

Piecewise Regression with Negative Binomial Type I Error on Real Data using **brms** Custom Family

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Goal

- Fit two piece negative binomial type 1 formulation to data
- From 2023-02-28 version of `nbinom_type1.R`

Negative Binomial distribution parameterized by mean (μ) and overdispersion parameter (θ).

This parameterization is referred to as NEGBIN type I (Cameron and Trivedi, 1998) as cited by

<https://doi.org/10.1080/03610926.2018.1563164>

`x ~ nbinom_type1(mu, theta), where E(x) = mu, Var(x) = (theta + 1) mu`

This should not be confused with the μ and shape parameterization of `nbinom` in R or the ‘alternative’ NB (`neg_binomial_2...`) in stan

Note using `disp` instead of `theta` because using `theta` gives the error

> Error: Currently ‘dirichlet’ is the only valid prior for simplex parameters. See `help(set_prior)` for more details.

when trying to fit the model.

Recap

- Code initially based on work in
 - `../2022-12-20_rstan_two.piece.qpoisson.with.real.data/rstan_two.piece_fit.various.models.to.real.data`
 -
 - That model behaved well but, because I was writing stan code directly, I hadn’t been able to group data by `male`
- Since then, I’ve created a `brms custom_family()` which uses the Type 1 formulation of the NB.

Set up

Install libraries

```
# install packages user might not have by replacing FALSE with TRUE

## load libraries
library(stats)
library(MASS) # provides negative binomial fitting: glm.nb
library(ggplot2)
library(ggpubr)
library(grid)
library(gridExtra)
library(GGally)
library(broom)
library(tidyverse)
library(viridisLite)
library(cmdstanr)
library(rstan)
options(mc.cores = (parallel::detectCores()-2))
rstan_options(auto_write = TRUE)
library(brms)
library(loo)

## options(ggplot2.continuous.colour="viridis",
##         ggplot2.discrete.colour="viridis",
##         ggplot2.scale_fill_discrete = scale_fill_viridis_d,
##         ggplot2.scale_fill_continuous = scale_fill_viridis_c)

library(reshape2)
library(lme4)
library(latex2exp)

output_dir <- "output"
```

Source family

```
source(".././../custom-brms-families/families/nbinom_type1.R")
```

Load Data

```
sapply(file.path("input", dir("input")),
       load, verbose = TRUE, envir = .GlobalEnv)

## Loading objects:
##   data_ind
## Loading objects:
```

```
## summary_stats
## Loading objects:
## stats_ind

## input/data_ind.Rda input/obs_summary_stats.Rda
## "data_ind" "summary_stats"
## input/stats_ind.Rda
## "stats_ind"
```

```
head(stats_ind)
```

```
## # A tibble: 6 x 9
## male round n_obs total_round mean_round sd_round cv_round total mean
## <fct> <dbl> <int> <int> <dbl> <dbl> <dbl> <int> <dbl>
## 1 T234 1 13 203 40.6 32.0 0.787 601 46.2
## 2 T235 1 13 882 176. 132. 0.748 2333 179.
## 3 T236 1 13 758 152. 46.0 0.303 2095 161.
## 4 T243 1 13 438 87.6 76.4 0.872 1861 143.
## 5 T244 1 13 270 54 14.7 0.272 993 76.4
## 6 T246 1 5 253 50.6 54.6 1.08 253 50.6
```

```
names(stats_ind)
```

```
## [1] "male" "round" "n_obs" "total_round" "mean_round"
## [6] "sd_round" "cv_round" "total" "mean"
```

```
head(data_ind)
```

```
## # A tibble: 6 x 11
## male index motif~1 temp~2 temp round trial~3 date counter y0_si~4 phi_ind
## <chr> <int> <int> <dbl> <dbl> <dbl> <dbl> <chr> <chr> <dbl> <dbl>
## 1 T234 1 0 42 43.0 1 1 02/0~ RAS 46.2 12.3
## 2 T234 1 30 44 44.5 1 2 02/0~ RAS 46.2 12.3
## 3 T234 1 34 27 27.2 1 3 02/0~ RAS 46.2 12.3
## 4 T234 1 87 40 41.1 1 4 02/0~ RAS 46.2 12.3
## 5 T234 1 52 35 36.1 1 5 02/1~ RAS 46.2 12.3
## 6 T234 1 32 40 39.5 2 1 04/2~ KIM 46.2 12.3
## # ... with abbreviated variable names 1: motif_count, 2: temp_target,
## # 3: trial_round, 4: y0_simple_est
```

```
names(data_ind)
```

```
## [1] "male" "index" "motif_count" "temp_target"
## [5] "temp" "round" "trial_round" "date"
## [9] "counter" "y0_simple_est" "phi_ind"
```

Prior Work

Fit with Stan: Separate: y_0 , and x_0 , Pooled θ

- Based on results in ../2022-12-20_rstan_two.piece.qpoisson.with.real.data/rstan_two.piece_fit.various.m

- Histograms of `x0[]` suggest following groupings
 1. `c(2, 4, 6, 8, 11)`
 2. `c(1, 3, 5, 7, 10)`
 3. 9 is ambiguous.
- NOTE: I'm not 100% sure these index values are the same as the ones we are using here!

```
x0_groups_2_base <- list(low = c(2, 4, 6, 8, 11), high = c(1, 3, 5, 7, 10)) ## Does not include bird wi

x0_groups_2a <- x0_groups_2b <- x0_groups_2_base

x0_groups_2a$low <- c(x0_groups_2_base$low, 9) %>% sort()
x0_groups_2b$high <- c(x0_groups_2_base$high, 9) %>% sort()
```

Fit Models

- Code derived from `../2023-02-23_brms_nb_focus.on.x0.fittings/nb_focus.on.estimating.x0.fittings.Rmd`

Set up functions, parameters, and results tibble

```
data_stan <- data_ind %>% rename(y = motif_count, x = temp) %>%
  mutate(male = factor(male))

xmax <- 46
stan_two_piece_func <- paste0(" real two_piece(real x, real x0, real y0) {
  real xmax = ", xmax, "; ## paste in value for xmax
  ## return y0 * (xmax - fmax(x0, x))/(xmax - x0);
  real val1 = xmax - x;
  real val2 = xmax - x0;
  real b0 = -y0/(xmax - x0);
  real y = y0 - fmin(val1, val2)*b0;
  return(y);
} ")

models <- c("piecewise") #, "asymptotic")
sampling_dists <- c("nbinom_type1") ##, "com_poisson") ## lognormal doesn't work since the counts can b
flags_x0 <- c("uniform_1",
             "groups_1", ## this doesn't work with x0_Intercept prior, suggests error in priors
             "groups_2a",
             "groups_2b",
             "individual")

flags_y0 <- c("uniform_1", "groups_1", "individual")

disp_prior_list <- c(4, 8, 16, 32, 64, 128)

N <- length(data)

fit_tbl <- crossing(model = models,
                   sampling_dist = sampling_dists,
```

```

x0_flag = flags_x0, y0_flag = flags_y0,
disp_prior = disp_prior_list,
desc = "NA_character",
y0_group_list = list(NA), #tbl_tmp, #list(NA),
x0_group_list = list(NA),
fit = list(NA),
llik = list(NA),
r_eff = list(NA),
loo = list(NA)
)

```

Run fits

```

sampling = "nbinom_type1"
flag_category <- "individual_individual"

switch(flag_category,
  simple = { ## x0 and y0 have single, shared value
    flags_x0_used = "uniform_1"
    flags_y0_used = "uniform_1"
  },
  simple_individual = {
    flags_x0_used = "uniform_1"
    flags_y0_used = "individual"
  },
  group1_individual = {
    flags_x0_used = "groups_1"
    flags_y0_used = "individual"
  },
  individual_individual = { # values vary between males
    flags_x0_used = "individual"
    flags_y0_used = "individual"
  }
)

flags_x0_used = c("individual", "uniform_1", "group_1")
flags_y0_used = c("individual")

for(model in models[[1]]) {

  switch(sampling,
    "nbinom_type1"= {
      family <- nbinom_type1(link = "identity", link_disp = "log")
      adapt_delta <- 0.8 #0.95 ## will decreasing value increase ESS? Seems like it
      iter <- 15000 # could try <100000
      warmup <- floor(3/4 * iter)
      thin <- 1
      n_cores <- 4 ## set to 1 if getting errors from stan in order to see relevant message.
      n_chains <- n_cores
      nbinom_type1_vars <-
        stanvar(scode = paste(

```

```

        stan_two_piece_func,
        stan_nbinom_type1, sep = "\n"),
        block = "functions")
    }
  )

for(x0_flag in flags_x0_used) {
  for(y0_flag in flags_y0_used) {
    for(dispprior in dispprior_list) {
      ## Set up variables for saving model and fit
      desc <- paste0(model, ": ", sampling, "; x0 ", x0_flag, "; y0 ", y0_flag, ", dispprior: ", dispprior)
      curr_row <- which(fit_tbl$sampling_dist == sampling &
        fit_tbl$x0_flag == x0_flag &
        fit_tbl$y0_flag == y0_flag &
        fit_tbl$dispprior == dispprior)
      fit_tbl[curr_row, ]$desc <- desc

      print(desc)
      ## Refresh data in case x0_group or y0_group are all set to 1
      data <- data_stan

      ## Set flags based on fitted model structure
      if(x0_flag %in% c("uniform_1", "groups_1")) data <- mutate(data, x0_group = 1)
      if(y0_flag %in% c("uniform_1", "groups_1")) data <- mutate(data, y0_group = 1)
      if(x0_flag %in% c("individual")) data <- mutate(data, x0_group = male)
      if(y0_flag %in% c("individual")) data <- mutate(data, y0_group = male)

      ## Note we need to put a tibble into a list because row updates, even if doing
      ## just one cell, require a list format.
      fit_tbl[[curr_row, "x0_group_list"]] <- list(unique(data[, c("male", "x0_group")]))
      fit_tbl[[curr_row, "y0_group_list"]] <- list(unique(data[, c("male", "y0_group")]))

      ## Parameter Structure
      x0_form <- switch(x0_flag,
        uniform_1 = formula(x0 ~ 1),
        uniform_2 = formula(x0 ~ x0_group),
        # Don't include x0_group info which is determined by the data set
        groups_1 = formula(x0 ~ 1 + (1|male)),
        groups_2 = formula(x0 ~ 1 + (1|male) + x0_group),
        individual = formula(x0 ~ 0 + male) ## Do not use 1 + male!
      )

      y0_form <- switch(y0_flag,
        uniform_1 = formula(y0 ~ 1),
        uniform_2 = formula(y0 ~ 0 + 1 + y0_group),
        groups_1 = formula(y0 ~ 0 + 1 + (1|male)),
        groups_2 = formula(y0 ~ 0 + 1 + (1|male) + y0_group),
        individual = formula(y0 ~ 0 + male)
      )
      ## -1 + ` gives me the error:
      ## Warning in parallel::mclapply(1:chains, FUN = callFun, mc.preschedule = FALSE):
      ## 4 function calls resulted in an error
      ## Error in FUN(X[[i]], ...) :

```

```

    ## trying to get slot "mode" from an object (class "try-error") that is not a
    ## should I use `0 +` or `-1 +` ?
  )

## Priors
## Strangely reducing the parameter of the exponential results in a higher estimate of 'disp' and
prior_core <- switch(1,
  set_prior( paste0("exponential(", disp_prior, ")"), class = "disp", lb = 0),
  normal(15, 2.8), ## Based on analysis of non-noisy 40C song data
  normal(6, 2.8), ## Based on analysis of non-noisy 40C song data
  exponential(0.667), ## 0.625 = 1/16 "
  constant(5) ## Making disp a constant oesn't really help.
) +
prior(uniform(25, 45), lb = 25, ub = 45, nlpar = "x0")

## Parameter Structure
x0_priors <- switch(x0_flag,
  uniform_1 = ,
  uniform_2 = ,
  # Don't include x0_group info which is determined by the data set
  groups_1 = ,
  groups_2 = ,
  individual = ,
)

y0_priors <- switch(y0_flag,
  uniform_1 = prior(normal(150, 100), nlpar = "y0"),
  uniform_2 = ,
  groups_1 = ,
  groups_2 = ,
  individual = prior(normal(150, 1000), nlpar = "y0", lb = 10, ub = 1000)
)

prior <- switch(sampling,
  "nbinom_type1" = {
    prior_core +
    x0_priors + y0_priors
  })

nlform <- bf(
  y ~ two_piece(x, x0, y0), nl = TRUE) +
  x0_form +
  y0_form

if(TRUE) print(get_prior(nlform,
  data = data,
  family = family
))

save_model <- paste0(paste("brms", model, sampling, x0_flag, y0_flag, sep="_"), ".stan")
#make_stancode( ... save_model = save_model)
fit <- brm(nlform,
  data = data,

```

```

    ## `link` refers to the mapping of the expectation of the distribution: log, sqrt, identity
    ## link_shape corresponds to `phi` of `stan`'s
    ## Negbinomial_2
    ## Defining `phi = mu/theta` creates a quasipoisson
    ## distribution with overdispersion parameter (1 +theta)
    family = family, #negbinomial(link = "identity", link_shape = "identity"),
    prior = prior,
    stanvars = nbinom_type1_vars,
    iter = iter,
    warmup = warmup,
    thin = thin,
    silent = ifelse(interactive(), 1, 2), # 0, 1, or 2. 1 is default
    control = list(adapt_delta = adapt_delta,
                   max_treedepth = 12
                   ##model_name = desc ## Incorrect way to set this.
                   ),
    ## Only print out sampling progress if in interactive mode
    refresh = ifelse(interactive(), max(iter/5, 1), 0),
    chains = n_chains,
    cores = n_cores,
    save_model = save_model
  )
## Avoid having brms recompile model by defining
## model in global environment
fit_tmp <- fit

fit_stan <- fit$fit
print(stan_hist(fit_stan, pars = c("b_y0", "disp") ))
print(stan_hist(fit_stan, pars = c("b_x0", "disp")))

#fit_exp <- expose_functions(fit) , vectorize = TRUE)
#fit_cr <- add_criterion(fit_exp, c("loo", "waic"))
print(desc)
print("Prior Information")
print(prior_summary(fit))
print("Fit Information")
print(fit)
save(file = file.path(output_dir, paste0(save_model, ".Rdata-tmp")), fit)
fit_tbl[[curr_row, "fit"]] <- list(fit)
## Print current warnings
warnings(summary)
## Clear warnings()
##warning(immediate. = FALSE)

}
}}
}

```

```

## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 4"
##   prior class      coef group resp dpar nlpar lb    ub      source

