: log_lik[11,1],The following variables have undefined values:
## log_lik[12,1],The following variables have undefined values: log_lik[13,1],The
## following variables have undefined values: log_lik[14,1],The following
## variables have undefined values: log_lik[15,1],The following variables have
## undefined values: log_lik[16,1],The following variables have undefined values:
## log_lik[17,1],The following variables have undefined values: log_lik[18,1],The
## following variables have undefined values: log_lik[19,1],The following
## variables have undefined values: log_lik[20,1],The following variables have
## undefined values: log_lik[21,1],The following variables have undefined values:
## log_lik[22,1],The following variables have undefined values: log_lik[23,1],The
## following variables have undefined values: log_lik[24,1],The following
## variables have undefined values: log_lik[25,1],The following variables have
## undefined values: log_lik[26,1],The following variables have undefined values:
## log_lik[27,1],The following variables have undefined values: log_lik[28,1],The
## following variables have undefined values: log_lik[29,1],The following
## variables have undefined values: log_lik[30,1],The following variables have
## undefined values: log_lik[31,1],The following variables have undefined values:
## log_lik[32,1],The following variables have undefined values: log_lik[33,1],The
## following variables have undefined values: log_lik[34,1],The following
## variables have undefined values: log_lik[35,1],The following variables have
## undefined values: log_lik[36,1],The following variables have undefined values:
## log_lik[37,1],The following variables have undefined values: log_lik[38,1],The
## following variables have undefined values: log_lik[39,1],The following
## variables have undefined values: log_lik[40,1],The following variables have
## undefined values: log_lik[41,1],The following variables have undefined values:
## log_lik[42,1],The following variables have undefined values: log_lik[43,1],The
## following variables have undefined values: log_lik[44,1],The following
## variables have undefined values: log_lik[45,1],The following variables have
## undefined values: log_lik[46,1],The following variables have undefined values:

```



```

## variables have undefined values: log_lik[29,2],The following variables have
## undefined values: log_lik[30,2],The following variables have undefined values:
## log_lik[31,2],The following variables have undefined values: log_lik[32,2],The
## following variables have undefined values: log_lik[33,2],The following
## variables have undefined values: log_lik[34,2],The following variables have
## undefined values: log_lik[35,2],The following variables have undefined values:
## log_lik[36,2],The following variables have undefined values: log_lik[37,2],The
## following variables have undefined values: log_lik[38,2],The following
## variables have undefined values: log_lik[39,2],The following variables have
## undefined values: log_lik[40,2],The following variables have undefined values:
## log_lik[41,2],The following variables have undefined values: log_lik[42,2],The
## following variables have undefined values: log_lik[43,2],The following
## variables have undefined values: log_lik[44,2],The following variables have
## undefined values: log_lik[45,2],The following variables have undefined values:
## log_lik[46,2],The following variables

```

School effect

Model 1

