

Online appendix: “Discrimination against mobile EU citizens before and during the first Covid-19 lockdown: Evidence from a conjoint experiment in Germany”

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1 Model specification

1.1 Equation

Model description:

$$\begin{aligned}
 Y_o &\sim \mathcal{B}(\pi_o) && \text{Main data component} \\
 \pi_o &= \text{logit}(\beta_{i,O,f} F_{o,f}) && \text{Linear relationship} \\
 \beta_{i,O,f} &\sim \mathcal{MN}(\mu_{i,O,f}, \Sigma_{\beta_O}) \\
 \Sigma_{\beta_O} &\sim \mathcal{IW}(0, 9) && \text{VCov for individual effects} \\
 \mu_{i,O,f} &= (\theta_{O,f,s,v} C_{i,v}) && \text{Explanation of individual behavior} \\
 \theta_{O,f,s,v} &\sim \mathcal{N}(\omega_{O,f}, \sigma_\theta) && \text{Priors for explanatory variables of individual behavior} \\
 \omega_{O,f} &\sim \mathcal{N}(0, 2.5) && \text{Prior for the effects shared by outcome} \\
 \sigma_{\theta_{O,f,v}} &\sim \mathcal{U}(0, 1) && \text{Prior for SD of individual behavior}
 \end{aligned}$$

Where:

- Y : Outcome variable capturing whether a profile has been prioritized (1) or not (0).
- o : Observation
- i : Individual
- O : Outcomes (Welfare/ Rights)
- s : Sample (Regular time, main sample / COVID-19 crisis sample)
- F : Matrix with the observations of features (the discrimination sources, plus intercept and first shown profile), for each experimental data point.
- C : Matrix with the characteristics v of the respondents, including their population p and the treatment t .
- f : Feature
- $\theta_{O,f,s,v}$: Main parameters of interest capturing the individual variables affecting discrimination effects by outcome, sample and profiles' feature.
- $\omega_{O,f}$: Hyper-parameters capturing the shared effect of individual characteristics on features over outcomes and sample.
- Σ_{β_O} : Variance-covariance matrix of the individual effects prioritizing the different profiles, by outcome.
- σ_θ : Between outcome/sample and within feature/individual characteristic's standard deviations.

The σ_θ can also be seen as a pooling factor. The higher, the more freely are the effects of pre-post COVID-19 to vary from the overall $\omega_{O,f}$ shared by outcome and feature. If it is restricted to be very close to 0 then it assumes that there should be a lot of variation from the two samples to make them different. Otherwise, they "borrow strength" from the overall means.

1.2 Software implementation

The JAGS code for the model is the following:

```
1  model {
2    for (o in 1:nO) {
3      Y[o] ~ dbern(p[o])
4      logit(p[o]) <- inprod(beta[id[o],id_outcome[o],1:nF], X[o,1:nF])
5    }
6    #
7    # Priors for effects
8    #
9    for (ocm in 1:nOutcome) {
10      for (id in 1:nId) {
11        for (f in 1:nF) {
12          beta[id,ocm,f] ~ dnorm(mu[id,ocm,f], 2.5^-2)
13        }
14      }
15    }
16
17    for (f in 1:nF) {
18      for (ocm in 1:nOutcome) {
19        for (id in 1:nId) {
20          mu[id,ocm,f] <- inprod(theta[ocm,f,ind_id_sample[id],1:nCov], C[id,1:nCov])
21        }
22        for (cov in 1:nCov) {
23          for (s in 1:nS) {
24            theta[ocm,f,s,cov] ~ dnorm(omega[f,cov], tau_theta[f,cov])
25          }
26        }
27      }
28      for (cov in 1:nCov) {
29        omega[f,cov] ~ dnorm(0, 2.5^-2)
30        tau_theta[f,cov] <- pow(sigma_theta[f,cov], -2)
31        sigma_theta[f,cov] ~ dt(0, 0.5^-2, 3)T(0, )
32      }
33    }
34
35    #
36    # Missing data
37    #
38    for (id in 1:nId) {
39      for (v in cov.missing) {
40        C[id,v] ~ dnorm(0, 1^-2)
41      }
42    }
43  }
```

2 Full model results

Figure 1 shows the parameters of the model reported in the article. Recall that the hypotheses refer to the difference of the parameters between the main sample and the COVID-19 crisis sample.

Table 1 presents the model fit in terms of percent correctly predicted.

Sample	Treatment	Outcome	Average PCP
Main	Not shown	Rights	81.1%
Main	Not shown	Welfare	80.9%
Main	Shown	Rights	80.9%
Main	Shown	Welfare	81.2%
Crisis	Not shown	Rights	81%
Crisis	Not shown	Welfare	80.9%
Crisis	Shown	Rights	81.1%
Crisis	Shown	Welfare	80.4%

Table 1: Model fit using posterior average of percent correctly predicted, by outcome, treatment and sample.