```

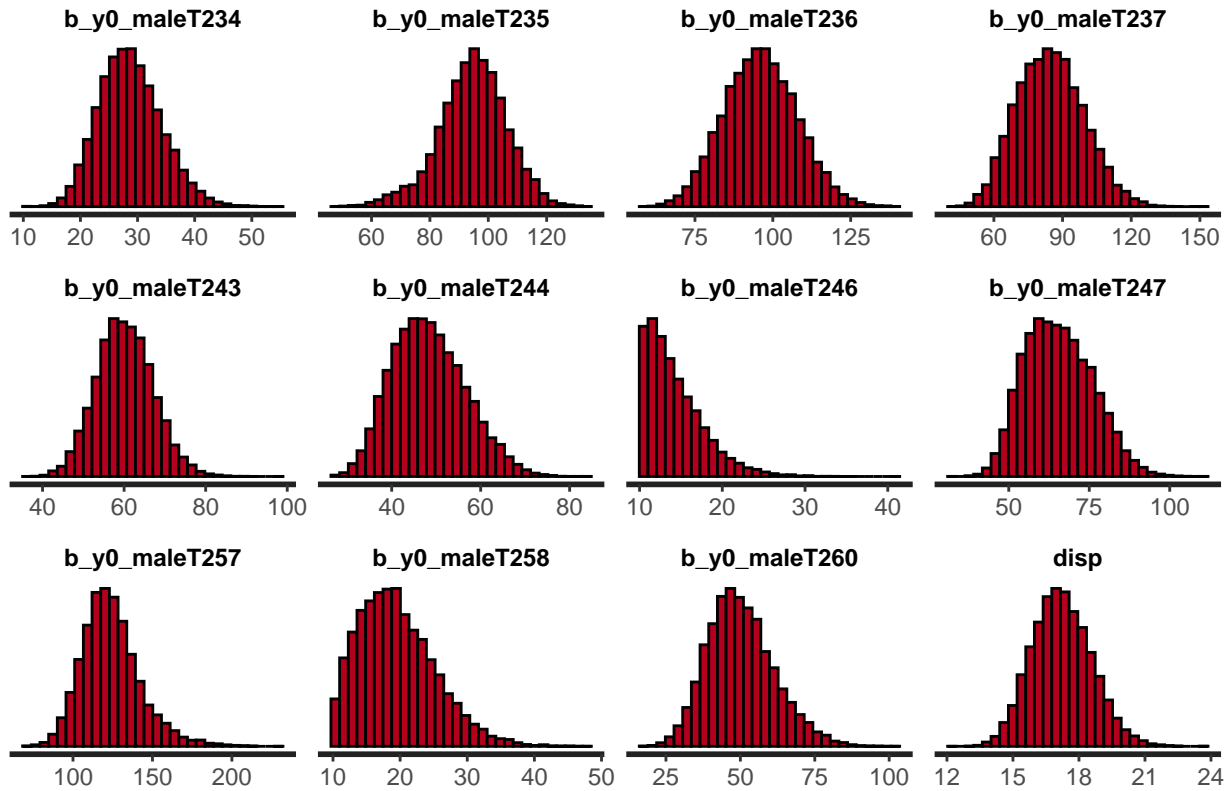


```
## (flat) disp 0 <NA> default
## (flat) b x0 default
## (flat) b maleT234 x0 (vectorized)
## (flat) b maleT235 x0 (vectorized)
## (flat) b maleT236 x0 (vectorized)
## (flat) b maleT237 x0 (vectorized)
## (flat) b maleT243 x0 (vectorized)
## (flat) b maleT244 x0 (vectorized)
## (flat) b maleT246 x0 (vectorized)
## (flat) b maleT247 x0 (vectorized)
## (flat) b maleT257 x0 (vectorized)
## (flat) b maleT258 x0 (vectorized)
## (flat) b maleT260 x0 (vectorized)
## (flat) b y0 default
## (flat) b maleT234 y0 (vectorized)
## (flat) b maleT235 y0 (vectorized)
## (flat) b maleT236 y0 (vectorized)
## (flat) b maleT237 y0 (vectorized)
## (flat) b maleT243 y0 (vectorized)
## (flat) b maleT244 y0 (vectorized)
## (flat) b maleT246 y0 (vectorized)
## (flat) b maleT247 y0 (vectorized)
## (flat) b maleT257 y0 (vectorized)
## (flat) b maleT258 y0 (vectorized)
## (flat) b maleT260 y0 (vectorized)
```

```
## recompiling to avoid crashing R session
```

```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quantiles may be unreliable.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```

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



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

```
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 4"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
## uniform(25, 45)      b                x0 25  45      user
## uniform(25, 45)      b maleT234          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT235          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT236          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT237          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT243          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT244          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT246          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT247          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT257          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT258          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT260          x0 25  45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258          y0 10 1000 (vectorized)
```

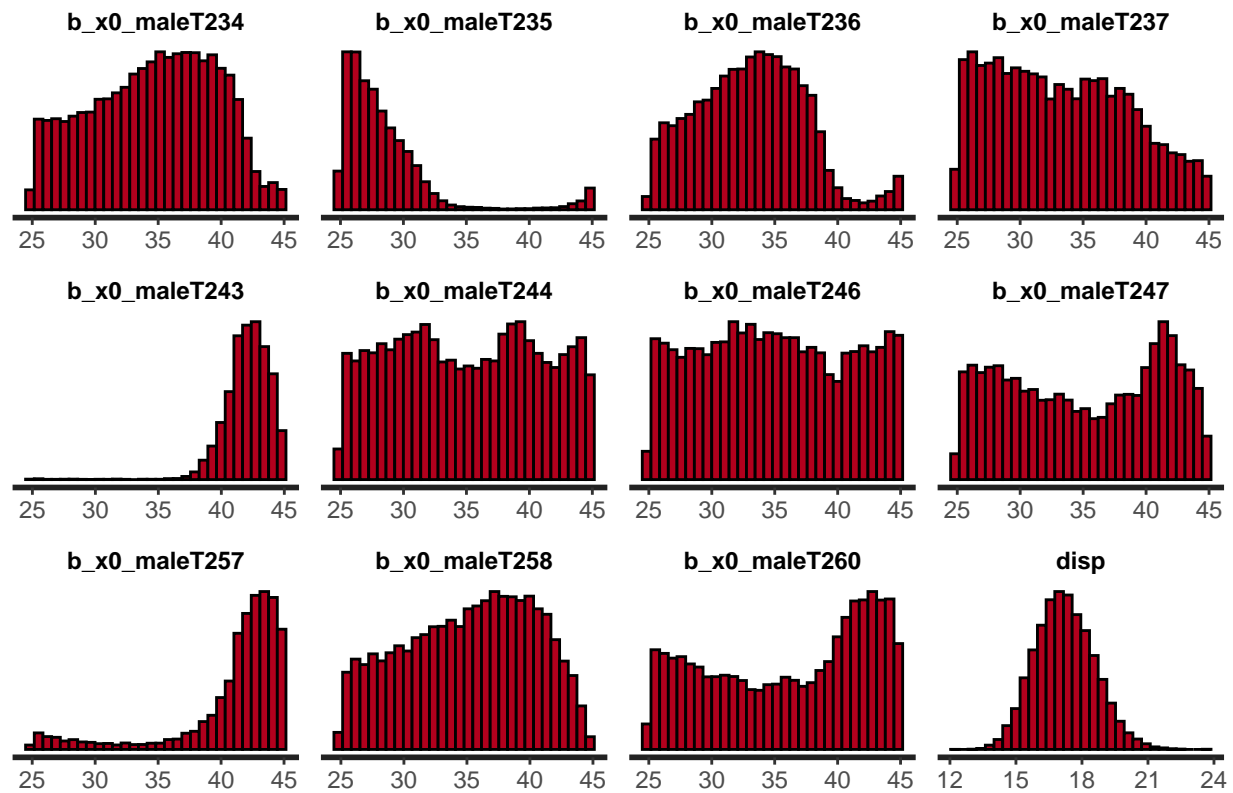
```

## normal(150, 1000)      b maleT260          y0 10 1000 (vectorized)
## exponential(4)  disp          0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 0 + male
##      y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    34.64     4.88   25.62   42.87 1.00   10093    8043
## x0_maleT235    28.55     3.91   25.12   44.12 1.00    1219     296
## x0_maleT236    33.09     4.25   25.67   43.15 1.00    6238    3320
## x0_maleT237    33.33     5.31   25.35   43.80 1.00    8321    7247
## x0_maleT243    42.06     1.85   38.51   44.69 1.00    9047    5429
## x0_maleT244    35.01     5.78   25.50   44.51 1.00    9918    9034
## x0_maleT246    35.01     5.79   25.51   44.63 1.00   15029    8757
## x0_maleT247    35.08     6.06   25.45   44.26 1.00    8140    9590
## x0_maleT257    40.91     4.53   26.33   44.85 1.00    6995    4117
## x0_maleT258    35.11     5.10   25.72   43.47 1.00   14584    8328
## x0_maleT260    36.17     6.26   25.45   44.66 1.00   10232    9512
## y0_maleT234    28.72     5.42   19.10   40.16 1.00   11379    8258
## y0_maleT235    94.62    11.55   68.69  116.26 1.00    1365     563
## y0_maleT236    96.06    11.63   74.03  119.27 1.00    8805    7812
## y0_maleT237    84.71    14.39   58.91  113.80 1.00    9783   10068
## y0_maleT243    60.19     6.90   47.28   74.20 1.00   13702    9956
## y0_maleT244    48.35     8.20   34.14   65.54 1.00   10937   10914
## y0_maleT246    14.29     3.46   10.19   23.03 1.00   10836    6032
## y0_maleT247    65.54    10.41   47.72   86.62 1.00    9106   10500
## y0_maleT257   123.95    18.49   93.11  167.15 1.00    7352    5275
## y0_maleT258    19.54     5.63   10.89   32.23 1.00    8680    4697
## y0_maleT260    50.18    11.16   30.79   74.59 1.00   10334    7890
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp    17.22     1.35   14.72   20.00 1.00   13852   10937
##
## 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).
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 8"
## prior class      coef group resp dpar nlpar lb  ub      source
## (flat)  disp              0 <NA>      default
## (flat)   b              x0      default
## (flat)   b maleT234      x0      (vectorized)
## (flat)   b maleT235      x0      (vectorized)
## (flat)   b maleT236      x0      (vectorized)
## (flat)   b maleT237      x0      (vectorized)
## (flat)   b maleT243      x0      (vectorized)
## (flat)   b maleT244      x0      (vectorized)

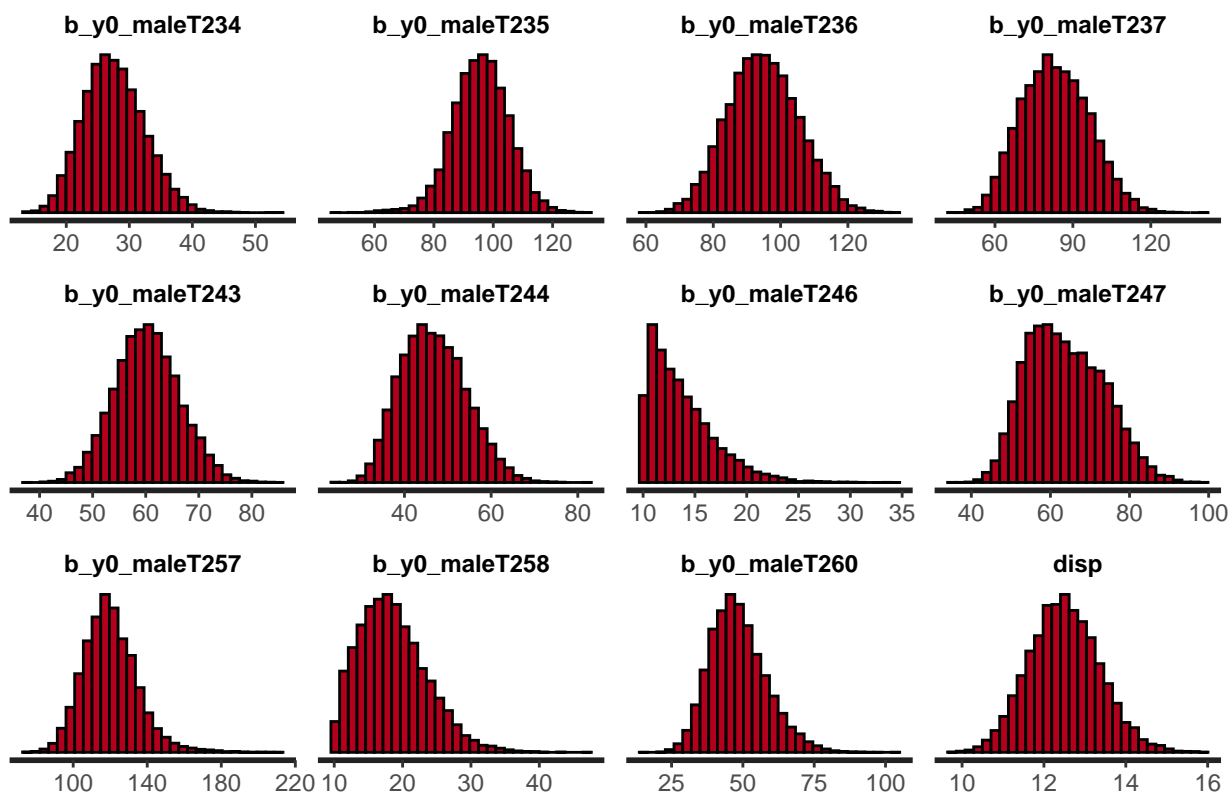
```

```
## (flat)      b maleT246      x0      (vectorized)
## (flat)      b maleT247      x0      (vectorized)
## (flat)      b maleT257      x0      (vectorized)
## (flat)      b maleT258      x0      (vectorized)
## (flat)      b maleT260      x0      (vectorized)
## (flat)      b                y0      default
## (flat)      b maleT234      y0      (vectorized)
## (flat)      b maleT235      y0      (vectorized)
## (flat)      b maleT236      y0      (vectorized)
## (flat)      b maleT237      y0      (vectorized)
## (flat)      b maleT243      y0      (vectorized)
## (flat)      b maleT244      y0      (vectorized)
## (flat)      b maleT246      y0      (vectorized)
## (flat)      b maleT247      y0      (vectorized)
## (flat)      b maleT257      y0      (vectorized)
## (flat)      b maleT258      y0      (vectorized)
## (flat)      b maleT260      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```



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



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

```
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 8"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
## uniform(25, 45)      b                x0 25  45      user
## uniform(25, 45)      b maleT234          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT235          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT236          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT237          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT243          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT244          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT246          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT247          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT257          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT258          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT260          x0 25  45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258          y0 10 1000 (vectorized)
```