```

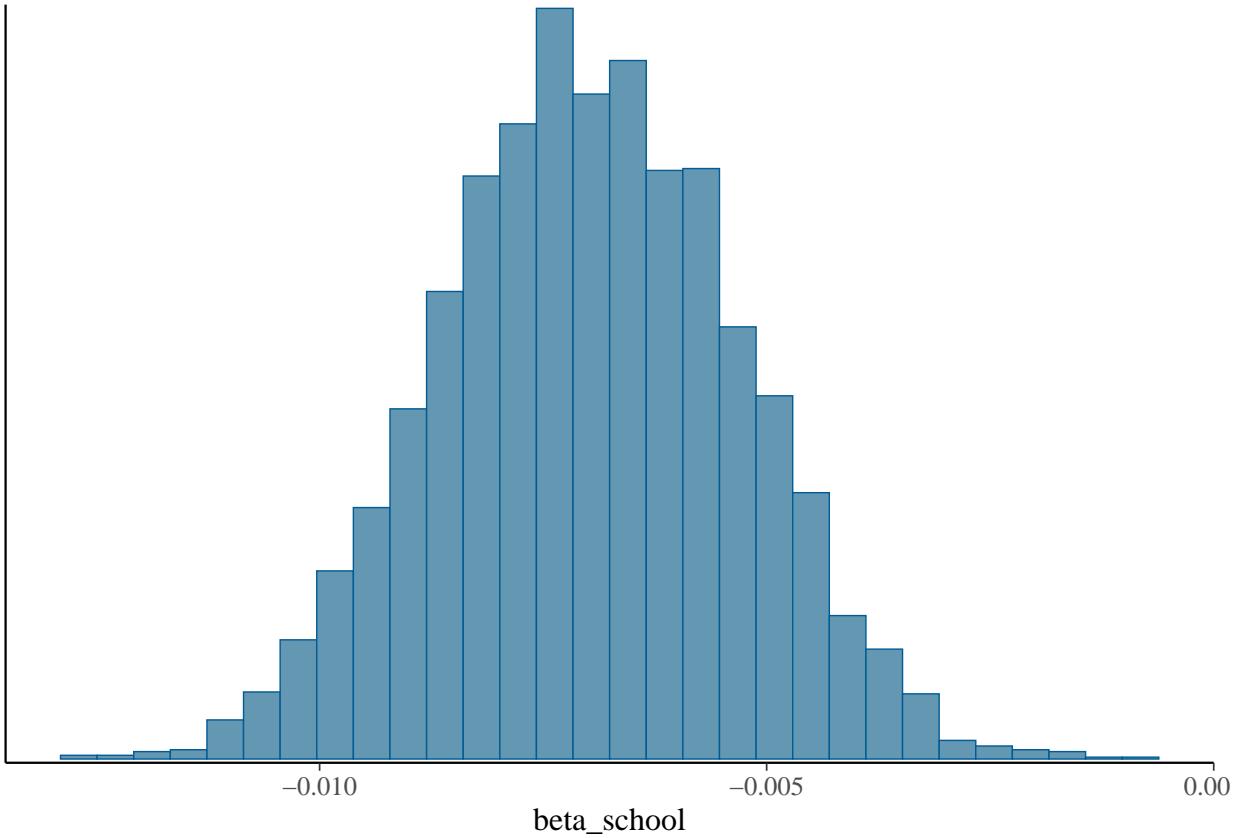
print(fit_grouped, pars='beta_school')

## Inference for Stan model: grouped_model_school.
## 4 chains, each with iter=2000; warmup=1000; thin=1;
## post-warmup draws per chain=1000, total post-warmup draws=4000.
##
##           mean se_mean sd  2.5%   25%   50%   75% 97.5% n_eff Rhat
## beta_school -0.01      0  0 -0.01 -0.01 -0.01 -0.01     0 2780    1
##
## Samples were drawn using NUTS(diag_e) at Fri Nov 27 15:12:56 2020.
## For each parameter, n_eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor on split chains (at
## convergence, Rhat=1).

mcmc_hist(fit_grouped, pars='beta_school')