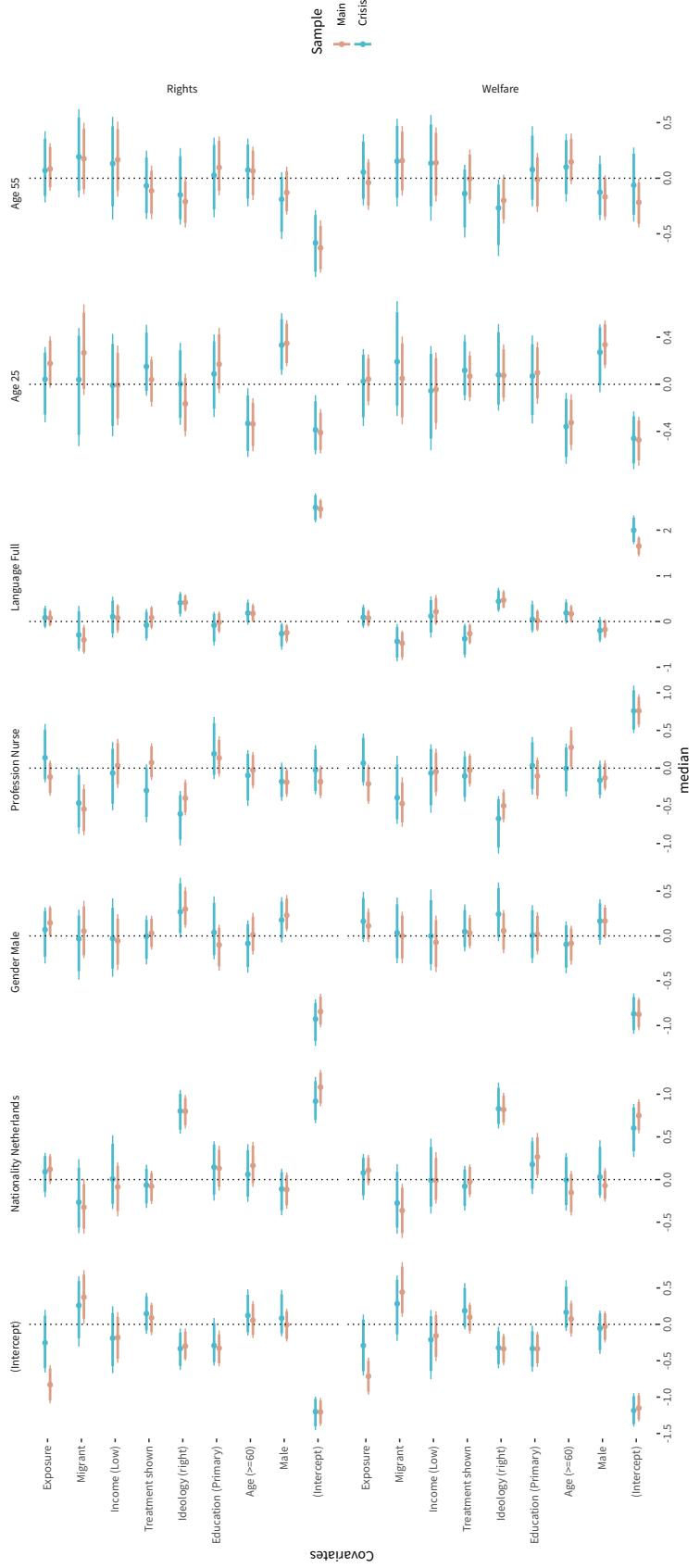


Figure 1: Posterior distributions for the main model parameters of interest (θ). Dots represent the median effect, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter. Colors allow us to compare the effects of the parameters during regular times and during COVID-19 crisis (Highest Posterior Density, HPD). Welfare/Rights are compared in the rows.

Figure 2 shows the comparison of relative importances at each percentile (sorted in increasing order). When importances are sorted, the two samples exhibit an almost identical behaviour, proving that the importance given to each feature has not changed between the main sample and the COVID-19 crisis sample.

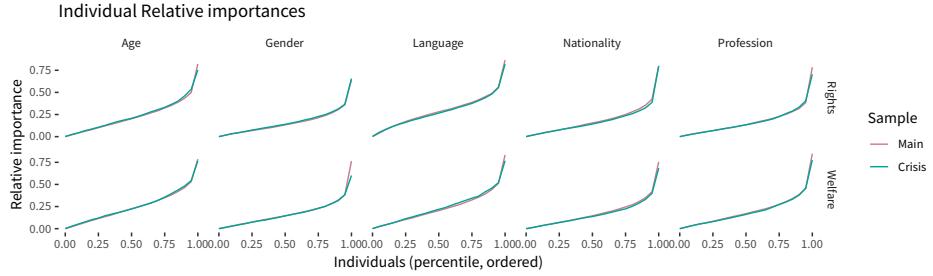


Figure 2: Comparison of relative importances for each sample.