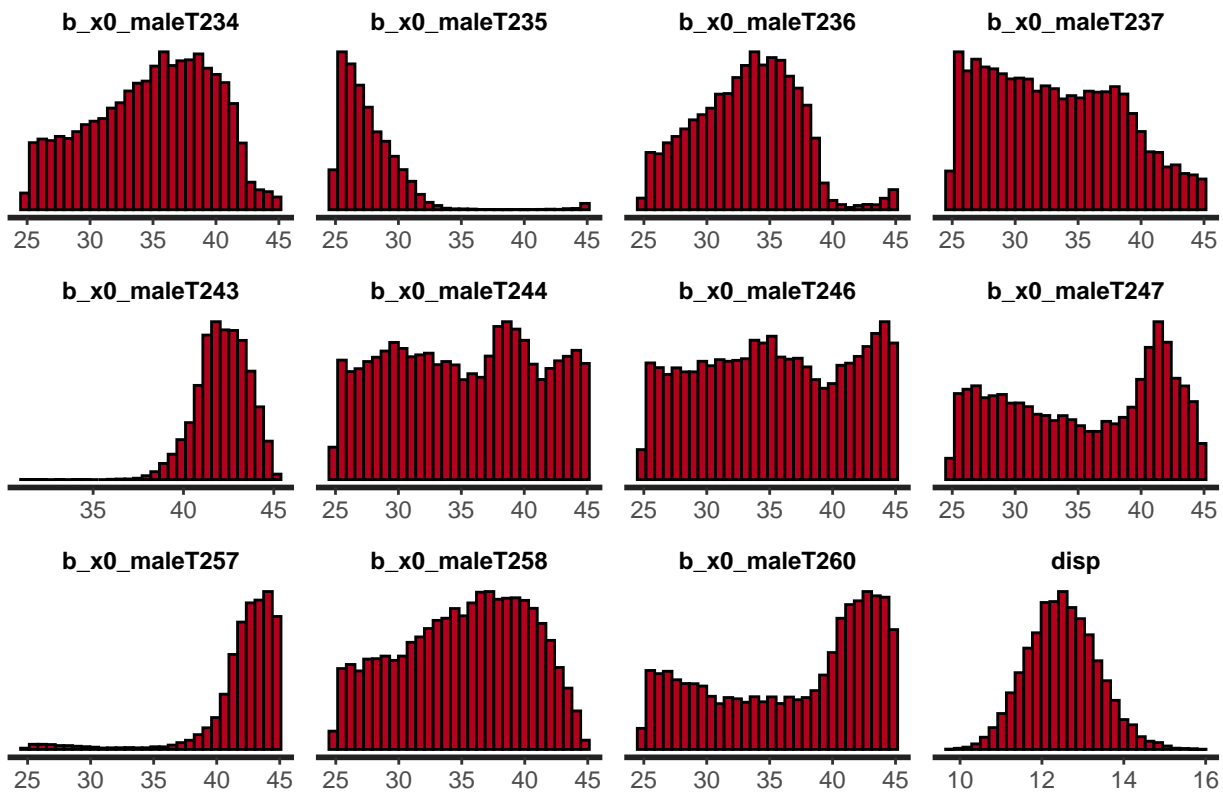
```

## normal(150, 1000)      b maleT260          y0 10 1000 (vectorized)
## exponential(8)  disp          0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 0 + male
##      y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    34.93     4.74   25.74   42.55 1.00    9875    6743
## x0_maleT235    27.66     2.60   25.10   32.37 1.00    4061    1706
## x0_maleT236    33.13     3.95   25.70   40.04 1.00    5501    2709
## x0_maleT237    33.14     5.21   25.34   43.56 1.00    8150    7151
## x0_maleT243    42.16     1.41   39.14   44.58 1.00    8625    4707
## x0_maleT244    35.14     5.78   25.49   44.61 1.00    7639    8548
## x0_maleT246    35.35     5.86   25.50   44.70 1.00   11613    7884
## x0_maleT247    35.38     6.11   25.44   44.23 1.00    6239    8083
## x0_maleT257    41.99     3.34   28.74   44.89 1.00    7325    2604
## x0_maleT258    35.10     5.03   25.70   43.35 1.00   13346    7791
## x0_maleT260    36.85     6.31   25.51   44.74 1.00    9284    9713
## y0_maleT234    27.59     4.81   18.98   37.57 1.00   10457    7793
## y0_maleT235    95.78     9.42   77.07  113.79 1.00    4906    1757
## y0_maleT236    94.86    10.52   75.00  115.86 1.00    7714    5867
## y0_maleT237    83.35    12.92   59.89  109.14 1.00    9268   10565
## y0_maleT243    60.27     6.09   48.71   72.53 1.00   12949    9194
## y0_maleT244    46.76     7.48   33.76   62.06 1.00    8342    9772
## y0_maleT246    13.78     3.14   10.14   21.60 1.00    9296    5421
## y0_maleT247    63.81     9.57   47.75   83.19 1.00    6701   11510
## y0_maleT257   120.13    14.79   94.50  152.89 1.00    8017    4405
## y0_maleT258    18.61     4.94   10.93   29.62 1.00    8936    5239
## y0_maleT260    48.38     9.88   31.45   70.47 1.00    9104    8901
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp    12.50     0.86   10.88   14.26 1.00   13010   10155
##
## 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).
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 16"
## prior class      coef group resp dpar nlpar lb  ub      source
## (flat)  disp              0 <NA>      default
## (flat)   b              x0      default
## (flat)   b maleT234      x0      (vectorized)
## (flat)   b maleT235      x0      (vectorized)
## (flat)   b maleT236      x0      (vectorized)
## (flat)   b maleT237      x0      (vectorized)
## (flat)   b maleT243      x0      (vectorized)
## (flat)   b maleT244      x0      (vectorized)

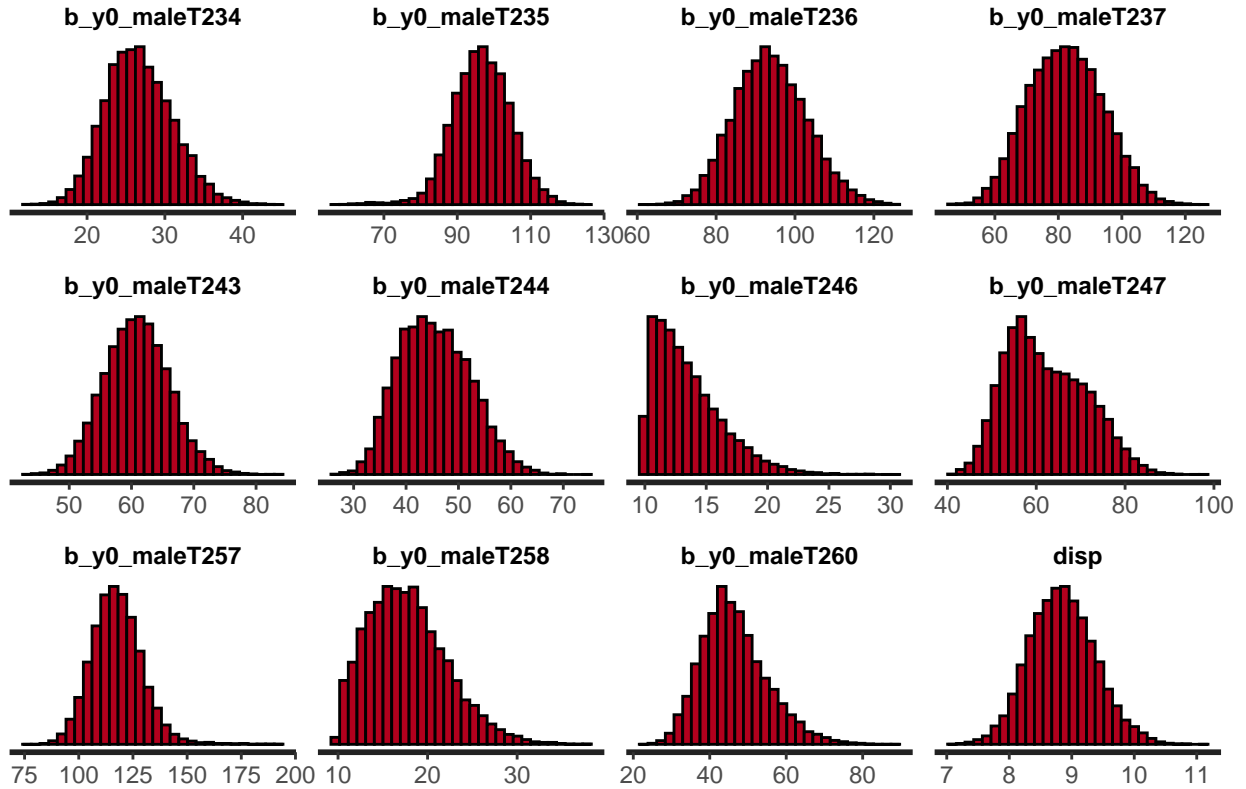
```

```
## (flat)      b maleT246      x0      (vectorized)
## (flat)      b maleT247      x0      (vectorized)
## (flat)      b maleT257      x0      (vectorized)
## (flat)      b maleT258      x0      (vectorized)
## (flat)      b maleT260      x0      (vectorized)
## (flat)      b                y0      default
## (flat)      b maleT234      y0      (vectorized)
## (flat)      b maleT235      y0      (vectorized)
## (flat)      b maleT236      y0      (vectorized)
## (flat)      b maleT237      y0      (vectorized)
## (flat)      b maleT243      y0      (vectorized)
## (flat)      b maleT244      y0      (vectorized)
## (flat)      b maleT246      y0      (vectorized)
## (flat)      b maleT247      y0      (vectorized)
## (flat)      b maleT257      y0      (vectorized)
## (flat)      b maleT258      y0      (vectorized)
## (flat)      b maleT260      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```



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



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

```
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 16"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
## uniform(25, 45)      b                x0 25  45      user
## uniform(25, 45)      b maleT234        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT235        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT236        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT237        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT243        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT244        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT246        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT247        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT257        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT258        x0 25  45 (vectorized)
## uniform(25, 45)      b maleT260        x0 25  45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258        y0 10 1000 (vectorized)
```



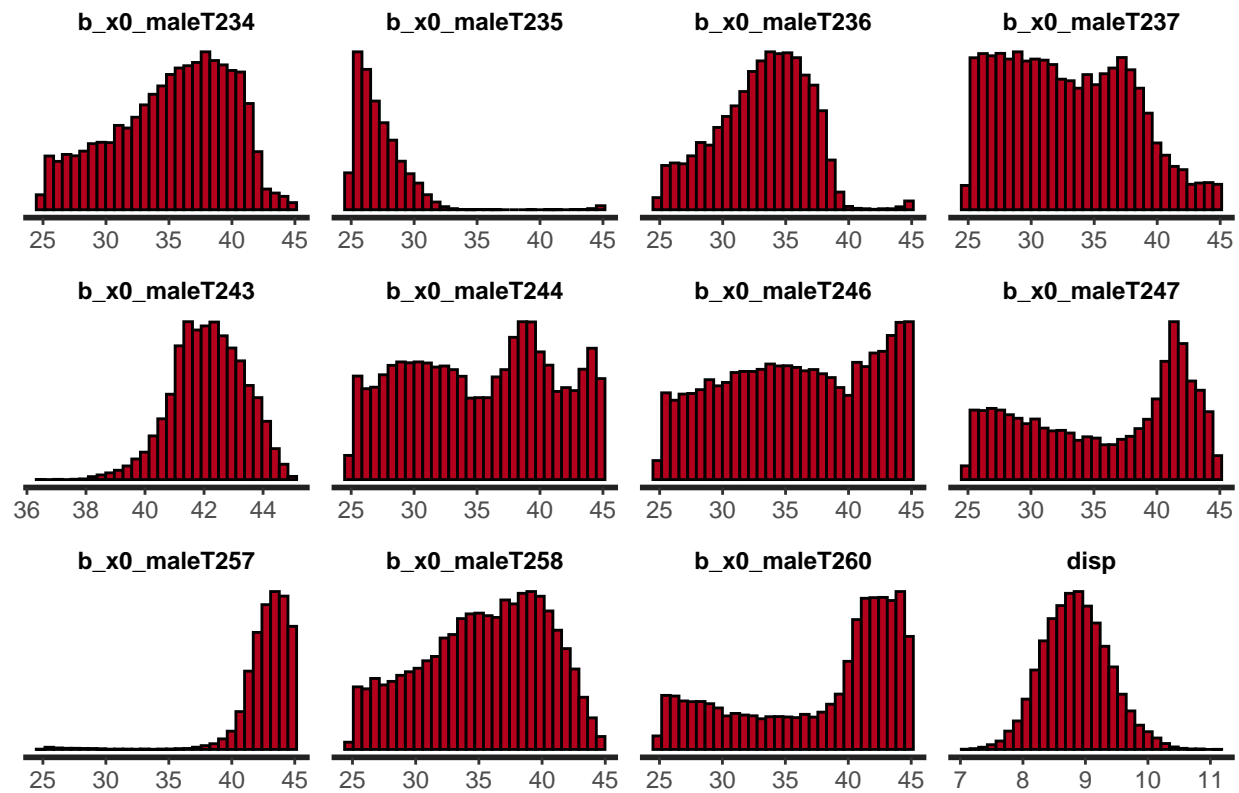
```

## normal(150, 1000)      b maleT260          y0 10 1000 (vectorized)
## exponential(16) disp          0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 0 + male
##      y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    35.26     4.59   25.79   42.26 1.00    8019    5568
## x0_maleT235    27.28     2.24   25.08   31.34 1.00    2098     852
## x0_maleT236    33.15     3.56   25.78   38.69 1.00    5061    4560
## x0_maleT237    32.91     4.92   25.42   42.98 1.00    7438    7192
## x0_maleT243    42.15     1.20   39.62   44.30 1.00   11723    6956
## x0_maleT244    35.23     5.75   25.53   44.58 1.00    5756    7997
## x0_maleT246    35.87     5.84   25.63   44.76 1.00   12457    8274
## x0_maleT247    35.85     6.16   25.51   44.18 1.00    5101    9108
## x0_maleT257    42.73     2.23   38.63   44.91 1.00    5756    3888
## x0_maleT258    35.36     4.86   25.82   43.19 1.00   12340    6261
## x0_maleT260    37.86     6.14   25.63   44.77 1.00    7664    8951
## y0_maleT234    26.67     4.29   18.90   35.57 1.00    9556    8332
## y0_maleT235    96.64     7.90   81.50  111.85 1.00    2220     808
## y0_maleT236    93.84     9.14   76.95  112.51 1.00    7384    6782
## y0_maleT237    82.37    11.63   60.80  105.07 1.00    8873   10066
## y0_maleT243    60.84     5.17   51.03   71.41 1.00   12795   10201
## y0_maleT244    45.49     6.72   33.93   59.16 1.00    7515   10202
## y0_maleT246    13.52     2.78   10.13   20.34 1.00    9823    5783
## y0_maleT247    62.16     8.94   47.73   80.27 1.00    4984   12388
## y0_maleT257   117.62    11.76   96.56  141.86 1.00    9176    4785
## y0_maleT258    17.78     4.40   10.82   27.62 1.00    9055    4639
## y0_maleT260    46.43     8.57   32.17   65.75 1.00    8065    9245
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      8.85      0.53    7.87    9.95 1.00   13223    9839
##
## 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).
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 32"
## prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp              0 <NA>      default
## (flat)  b              x0      default
## (flat)  b maleT234      x0      (vectorized)
## (flat)  b maleT235      x0      (vectorized)
## (flat)  b maleT236      x0      (vectorized)
## (flat)  b maleT237      x0      (vectorized)
## (flat)  b maleT243      x0      (vectorized)
## (flat)  b maleT244      x0      (vectorized)

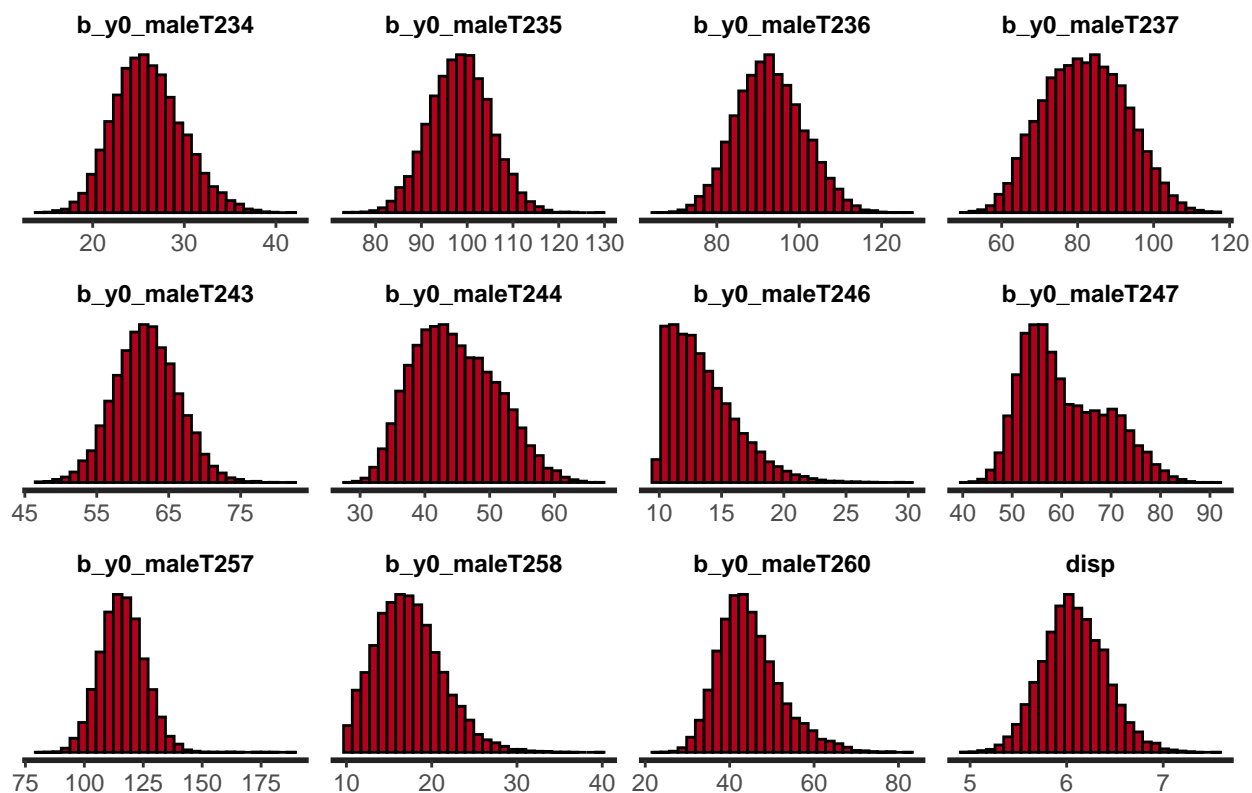
```

```
## (flat)      b maleT246      x0      (vectorized)
## (flat)      b maleT247      x0      (vectorized)
## (flat)      b maleT257      x0      (vectorized)
## (flat)      b maleT258      x0      (vectorized)
## (flat)      b maleT260      x0      (vectorized)
## (flat)      b                y0      default
## (flat)      b maleT234      y0      (vectorized)
## (flat)      b maleT235      y0      (vectorized)
## (flat)      b maleT236      y0      (vectorized)
## (flat)      b maleT237      y0      (vectorized)
## (flat)      b maleT243      y0      (vectorized)
## (flat)      b maleT244      y0      (vectorized)
## (flat)      b maleT246      y0      (vectorized)
## (flat)      b maleT247      y0      (vectorized)
## (flat)      b maleT257      y0      (vectorized)
## (flat)      b maleT258      y0      (vectorized)
## (flat)      b maleT260      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```