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

```



Model 2

```

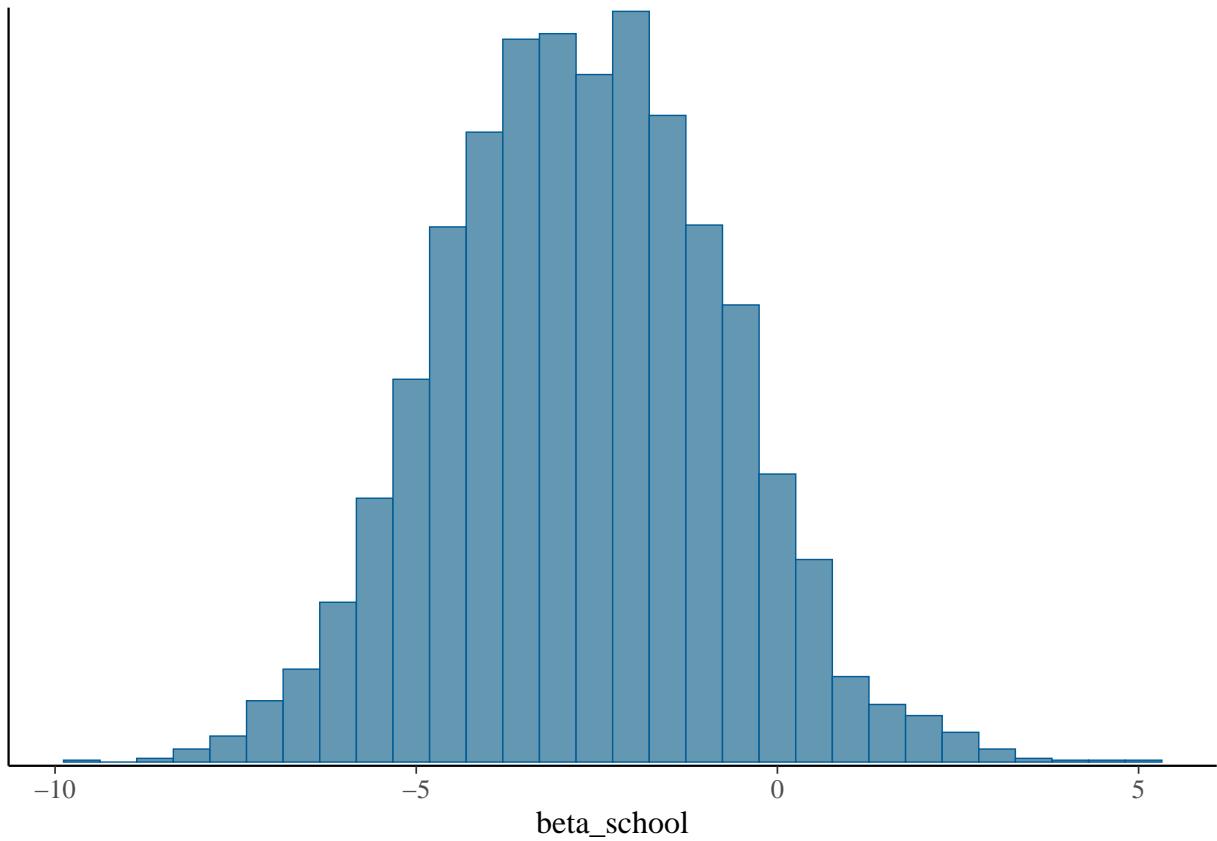
print(fit_grouped_2, pars='beta_school')

## Inference for Stan model: grouped_model_school_2.
## 4 chains, each with iter=2000; warmup=1000; thin=1;
## post-warmup draws per chain=1000, total post-warmup draws=4000.
##
##           mean se_mean    sd  2.5%   25%   50%   75% 97.5% n_eff Rhat
## beta_school -2.7    0.03 1.92 -6.43 -4.04 -2.71 -1.37  1.07  3168     1
##
## Samples were drawn using NUTS(diag_e) at Fri Nov 27 18:07:49 2020.
## For each parameter, n_eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor on split chains (at
## convergence, Rhat=1).

mcmc_hist(fit_grouped_2, pars='beta_school')