3 Sample description

The data used contains two representative samples of German citizens taken at two points in time. This section presents descriptive statistics for their characteristics.

For discrete variables the table reports the number of individuals in each sample, as well as their proportion in the sample (in parenthesis). For continuous variables (age and ideology) it reports the mean and the standard deviation (in parenthesis). In addition the *p*-value of the corresponding t-test is reported.

Table 2: Summary descriptives table by groups of ‘Sample’

	Main N=2974	Crisis N=1063	p.overall
Gender:			0.573
Female	1551 (52.2%)	543 (51.1%)	
Male	1423 (47.8%)	520 (48.9%)	
Age	49.9 (16.3)	49.8 (16.7)	0.864
Education:			0.116
Primary	722 (24.3%)	228 (21.4%)	
Secondary	1124 (37.8%)	415 (39.0%)	
Still studying	52 (1.75%)	12 (1.13%)	
Tertiary	1076 (36.2%)	408 (38.4%)	
Ideology	4.62 (2.09)	4.60 (2.00)	0.813
Migration:			0.242
No	2646 (89.3%)	932 (87.9%)	
Yes	317 (10.7%)	128 (12.1%)	
Income availability:			1.000
Not reported	2340 (78.7%)	836 (78.6%)	
Reported	634 (21.3%)	227 (21.4%)	
Income level (low):			0.442
Above €1,500	2303 (77.4%)	836 (78.6%)	
Below €1,500	671 (22.6%)	227 (21.4%)	
Income level (high):			0.071
Above €4,000	370 (12.4%)	156 (14.7%)	
Below €4,000	2604 (87.6%)	907 (85.3%)	

4 Robustness checks

4.1 Exposure to COVID without context

This section presents the results of the same main model presented in the article (and shown in this document on Figure 1), but the variable "Exposition to COVID" is not contextual. That is, the exposure of each region is relative to the overall exposure in the date of the two samples, not relative to the rest of the regions in each of the samples (Figure 3).

The results are presented in Figure 3 (model parameters), Table 3 (model fit) Table 4, Table 5 and Table 6 (Hypotheses 1, 2 and 3, respectively).

Sample	Treatment	Outcome	Average PCP
Main	Not shown	Rights	81.5%
Main	Not shown	Welfare	81.4%
Main	Shown	Rights	81.4%
Main	Shown	Welfare	81.6%
Crisis	Not shown	Rights	81%
Crisis	Not shown	Welfare	80.9%
Crisis	Shown	Rights	81.1%
Crisis	Shown	Welfare	80.4%

Table 3: Model fit using posterior average of percent correctly predicted, by outcome, treatment and sample (exposure model).