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



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

```
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 32"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb   ub      source
## uniform(25, 45)      b                x0 25   45      user
## uniform(25, 45)      b maleT234        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT235        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT236        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT237        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT243        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT244        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT246        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT247        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT257        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT258        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT260        x0 25   45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257        y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258        y0 10 1000 (vectorized)
```

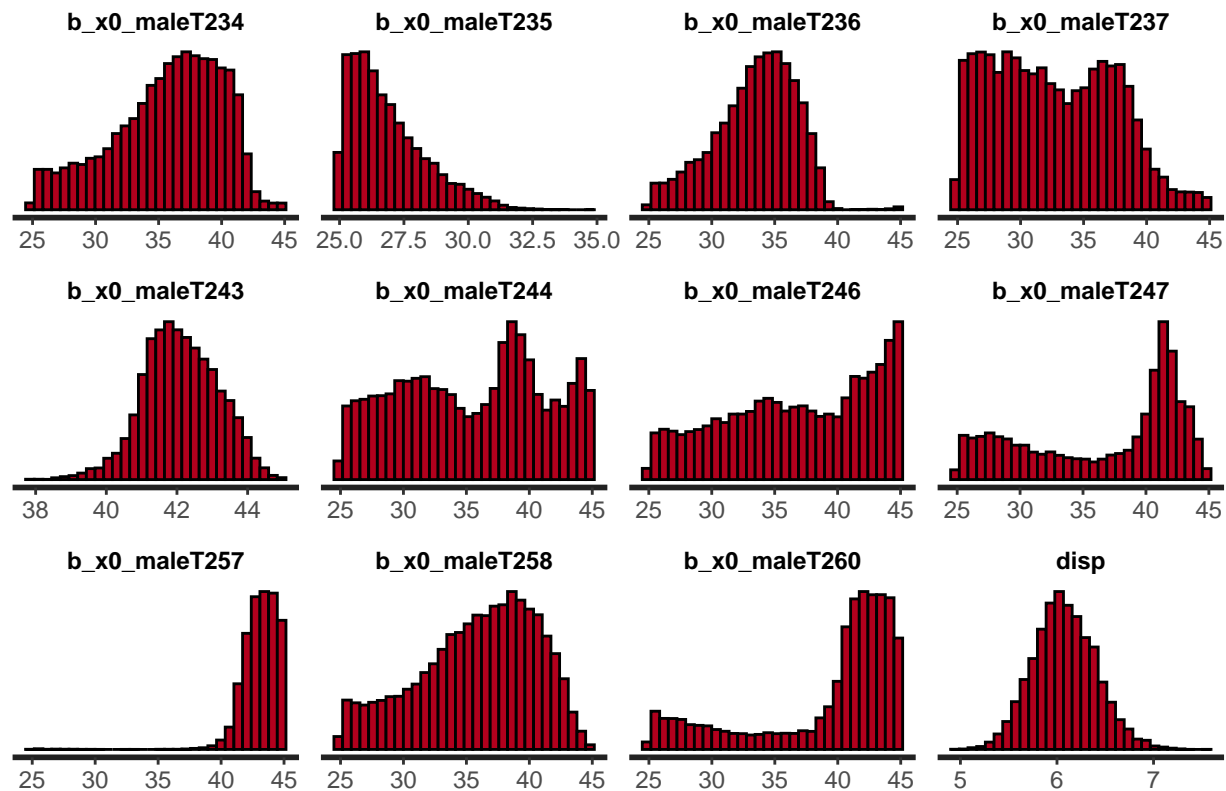
```

## normal(150, 1000)      b maleT260          y0 10 1000 (vectorized)
## exponential(32) disp          0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 0 + male
##      y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    35.67     4.33   26.04   42.02 1.00    7613    5449
## x0_maleT235    26.87     1.47   25.07   30.46 1.00    7837    5788
## x0_maleT236    33.42     3.22   26.22   38.41 1.00    6482    5192
## x0_maleT237    32.65     4.77   25.36   41.87 1.00    6198    6914
## x0_maleT243    42.11     1.06   39.99   44.08 1.00    9748    6910
## x0_maleT244    35.45     5.72   25.62   44.60 1.00    6146    8465
## x0_maleT246    36.85     5.85   25.80   44.85 1.00   10538    8261
## x0_maleT247    36.67     6.13   25.54   44.01 1.00    3467    7918
## x0_maleT257    43.09     1.49   40.40   44.92 1.00    5666    4335
## x0_maleT258    35.85     4.67   25.88   43.05 1.00    9917    5761
## x0_maleT260    39.23     5.71   25.74   44.82 1.00    5945    7164
## y0_maleT234    26.10     3.71   19.50   34.01 1.00    8591    8716
## y0_maleT235    98.47     6.56   85.70  111.36 1.00   11839    9971
## y0_maleT236    92.93     8.12   77.78  109.37 1.00    7930    7731
## y0_maleT237    81.95    10.72   62.33  102.51 1.00    7584   10437
## y0_maleT243    61.89     4.39   53.45   70.59 1.00   11913   10067
## y0_maleT244    44.69     6.32   34.02   57.51 1.00    6968    9889
## y0_maleT246    13.55     2.69   10.15   20.08 1.00    9267    5261
## y0_maleT247    60.46     8.46   48.00   78.16 1.00    3565   10585
## y0_maleT257   116.28     9.44   98.63  135.13 1.00   11153    7077
## y0_maleT258    17.37     3.90   10.91   25.92 1.00    8015    4217
## y0_maleT260    44.71     7.39   32.88   62.38 1.00    6160    7548
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      6.08      0.33     5.47     6.75 1.00   12069    9939
##
## 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).
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 64"
## prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp              0 <NA>      default
## (flat)  b              x0      default
## (flat)  b maleT234      x0      (vectorized)
## (flat)  b maleT235      x0      (vectorized)
## (flat)  b maleT236      x0      (vectorized)
## (flat)  b maleT237      x0      (vectorized)
## (flat)  b maleT243      x0      (vectorized)
## (flat)  b maleT244      x0      (vectorized)

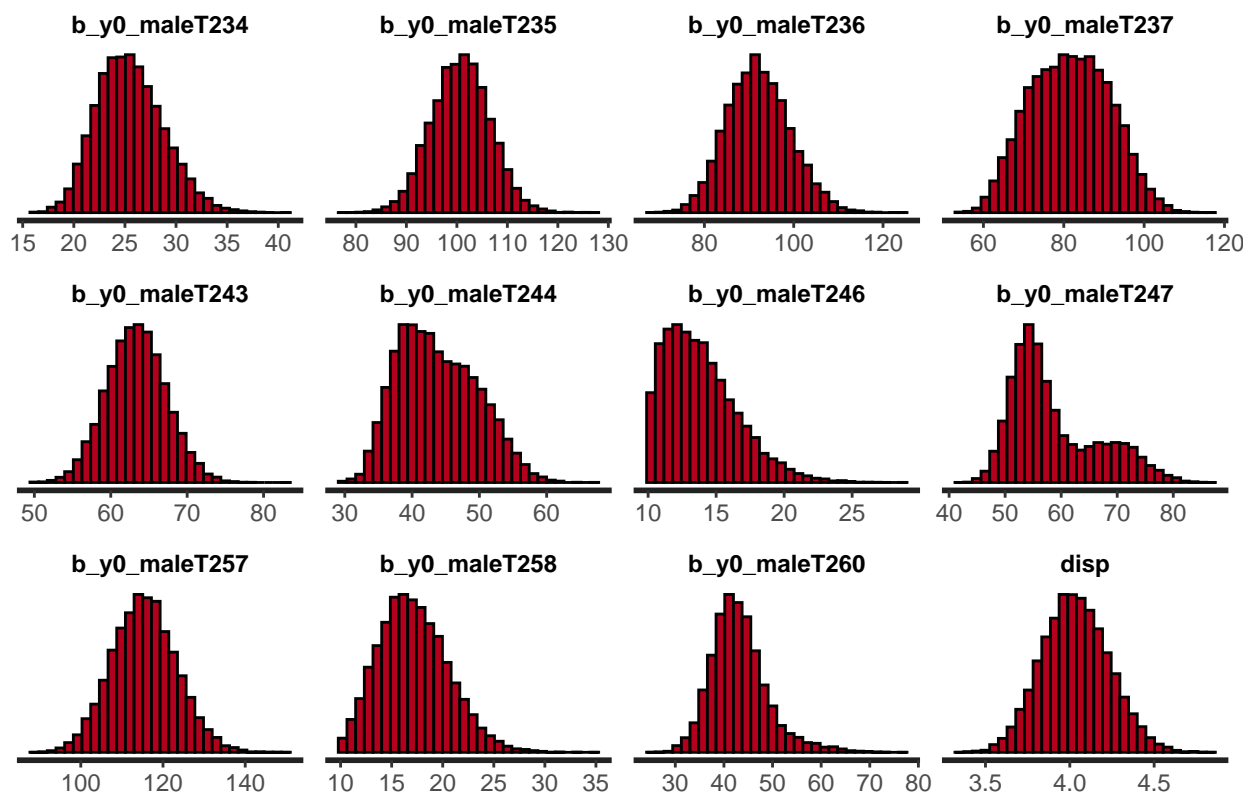
```

```
## (flat)      b maleT246      x0      (vectorized)
## (flat)      b maleT247      x0      (vectorized)
## (flat)      b maleT257      x0      (vectorized)
## (flat)      b maleT258      x0      (vectorized)
## (flat)      b maleT260      x0      (vectorized)
## (flat)      b                y0      default
## (flat)      b maleT234      y0      (vectorized)
## (flat)      b maleT235      y0      (vectorized)
## (flat)      b maleT236      y0      (vectorized)
## (flat)      b maleT237      y0      (vectorized)
## (flat)      b maleT243      y0      (vectorized)
## (flat)      b maleT244      y0      (vectorized)
## (flat)      b maleT246      y0      (vectorized)
## (flat)      b maleT247      y0      (vectorized)
## (flat)      b maleT257      y0      (vectorized)
## (flat)      b maleT258      y0      (vectorized)
## (flat)      b maleT260      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```



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



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

```
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 64"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
## uniform(25, 45)      b                x0 25  45      user
## uniform(25, 45)      b maleT234          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT235          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT236          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT237          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT243          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT244          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT246          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT247          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT257          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT258          x0 25  45 (vectorized)
## uniform(25, 45)      b maleT260          x0 25  45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257          y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258          y0 10 1000 (vectorized)
```

```

## normal(150, 1000)      b maleT260          y0 10 1000 (vectorized)
## exponential(64) disp          0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 0 + male
##      y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    36.45     3.90   26.85   41.91 1.00    7422    4134
## x0_maleT235    26.64     1.28   25.07   29.83 1.00    8098    5554
## x0_maleT236    33.85     2.85   27.13   38.15 1.00    6831    4963
## x0_maleT237    32.49     4.55   25.37   40.53 1.00    6285    7129
## x0_maleT243    42.02     0.90   40.35   43.84 1.00    9445    5765
## x0_maleT244    35.92     5.63   25.70   44.67 1.00    5013    7346
## x0_maleT246    38.49     5.61   26.34   44.91 1.00    9854    8683
## x0_maleT247    37.87     5.90   25.62   43.97 1.00    2550    6475
## x0_maleT257    43.31     1.09   41.13   44.92 1.00    7063    4300
## x0_maleT258    36.32     4.18   26.81   42.79 1.00   10760    6289
## x0_maleT260    40.89     4.57   26.40   44.86 1.00    4820    3438
## y0_maleT234    25.52     3.24   19.88   32.30 1.00    9551    9519
## y0_maleT235   100.77     5.76   89.63  112.07 1.00   13091    9654
## y0_maleT236    92.12     7.04   79.09  106.59 1.00    8039    8124
## y0_maleT237    81.62     9.83   63.60  100.26 1.00    7571   10627
## y0_maleT243    63.35     3.87   55.90   71.09 1.00   11924    8914
## y0_maleT244    43.82     5.84   34.26   55.62 1.00    5778   10090
## y0_maleT246    13.92     2.67   10.24   20.27 1.00    7964    4673
## y0_maleT247    58.65     7.81   48.12   76.22 1.00    2718    7630
## y0_maleT257   115.43     7.82  100.48  131.13 1.00   13410    8920
## y0_maleT258    17.17     3.38   11.30   24.40 1.00    8332    4470
## y0_maleT260    43.14     5.89   33.41   57.93 1.00    4741    3857
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      4.03      0.20    3.66    4.43 1.00   12132   10192
##
## 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).
## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 128"
## prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp              0 <NA>      default
## (flat)  b              x0      default
## (flat)  b maleT234      x0      (vectorized)
## (flat)  b maleT235      x0      (vectorized)
## (flat)  b maleT236      x0      (vectorized)
## (flat)  b maleT237      x0      (vectorized)
## (flat)  b maleT243      x0      (vectorized)
## (flat)  b maleT244      x0      (vectorized)

```

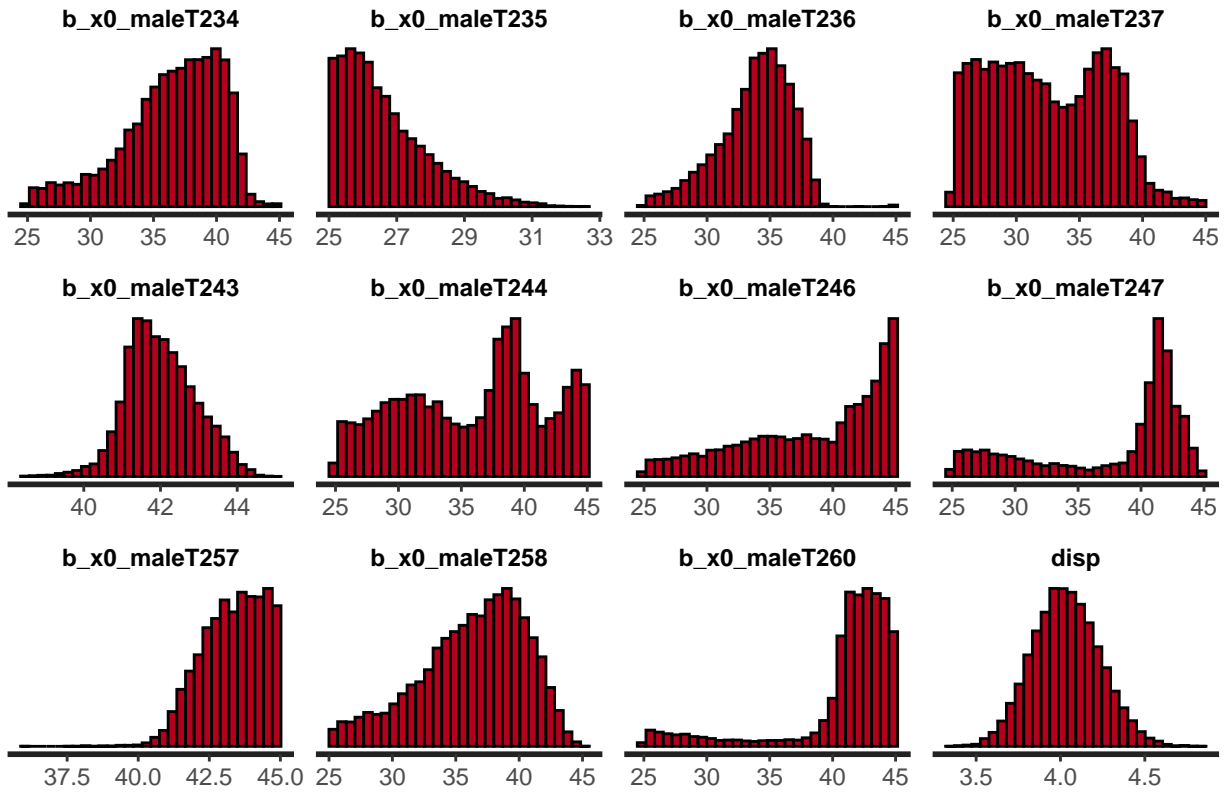
```
## (flat)      b maleT246      x0      (vectorized)
## (flat)      b maleT247      x0      (vectorized)
## (flat)      b maleT257      x0      (vectorized)
## (flat)      b maleT258      x0      (vectorized)
## (flat)      b maleT260      x0      (vectorized)
## (flat)      b                y0      default
## (flat)      b maleT234      y0      (vectorized)
## (flat)      b maleT235      y0      (vectorized)
## (flat)      b maleT236      y0      (vectorized)
## (flat)      b maleT237      y0      (vectorized)
## (flat)      b maleT243      y0      (vectorized)
## (flat)      b maleT244      y0      (vectorized)
## (flat)      b maleT246      y0      (vectorized)
## (flat)      b maleT247      y0      (vectorized)
## (flat)      b maleT257      y0      (vectorized)
## (flat)      b maleT258      y0      (vectorized)
## (flat)      b maleT260      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```