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

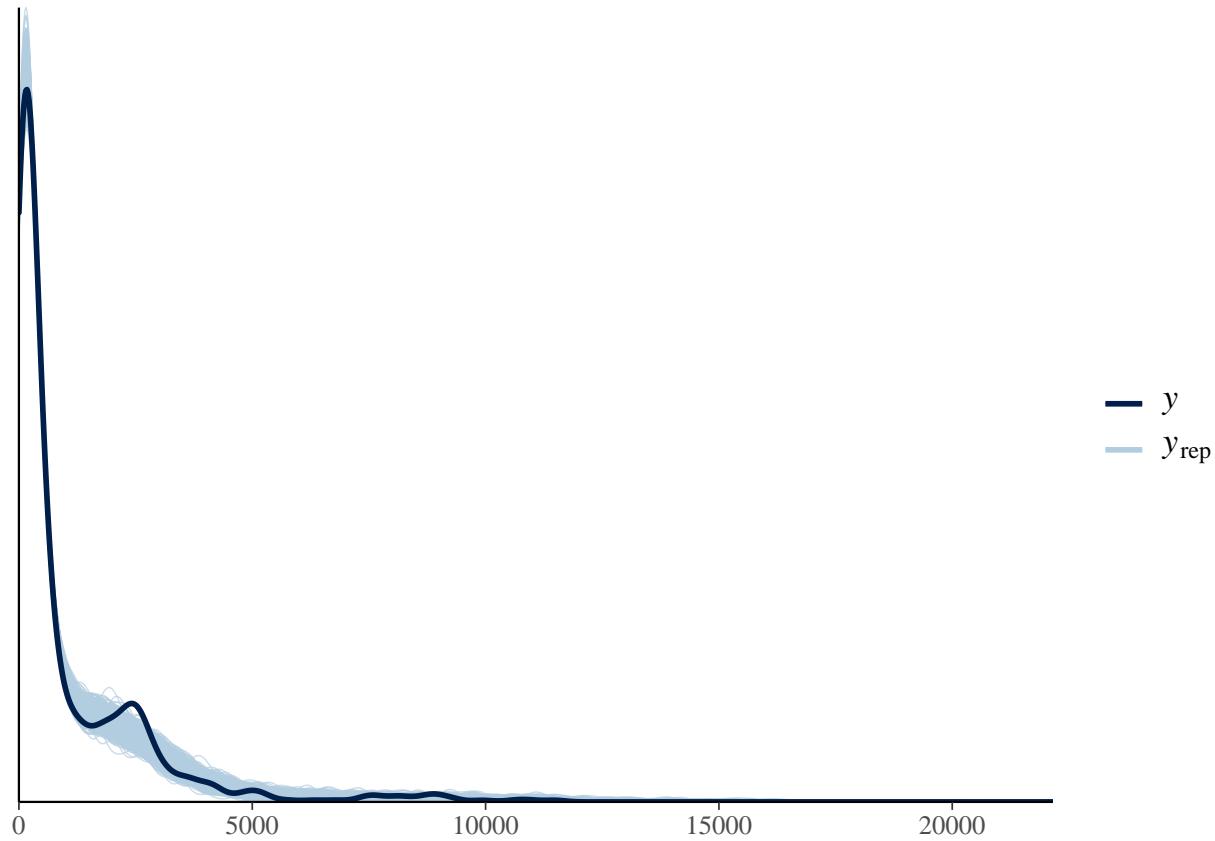
```



Posterior predictive check

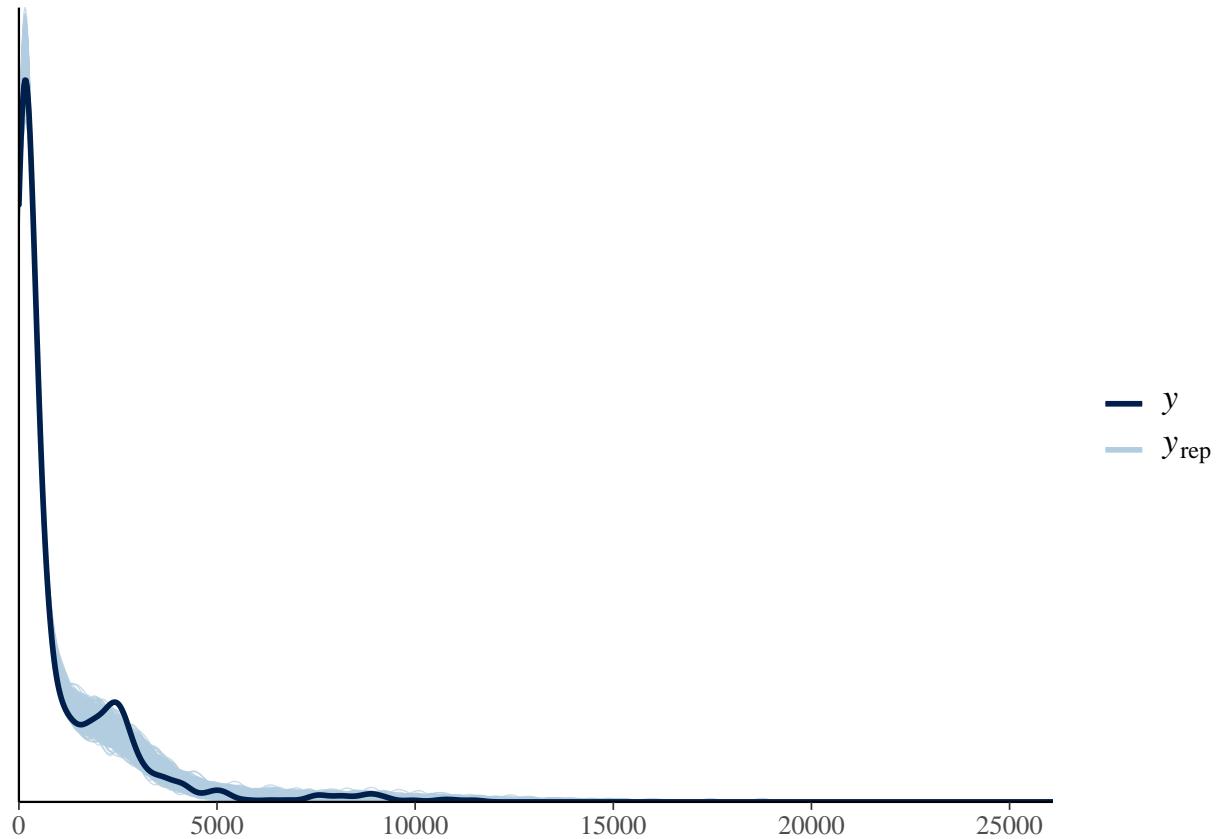
Model 1

```
y_rep <- as.matrix(fit_grouped, pars = "y_rep")
ppc_dens_overlay(y = as.vector(stan_data_grouped$nonzero_positives), y_rep[1:1000, ])
```



Model 2

```
y_rep_2 <- as.matrix(fit_grouped_2, pars = "y_rep")
ppc_dens_overlay(y = as.vector(stan_data_grouped_2$nonzero_positives), y_rep_2[1:1000, ])
```



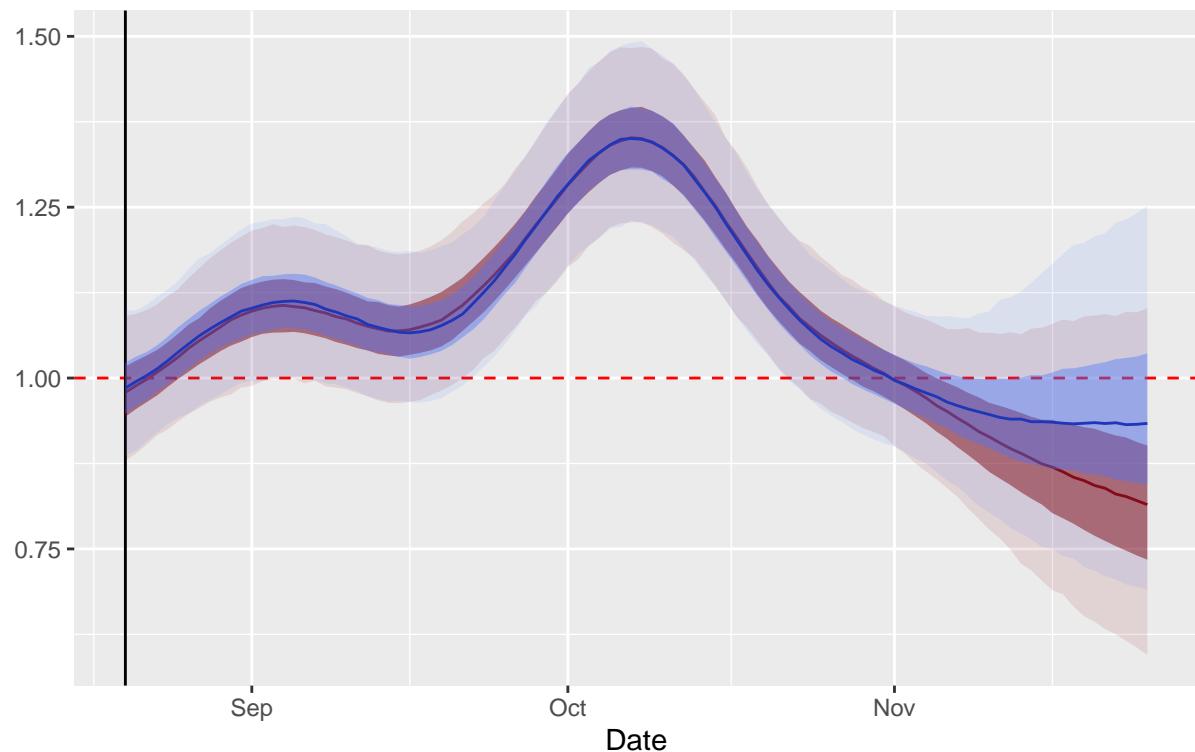
Rt

Lazio