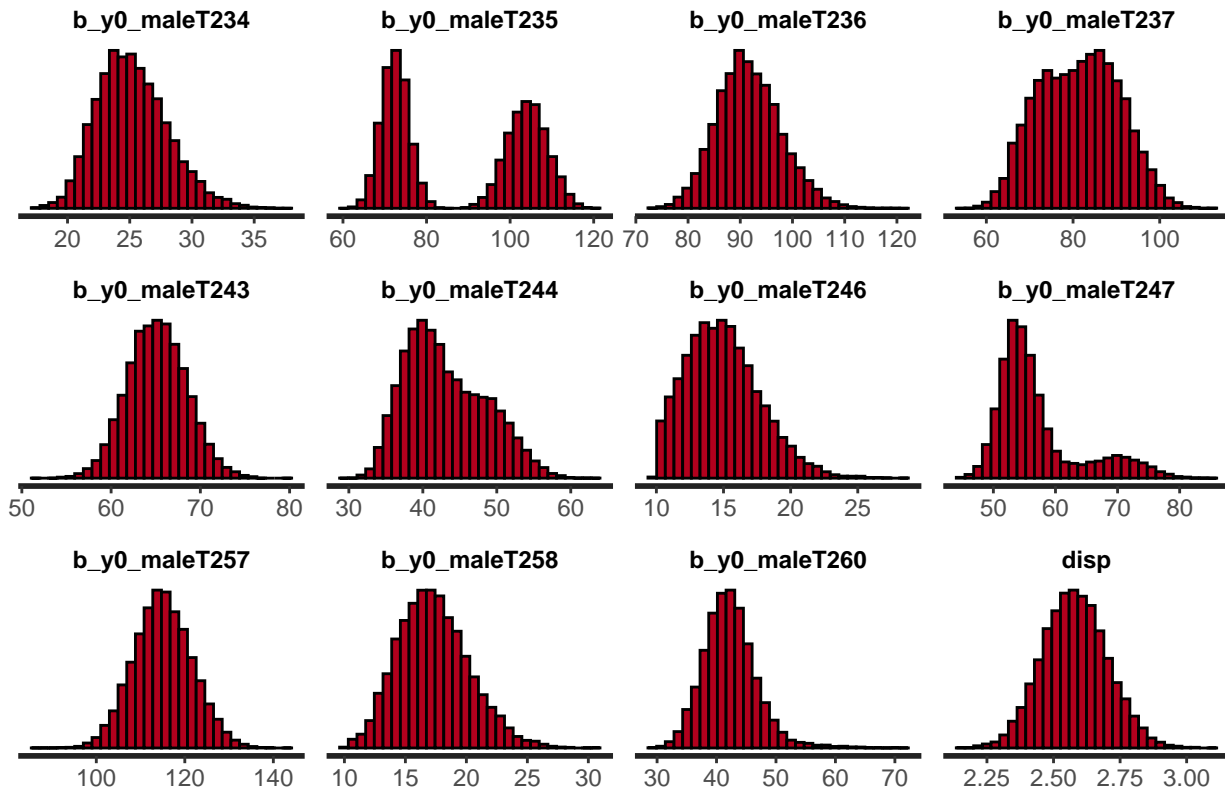
```
## Warning: The largest R-hat is 1.73, indicating chains have not mixed.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#r-hat
```

```
## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess
```

```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quant.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```

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



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

```

## [1] "piecewise: nbinom_type1; x0 individual; y0 individual, disp prior: 128"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb   ub      source
## uniform(25, 45)      b                x0 25   45      user
## uniform(25, 45)      b maleT234        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT235        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT236        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT237        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT243        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT244        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT246        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT247        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT257        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT258        x0 25   45 (vectorized)
## uniform(25, 45)      b maleT260        x0 25   45 (vectorized)
## normal(150, 1000)    b                y0 10 1000      user
## normal(150, 1000)    b maleT234        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT235        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT236        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT237        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT243        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT244        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT246        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT247        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT257        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT258        y0 10 1000 (vectorized)
## normal(150, 1000)    b maleT260        y0 10 1000 (vectorized)
## exponential(128) disp                0      user
## [1] "Fit Information"

## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.

## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##          x0 ~ 0 + male
##          y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##        total post-warmup draws = 15000
##
## Population-Level Effects:
##           Estimate Est.Error 1-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_maleT234    37.26     3.44   28.21   41.81 1.00    7199    4103
## x0_maleT235    35.64     9.30   25.12   45.00 1.73         6     114
## x0_maleT236    34.24     2.45   28.28   38.02 1.00    6312    3615
## x0_maleT237    32.36     4.45   25.35   39.58 1.00    5267    6999
## x0_maleT243    41.91     0.76   40.63   43.55 1.00    8470    5813
## x0_maleT244    36.50     5.43   25.98   44.70 1.00    4131    7058
## x0_maleT246    40.85     4.68   28.27   44.96 1.00    9988    8683
## x0_maleT247    39.19     5.21   25.86   43.84 1.00    1422    2450
## x0_maleT257    43.43     0.98   41.48   44.92 1.00    7444    4495

```

```
## x0_maleT258    36.75      3.87    27.18    42.64 1.00    10432    4752
## x0_maleT260    42.10      3.01    30.06    44.88 1.00     4363    1488
## y0_maleT234    25.21      2.81    20.40    31.35 1.00     7993    8008
## y0_maleT235    88.26     16.37    67.06   112.07 1.73         6     101
## y0_maleT236    91.68      6.14    80.41   104.61 1.00     6684    5687
## y0_maleT237    81.37      9.22    64.82    98.54 1.00     5743   10525
## y0_maleT243    65.15      3.30    58.84    71.75 1.00    12091    9337
## y0_maleT244    43.08      5.42    34.58    54.30 1.00     4830    9506
## y0_maleT246    14.97      2.75    10.52    21.06 1.00     6774    3591
## y0_maleT247    56.98      6.84    48.70    74.75 1.00     1415    2802
## y0_maleT257   115.04      6.59   102.37   128.19 1.00    13656   10451
## y0_maleT258    17.33      2.92    12.18    23.58 1.00     9760    5785
## y0_maleT260    42.27      4.53    34.45    52.12 1.00     5609    2629
```

```
##
```

```
## Family Specific Parameters:
```

```
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      2.58      0.12      2.35      2.83 1.03         83      8383
```

```
##
```

```
## 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).
```

```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 4"
```

```
##   prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp                                0 <NA>      default
## (flat)      b                                x0      default
## (flat)      b Intercept                      x0      (vectorized)
## (flat)      b                                y0      default
## (flat)      b maleT234                      y0      (vectorized)
## (flat)      b maleT235                      y0      (vectorized)
## (flat)      b maleT236                      y0      (vectorized)
## (flat)      b maleT237                      y0      (vectorized)
## (flat)      b maleT243                      y0      (vectorized)
## (flat)      b maleT244                      y0      (vectorized)
## (flat)      b maleT246                      y0      (vectorized)
## (flat)      b maleT247                      y0      (vectorized)
## (flat)      b maleT257                      y0      (vectorized)
## (flat)      b maleT258                      y0      (vectorized)
## (flat)      b maleT260                      y0      (vectorized)
```

```
## recompiling to avoid crashing R session
```

```
## Warning: The largest R-hat is 1.08, indicating chains have not mixed.
```

```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#r-hat
```

```
## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
```

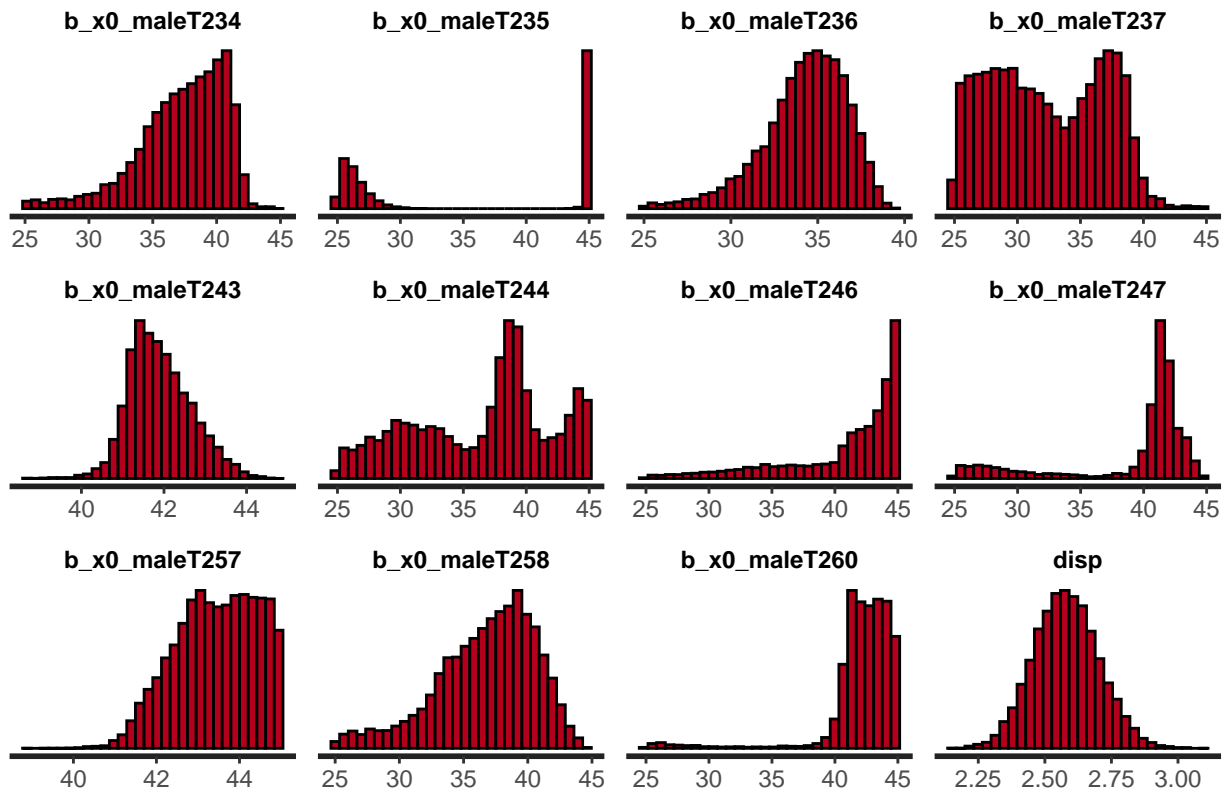
```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#bulk-ess
```

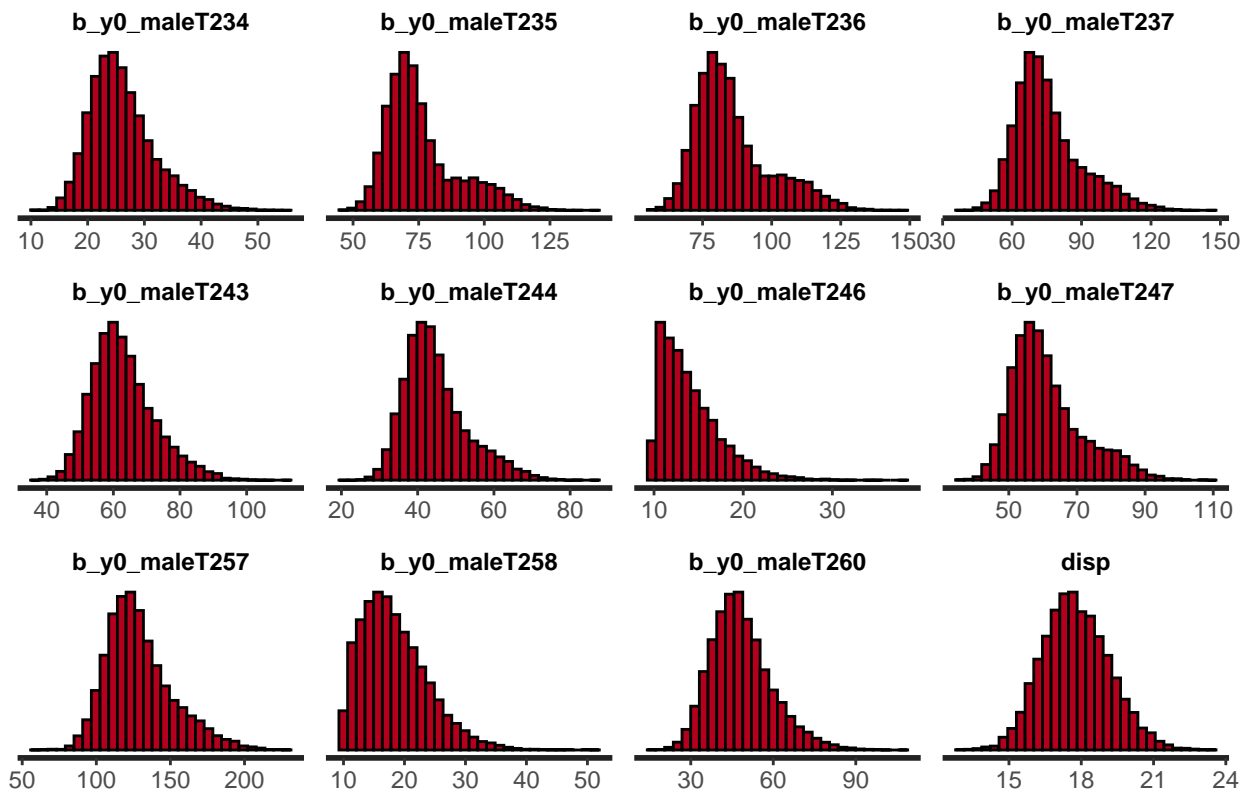
```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quant
```

```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#tail-ess
```



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



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

```

## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 4"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
## uniform(25, 45)      b                x0 25  45      user
## uniform(25, 45)      b Intercept      x0 25  45 (vectorized)
## normal(150, 1000)     b                y0 10 1000      user
## normal(150, 1000)     b maleT234      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT235      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT236      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT237      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT243      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT244      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT246      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT247      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT257      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT258      y0 10 1000 (vectorized)
## normal(150, 1000)     b maleT260      y0 10 1000 (vectorized)
## exponential(4) disp                0      user
## [1] "Fit Information"

## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.