```
p<-plot_rt_hier(grouped_data, fit_grouped, regions, 'Lazio')
plot_overlay(grouped_data, fit_grouped_2, regions , p, 'Lazio') +
  labs(subtitle = 'model 1 (red) vs model 2 (blue) ')
```

Rt Lazio

model 1 (red) vs model 2 (blue)

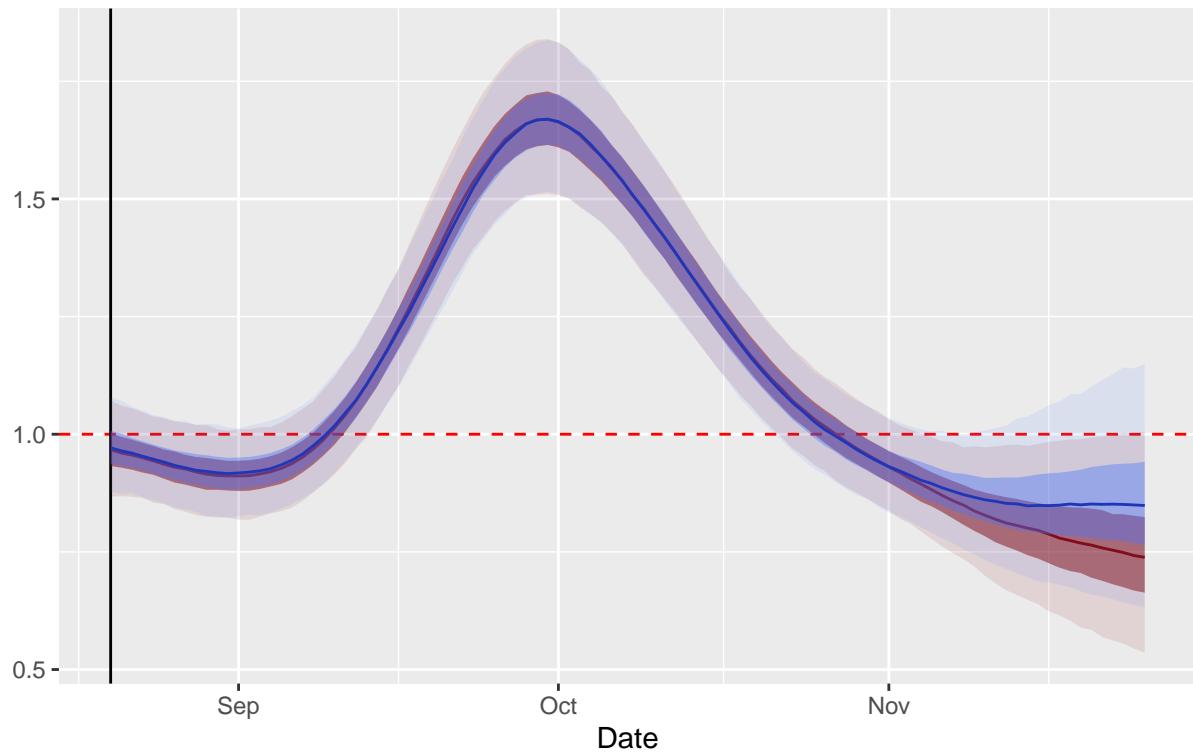


Lombardia

```
p<-plot_rt_hier(grouped_data, fit_grouped, regions, 'Lombardia')
plot_overlay(grouped_data, fit_grouped_2, regions , p, 'Lombardia') +
  labs(subtitle = 'model 1 (red) vs model 2 (blue) ')
```

Rt Lombardia

model 1 (red) vs model 2 (blue)

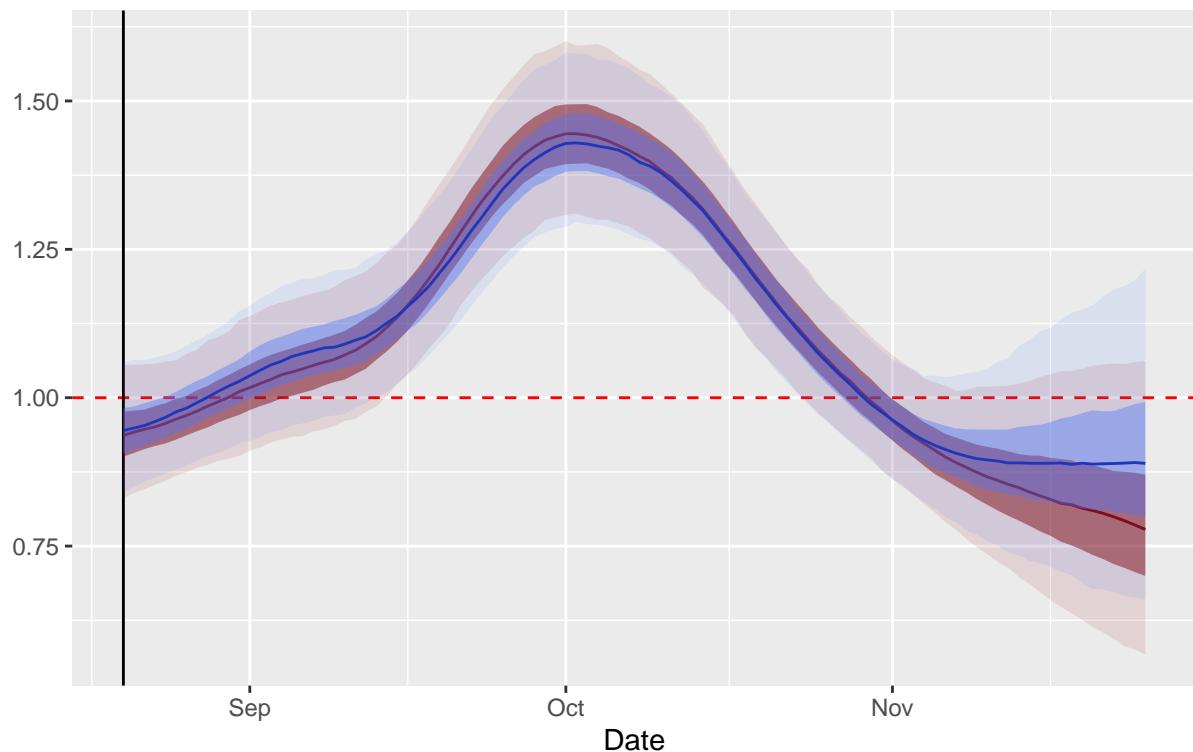


Abruzzo

```
p<-plot_rt_hier(grouped_data, fit_grouped, regions, 'Abruzzo')
plot_overlay(grouped_data, fit_grouped_2, regions , p, 'Abruzzo') +
  labs(subtitle = 'model 1 (red) vs model 2 (blue) ')
```

Rt Abruzzo

model 1 (red) vs model 2 (blue)



Model comparison

```
log_liik_1 <- extract_log_liik(fit_grouped)
loo_1 <- loo(log_liik_1)
waic_1 <- waic(log_liik_1)

log_liik_2 <- extract_log_liik(fit_grouped_2)
loo_2 <- loo(log_liik_2)
waic_2 <- waic(log_liik_2)

loo_compare(loo_1, loo_2)

##          elpd_diff se_diff
## model1    0.0      0.0
## model2 -5.1     2.1

looic
loo_1$estimates[3,1]

## [1] 10122.79
loo_2$estimates[3,1]

## [1] 10133.09

waic
```

```
loo_compare(waic_1, waic_2)

##          elpd_diff se_diff
## model1    0.0      0.0
## model2 -5.0     2.1
```