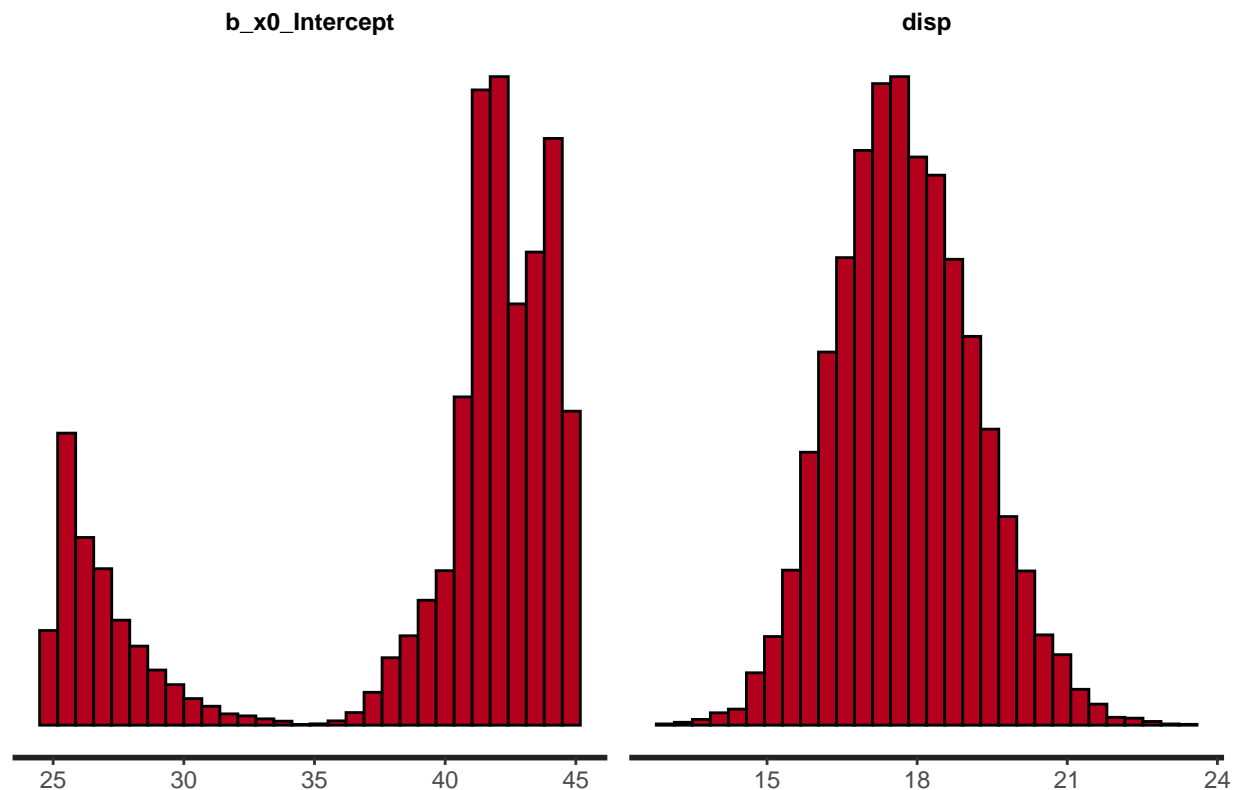
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##          x0 ~ 1
##          y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##        total post-warmup draws = 15000
##
## Population-Level Effects:
##           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_Intercept    38.89      6.56   25.23   44.78 1.08      38      144
## y0_maleT234     26.09      5.77   17.06   39.89 1.05      76      195
## y0_maleT235     75.96     13.91   57.12  110.00 1.07      41      170
## y0_maleT236     85.79     13.72   66.66  119.05 1.07      40      121
## y0_maleT237     75.52     14.49   54.28  110.63 1.06      54      155
## y0_maleT243     62.94      9.44   47.45   85.23 1.04      78      174
## y0_maleT244     44.68      8.35   32.16   64.89 1.06      48      132
## y0_maleT246     14.05      3.36   10.12   22.48 1.00     3782     3905
## y0_maleT247     61.13     10.58   45.55   86.36 1.07      46      157
## y0_maleT257    129.05     22.70   93.68  183.36 1.06      49      156
## y0_maleT258     18.38      5.44   10.62   31.24 1.01     498     1973
## y0_maleT260     48.37     11.20   29.90   74.38 1.03     133      314
##
## Family Specific Parameters:
##           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp    17.78      1.39   15.23   20.67 1.00     5352     6595
##
## Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential

```

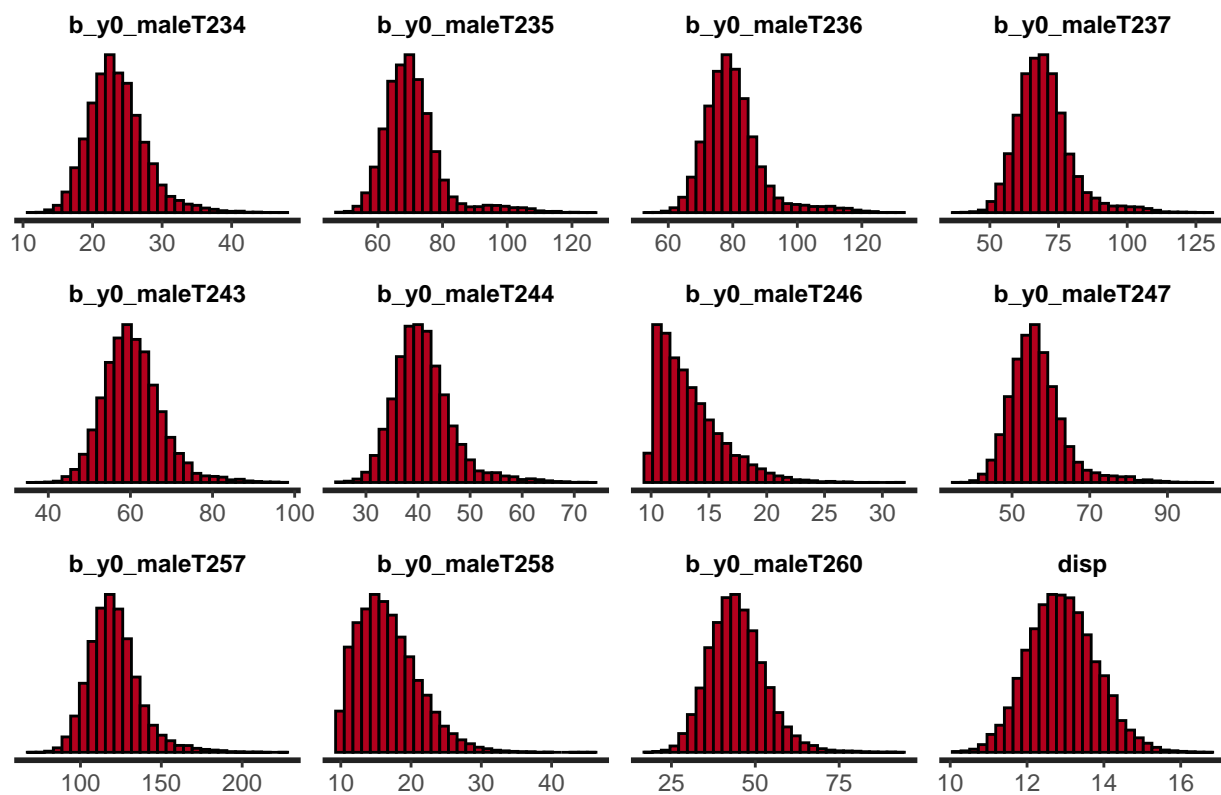
```
## scale reduction factor on split chains (at convergence, Rhat = 1).
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 8"
##   prior class      coef group resp dpar nlpar lb   ub      source
## (flat)  disp                                0 <NA>    default
## (flat)    b                                x0      default
## (flat)    b Intercept                       x0    (vectorized)
## (flat)    b                                y0      default
## (flat)    b maleT234                       y0    (vectorized)
## (flat)    b maleT235                       y0    (vectorized)
## (flat)    b maleT236                       y0    (vectorized)
## (flat)    b maleT237                       y0    (vectorized)
## (flat)    b maleT243                       y0    (vectorized)
## (flat)    b maleT244                       y0    (vectorized)
## (flat)    b maleT246                       y0    (vectorized)
## (flat)    b maleT247                       y0    (vectorized)
## (flat)    b maleT257                       y0    (vectorized)
## (flat)    b maleT258                       y0    (vectorized)
## (flat)    b maleT260                       y0    (vectorized)
```

```
## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess
```

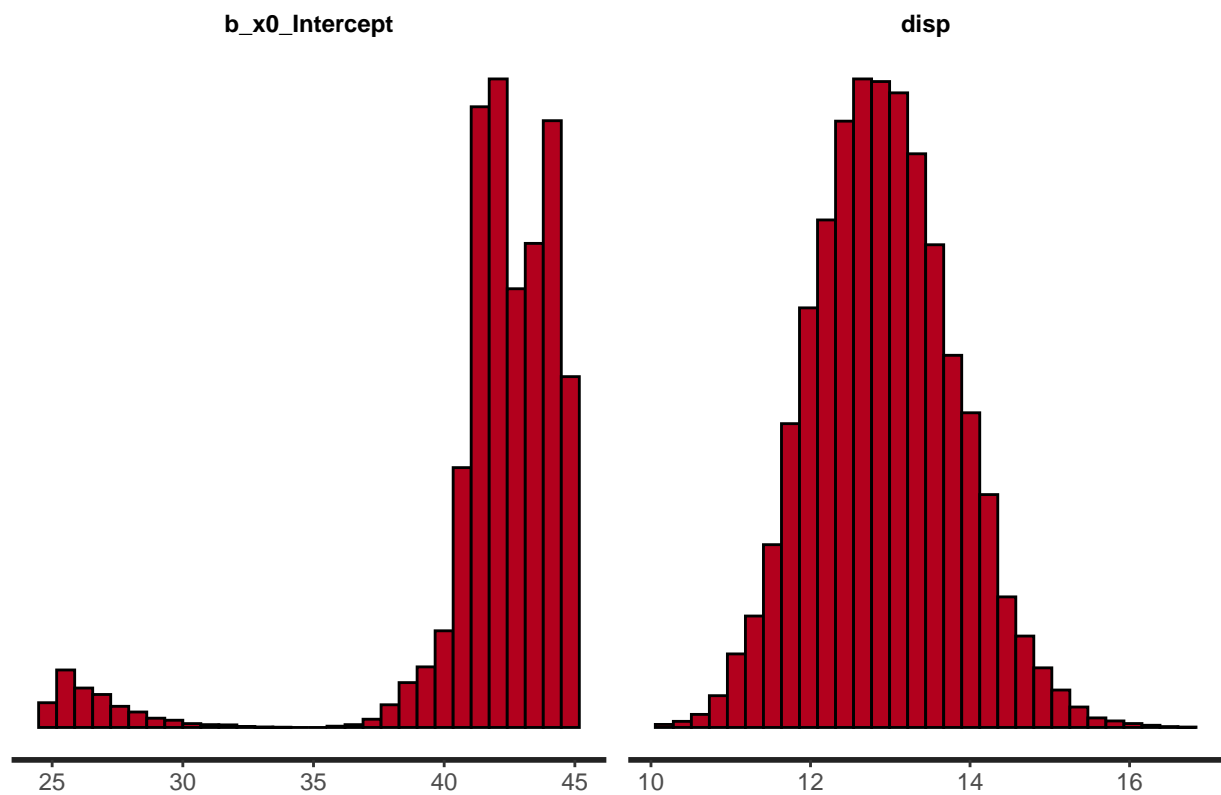
```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quant
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```



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



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



[1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 8"

```

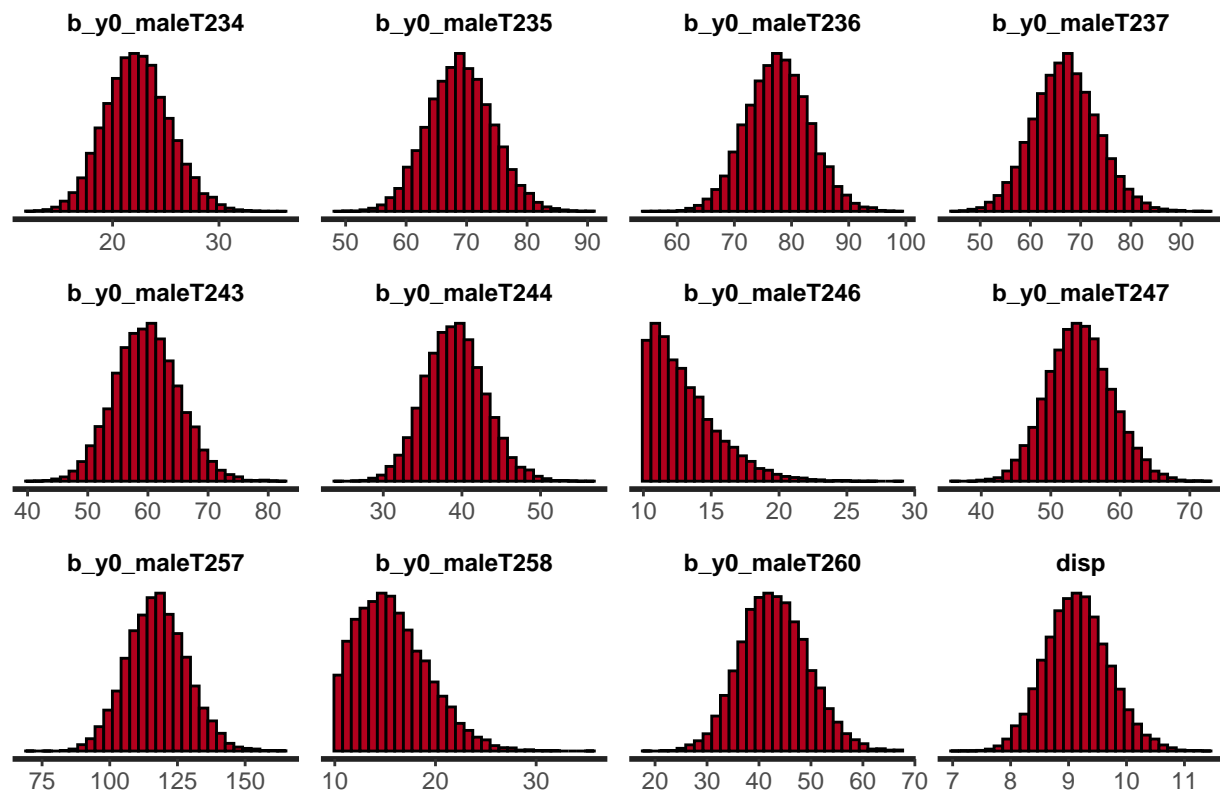
## [1] "Prior Information"
##      prior class      coef group resp dpar nlpar lb  ub      source
##  uniform(25, 45)      b                                x0 25  45      user
##  uniform(25, 45)      b Intercept                      x0 25  45 (vectorized)
##  normal(150, 1000)     b                                y0 10 1000      user
##  normal(150, 1000)     b maleT234                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT235                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT236                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT237                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT243                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT244                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT246                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT247                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT257                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT258                      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT260                      y0 10 1000 (vectorized)
##  exponential(8)  disp                                0      user
## [1] "Fit Information"
##  Family: nbinom_type1
##  Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##      x0 ~ 1
##      y0 ~ 0 + male
##  Data: data (Number of observations: 107)
##  Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##      total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_Intercept      41.65      3.96    26.05    44.87 1.04      110      22
## y0_maleT234        23.57      4.11    16.70    33.27 1.03      137      60
## y0_maleT235        70.69      9.12    57.34    98.08 1.04       82      25
## y0_maleT236        80.11      9.20    66.29   106.97 1.03       93      27
## y0_maleT237        69.71     10.06    53.70    96.82 1.03       91      35
## y0_maleT243        60.56      7.08    48.32    76.63 1.02      141      53
## y0_maleT244        40.95      5.65    31.79    55.09 1.03      105      35
## y0_maleT246        13.36      2.80    10.12    20.32 1.00     9785    5837
## y0_maleT247        56.37      7.07    45.26    75.46 1.03      119      31
## y0_maleT257       120.98     15.86    94.76   159.66 1.03      110      44
## y0_maleT258        16.74      4.35    10.41    26.86 1.01     1320    1161
## y0_maleT260        44.62      8.40    29.88    62.90 1.02      254     101
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      12.92      0.88    11.28    14.73 1.00     11402    10021
##
## 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).
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 16"
##      prior class      coef group resp dpar nlpar lb  ub      source
## (flat)  disp                                0 <NA>      default
## (flat)      b                                x0      default
## (flat)      b Intercept                      x0      (vectorized)

```

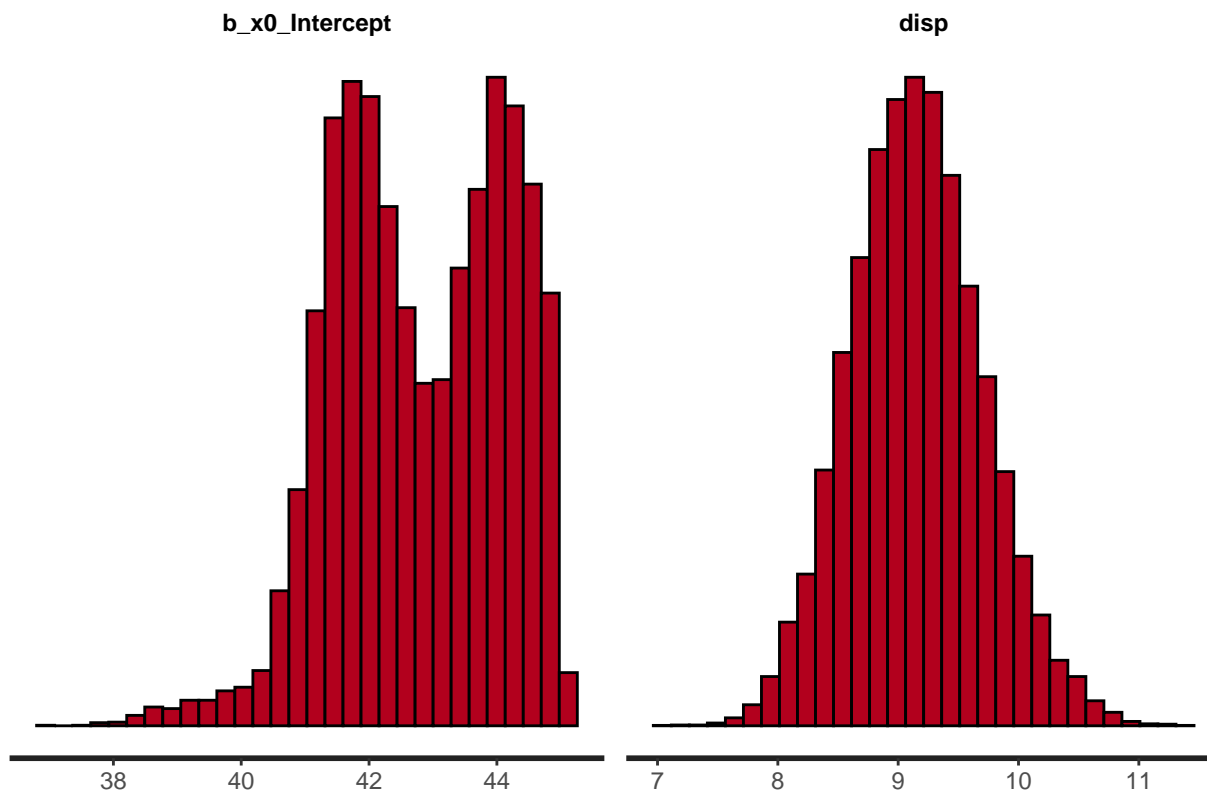


```
## (flat)      b      y0      default
## (flat)      b maleT234 y0      (vectorized)
## (flat)      b maleT235 y0      (vectorized)
## (flat)      b maleT236 y0      (vectorized)
## (flat)      b maleT237 y0      (vectorized)
## (flat)      b maleT243 y0      (vectorized)
## (flat)      b maleT244 y0      (vectorized)
## (flat)      b maleT246 y0      (vectorized)
## (flat)      b maleT247 y0      (vectorized)
## (flat)      b maleT257 y0      (vectorized)
## (flat)      b maleT258 y0      (vectorized)
## (flat)      b maleT260 y0      (vectorized)
```

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



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



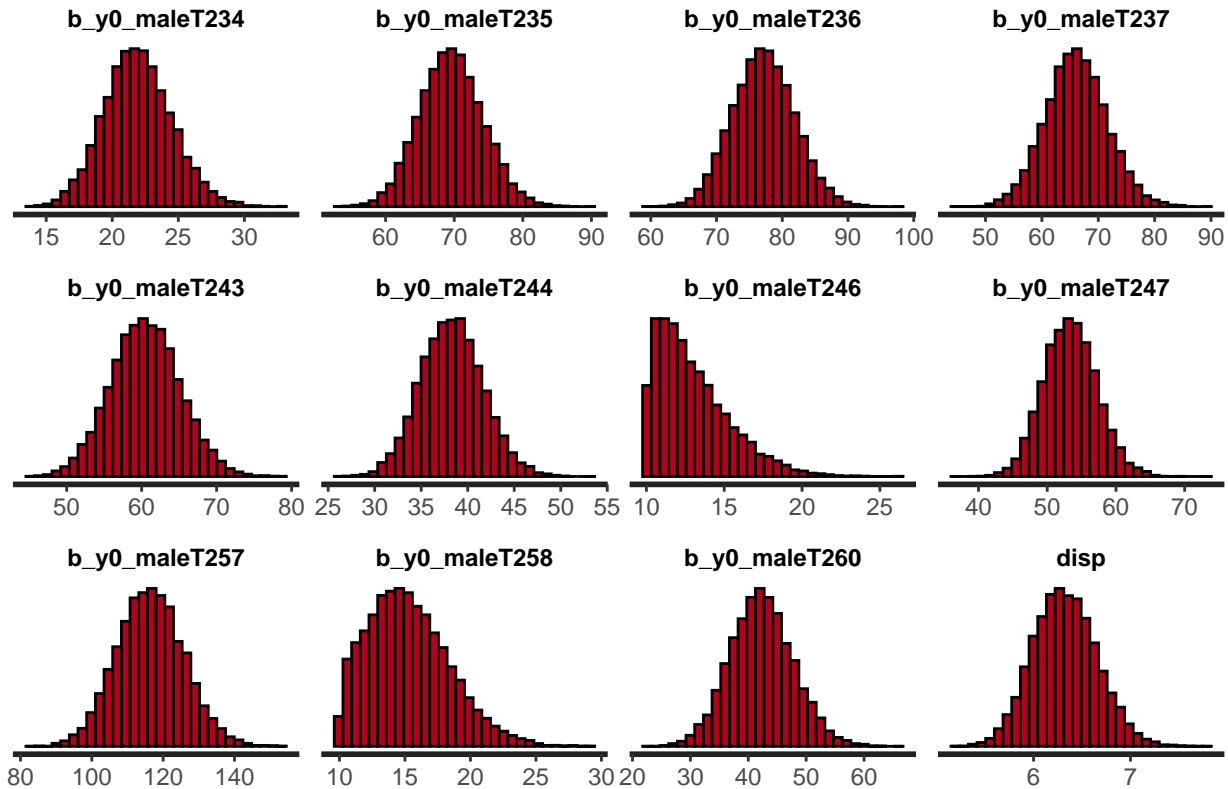
```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 16"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
##  uniform(25, 45)      b              x0 25  45      user
##  uniform(25, 45)      b Intercept    x0 25  45 (vectorized)
##  normal(150, 1000)     b          y0 10 1000      user
##  normal(150, 1000)     b maleT234    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT235    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT236    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT237    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT243    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT244    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT246    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT247    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT257    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT258    y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT260    y0 10 1000 (vectorized)
##  exponential(16) disp              0      user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##          x0 ~ 1
##          y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##        total post-warmup draws = 15000
##
```

```

## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_Intercept    42.80     1.35   40.27   44.91 1.00     5378     4427
## y0_maleT234     22.36     2.99   16.75   28.53 1.00    10432     7549
## y0_maleT235     69.01     5.34   58.81   79.73 1.00    13921     9648
## y0_maleT236     77.66     5.53   66.97   88.72 1.00    14184     9656
## y0_maleT237     67.01     6.42   54.71   80.13 1.00    13243     9067
## y0_maleT243     59.82     5.31   49.70   70.50 1.00     9838     9262
## y0_maleT244     39.12     3.80   31.94   46.92 1.00    13055     9938
## y0_maleT246     13.06     2.48   10.10   19.22 1.00     6486     4366
## y0_maleT247     54.18     4.57   45.53   63.42 1.00    12284     9645
## y0_maleT257    117.48    11.06   96.45  139.76 1.00    12664     9717
## y0_maleT258     15.78     3.53   10.45   23.70 1.00     6800     4179
## y0_maleT260     42.99     6.46   31.04   56.20 1.00    11581     7864
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      9.15      0.55     8.12    10.28 1.00     9130     8993
##
## 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).
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 32"
##   prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp                                0 <NA>      default
## (flat)  b                                x0              default
## (flat)  b Intercept                       x0      (vectorized)
## (flat)  b                                y0              default
## (flat)  b maleT234                       y0      (vectorized)
## (flat)  b maleT235                       y0      (vectorized)
## (flat)  b maleT236                       y0      (vectorized)
## (flat)  b maleT237                       y0      (vectorized)
## (flat)  b maleT243                       y0      (vectorized)
## (flat)  b maleT244                       y0      (vectorized)
## (flat)  b maleT246                       y0      (vectorized)
## (flat)  b maleT247                       y0      (vectorized)
## (flat)  b maleT257                       y0      (vectorized)
## (flat)  b maleT258                       y0      (vectorized)
## (flat)  b maleT260                       y0      (vectorized)

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

```



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

```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 32"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
##  uniform(25, 45)    b                x0 25   45          user
##  uniform(25, 45)    b Intercept      x0 25   45 (vectorized)
##  normal(150, 1000)  b                y0 10 1000          user
##  normal(150, 1000)  b maleT234      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT235      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT236      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT237      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT243      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT244      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT246      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT247      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT257      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT258      y0 10 1000 (vectorized)
##  normal(150, 1000)  b maleT260      y0 10 1000 (vectorized)
##  exponential(32)  disp                0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##          x0 ~ 1
##          y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
```

```
##           total post-warmup draws = 15000
```

```
##
```

```
## Population-Level Effects:
```

##	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
## x0_Intercept	43.05	1.24	40.91	44.93	1.00	4800	5727
## y0_maleT234	21.94	2.55	17.14	27.20	1.00	9381	7844
## y0_maleT235	69.56	4.60	60.78	78.83	1.00	21331	9242
## y0_maleT236	77.17	4.71	68.16	86.59	1.00	19365	9738
## y0_maleT237	66.10	5.44	55.53	77.01	1.00	17129	10495
## y0_maleT243	60.51	4.59	51.70	69.67	1.00	9980	10176
## y0_maleT244	38.29	3.35	31.86	45.04	1.00	13437	9012
## y0_maleT246	13.01	2.34	10.12	18.70	1.00	4524	3061
## y0_maleT247	53.36	3.88	46.04	61.18	1.00	13599	10014
## y0_maleT257	116.38	9.33	98.57	135.17	1.00	14502	10371
## y0_maleT258	15.28	3.09	10.42	22.14	1.00	4488	2933
## y0_maleT260	42.31	5.45	31.87	53.30	1.00	9673	7982

```
##
```

```
## Family Specific Parameters:
```

##	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
## disp	6.32	0.33	5.70	6.99	1.00	5830	7314

```
##
```

```
## 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).
```

```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 64"
```

##	prior	class	coef	group	resp	dpar	nlpar	lb	ub	source
##	(flat)	disp						0	<NA>	default
##	(flat)	b					x0			default
##	(flat)	b	Intercept				x0			(vectorized)
##	(flat)	b					y0			default
##	(flat)	b	maleT234				y0			(vectorized)
##	(flat)	b	maleT235				y0			(vectorized)
##	(flat)	b	maleT236				y0			(vectorized)
##	(flat)	b	maleT237				y0			(vectorized)
##	(flat)	b	maleT243				y0			(vectorized)
##	(flat)	b	maleT244				y0			(vectorized)
##	(flat)	b	maleT246				y0			(vectorized)
##	(flat)	b	maleT247				y0			(vectorized)
##	(flat)	b	maleT257				y0			(vectorized)
##	(flat)	b	maleT258				y0			(vectorized)
##	(flat)	b	maleT260				y0			(vectorized)

```
## Warning: The largest R-hat is 1.29, indicating chains have not mixed.
```

```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#r-hat
```

```
## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
```

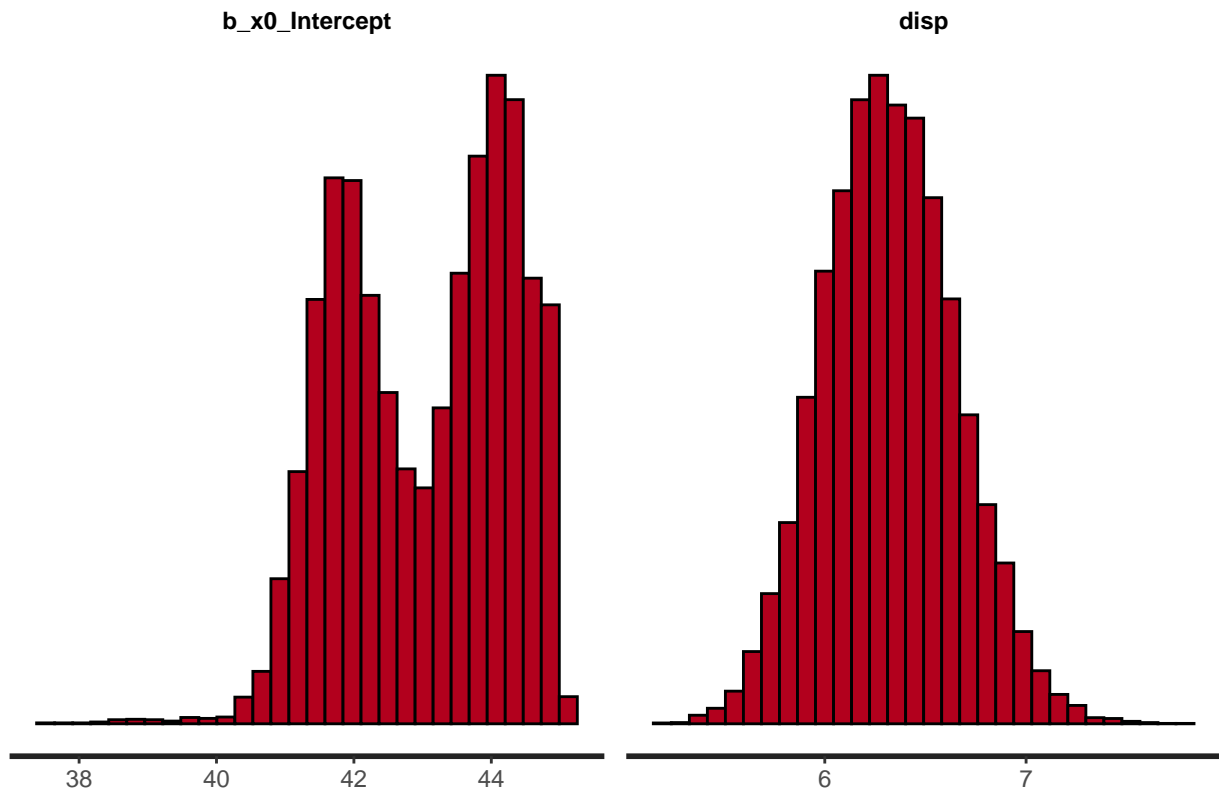
```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#bulk-ess
```

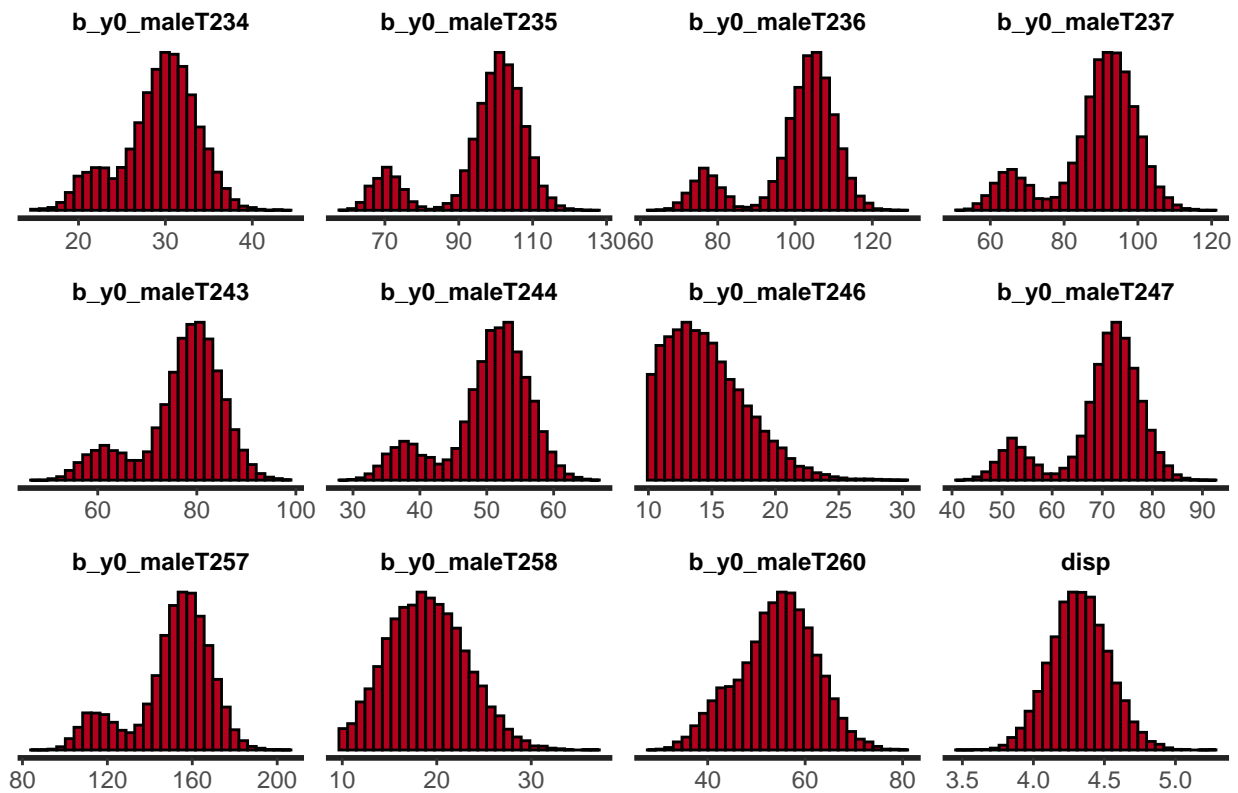
```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quant.
```

```
## Running the chains for more iterations may help. See
```

```
## https://mc-stan.org/misc/warnings.html#tail-ess
```



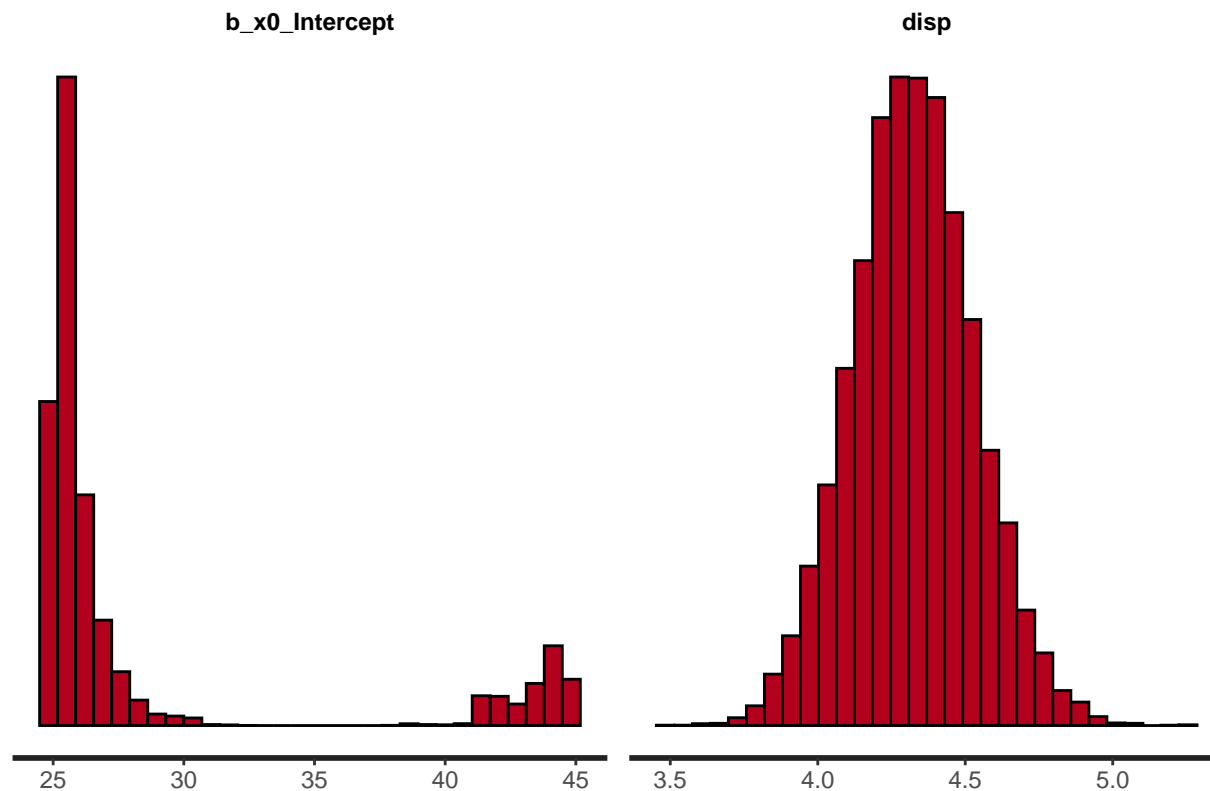
'stat_bin()' using 'bins = 30'. Pick better value with 'binwidth'.



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

```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 64"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
##  uniform(25, 45)      b                x0 25  45      user
##  uniform(25, 45)      b Intercept      x0 25  45 (vectorized)
##  normal(150, 1000)     b                y0 10 1000     user
##  normal(150, 1000)     b maleT234      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT235      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT236      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT237      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT243      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT244      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT246      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT247      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT257      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT258      y0 10 1000 (vectorized)
##  normal(150, 1000)     b maleT260      y0 10 1000 (vectorized)
##  exponential(64) disp                0      user
## [1] "Fit Information"

## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.
```



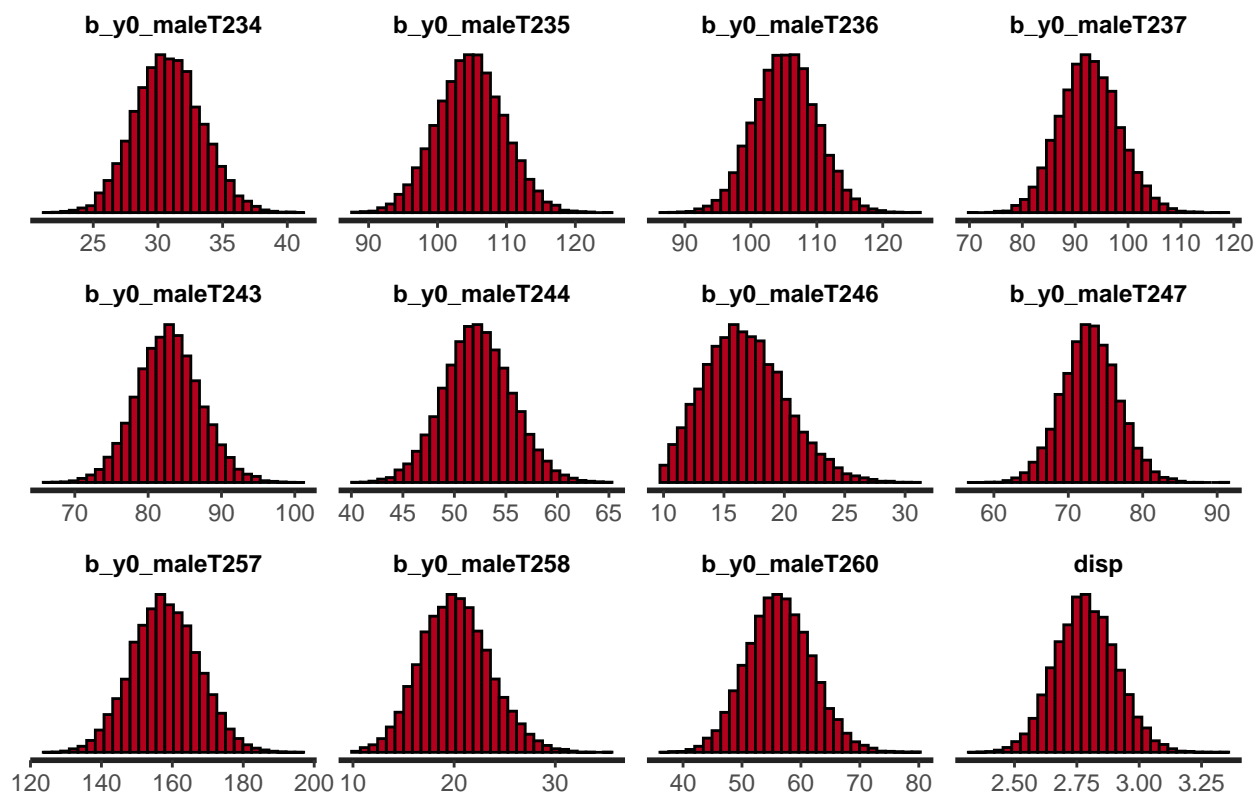
```
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##           x0 ~ 1
```

```

##          y0 ~ 0 + male
##      Data: data (Number of observations: 107)
##      Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
##            total post-warmup draws = 15000
##
## Population-Level Effects:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_Intercept      28.48      6.39    25.02    44.53 1.29      10      15
## y0_maleT234        29.30      4.37    19.67    36.61 1.27      11      16
## y0_maleT235        96.88     12.48    66.63   112.75 1.29      10      15
## y0_maleT236       100.47     11.30    73.19   115.24 1.29      10      15
## y0_maleT237        88.72     11.65    60.90   105.67 1.28      10      17
## y0_maleT243        77.13      8.31    57.05    89.73 1.28      10      15
## y0_maleT244        50.15      6.41    35.03    59.72 1.29      10      15
## y0_maleT246        14.66      3.12    10.24    21.77 1.01     755    3611
## y0_maleT247        69.82      8.53    49.36    81.74 1.28      10      16
## y0_maleT257       150.81     18.41   107.65   178.06 1.28      10      16
## y0_maleT258        18.98      4.15    11.48    27.39 1.11      23      71
## y0_maleT260        54.11      7.94    37.87    68.64 1.23      12      18
##
## Family Specific Parameters:
##      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp      4.32      0.21      3.92      4.74 1.02     185    3651
##
## 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).
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 128"
##      prior class      coef group resp dpar nlpar lb  ub      source
## (flat) disp              0 <NA>      default
## (flat)  b                x0      default
## (flat)  b Intercept      x0      (vectorized)
## (flat)  b                y0      default
## (flat)  b maleT234        y0      (vectorized)
## (flat)  b maleT235        y0      (vectorized)
## (flat)  b maleT236        y0      (vectorized)
## (flat)  b maleT237        y0      (vectorized)
## (flat)  b maleT243        y0      (vectorized)
## (flat)  b maleT244        y0      (vectorized)
## (flat)  b maleT246        y0      (vectorized)
## (flat)  b maleT247        y0      (vectorized)
## (flat)  b maleT257        y0      (vectorized)
## (flat)  b maleT258        y0      (vectorized)
## (flat)  b maleT260        y0      (vectorized)

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

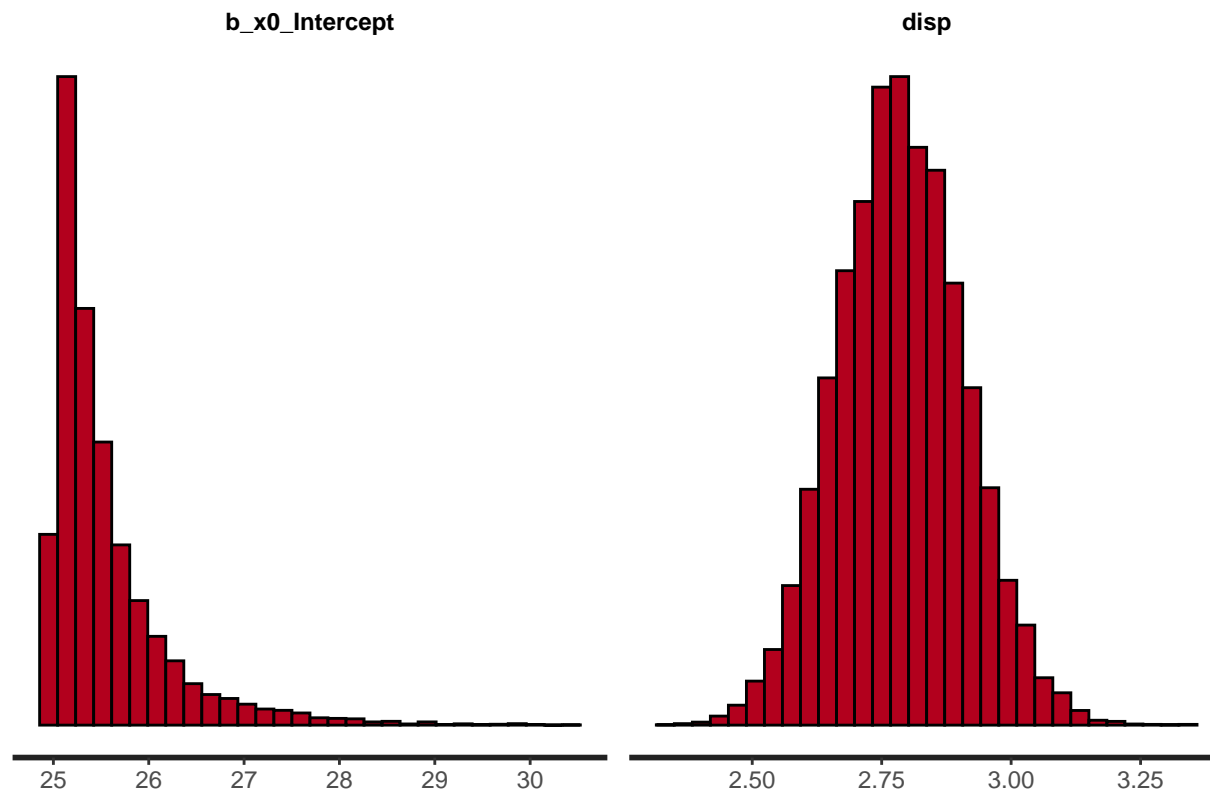
```

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

```
## [1] "piecewise: nbinom_type1; x0 uniform_1; y0 individual, disp prior: 128"
## [1] "Prior Information"
##           prior class      coef group resp dpar nlpar lb  ub      source
##  uniform(25, 45)    b                x0 25   45          user
##  uniform(25, 45)    b Intercept      x0 25   45 (vectorized)
##  normal(150, 1000)   b                y0 10 1000          user
##  normal(150, 1000)   b maleT234      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT235      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT236      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT237      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT243      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT244      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT246      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT247      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT257      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT258      y0 10 1000 (vectorized)
##  normal(150, 1000)   b maleT260      y0 10 1000 (vectorized)
##  exponential(128)  disp                0          user
## [1] "Fit Information"
## Family: nbinom_type1
## Links: mu = identity; disp = identity
## Formula: y ~ two_piece(x, x0, y0)
##          x0 ~ 1
##          y0 ~ 0 + male
## Data: data (Number of observations: 107)
## Draws: 4 chains, each with iter = 15000; warmup = 11250; thin = 1;
```

```
##           total post-warmup draws = 15000
##
## Population-Level Effects:
##           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## x0_Intercept      25.55      0.64    25.01    27.44 1.00      9641      7692
## y0_maleT234        30.82      2.58    25.91    35.92 1.00     15331      9972
## y0_maleT235       104.77      4.86    95.31   114.34 1.00     15103     11036
## y0_maleT236       105.28      4.71    96.24   114.61 1.00     17046     10620
## y0_maleT237        92.68      5.61    82.07   104.02 1.00     16406     10222
## y0_maleT243        82.81      4.35    74.42    91.52 1.00     15649     11079
## y0_maleT244        52.28      3.32    45.82    58.95 1.00     16098     10274
## y0_maleT246        16.77      3.33    10.99    23.88 1.00      9805      4705
## y0_maleT247        72.95      3.75    65.63    80.37 1.00     16592     10860
## y0_maleT257       158.01      9.36   140.05   176.60 1.00     16610     11652
## y0_maleT258        20.16      3.43    13.77    27.26 1.00     13795      5971
## y0_maleT260        56.37      5.52    45.90    67.51 1.00     16919     10461
##
## Family Specific Parameters:
##           Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## disp          2.79      0.12      2.55      3.03 1.00     17449     11139
##
## 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).
## [1] "piecewise: nbinom_type1; x0 group_1; y0 individual, disp prior: 4"
##
## Error in `data[, c("male", "x0_group")]`:
## ! Can't subset columns that don't exist.
## x Column 'x0_group' doesn't exist.
```



Work with stan object

```
fit_stan@model_pars
```

```
## [1] "b_x0" "b_y0" "disp" "lprior" "lp__"
```

```
fit_stan@par_dims
```

```
## $b_x0  
## [1] 1  
##  
## $b_y0  
## [1] 11  
##  
## $disp  
## numeric(0)  
##  
## $lprior  
## numeric(0)  
##  
## $lp__  
## numeric(0)
```

```
#save(file = file.path(output_dir, paste0("fit_tbl_", format(Sys.time(), "%Y-%m-%d_%H-%M")), ".Rdata")),
```