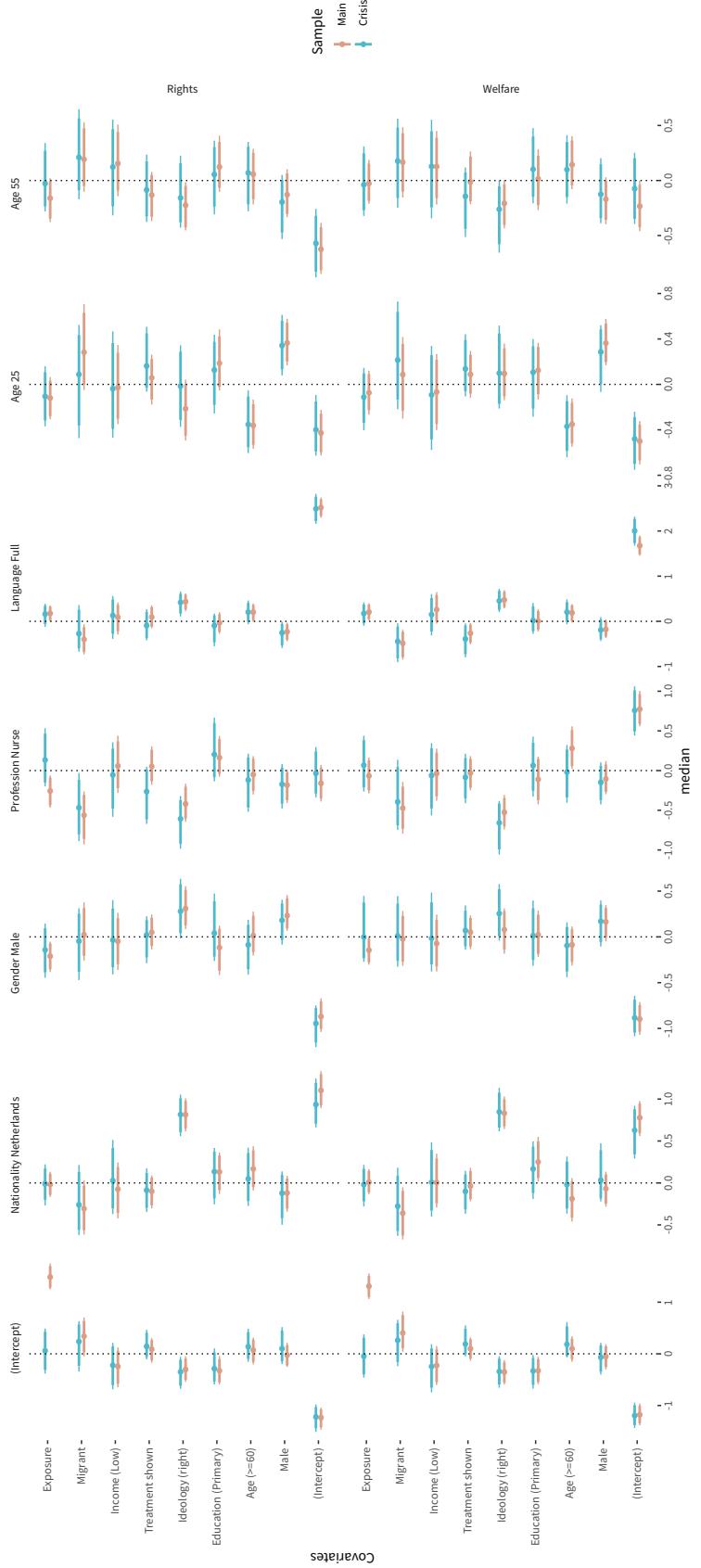


Figure 3: Posterior distributions for the parameters of interest (θ) of the model where exposure is without context. Dots represent the median effect, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter. Colors allow us to compare the effects of the parameters during regular times and during COVID-19 crisis (Highest Posterior Density, HPD). Welfare/Rights are compared in the rows.

Outcome	Feature	Prob H1
Welfare	Language Full	96.7%
Rights	Language Full	44.1%
Welfare	Nationality Netherlands	18.9%
Rights	Nationality Netherlands	14.4%

Table 4: Evidence for Hypothesis 1. (exposure model)

Outcome	Feature	Prob H2
Rights	Nationality Netherlands	53.1%
Rights	Language Full	45%
Welfare	Nationality Netherlands	40.3%
Welfare	Language Full	39.9%

Table 5: Evidence for Hypothesis 2.

Outcome	Feature	Covariate	Prob H3
Welfare	Language Full	Age ($>=60$)	52.2%
Rights	Language Full	Age ($>=60$)	49.7%
Rights	Language Full	Income (Low)	42.8%
Welfare	Nationality Netherlands	Income (Low)	38.4%
Rights	Nationality Netherlands	Income (Low)	34.7%
Welfare	Language Full	Income (Low)	29.6%
Rights	Nationality Netherlands	Age ($>=60$)	26.6%
Welfare	Nationality Netherlands	Age ($>=60$)	18.7%

Table 6: Evidence for Hypothesis 3. (exposure model)

4.2 Average Marginal Component Errors (AMCE) model

This section presents the results using a simpler model based on Hainmueller, Hopkins, and Yamamoto reporting Average Marginal Component Effects (AMCE). The individual part-worths are not estimated in this simpler scenario, but the hierarchical structure of the model is employed.

The model description in this case is as follows (where notation is equal to the main model explained in Section 1.1):

$$\begin{aligned}
 Y_o &\sim \mathcal{N}(\mu_o, \sigma_i) && \text{Main data component} \\
 \mu_o &= \theta_{s,o,f,v} C_{i,v} && \text{Linear relationship} \\
 \theta_{O,f,s,v} &\sim \mathcal{N}(\omega_{O,f}, \sigma_\theta) && \text{Priors for explanatory variables of individual behavior} \\
 \omega_{O,f} &\sim \mathcal{N}(0, 2.5) && \text{Prior for the effects shared by outcome} \\
 \sigma_{\theta_{O,f,v}} &\sim \mathcal{U}(0, 1) && \text{Prior for SD of individual behavior}
 \end{aligned}$$

The results are presented in Figure 4 (model parameters), Table 7 (model fit) Table 8, Table 9 and Table 10 (Hypotheses 1, 2 and 3, respectively).

Sample	Treatment	Outcome	Average PCP
Main	Not shown	Rights	67.5%
Main	Not shown	Welfare	65.5%
Main	Shown	Rights	67.1%
Main	Shown	Welfare	65.1%
Crisis	Not shown	Rights	63.5%
Crisis	Not shown	Welfare	60.3%
Crisis	Shown	Rights	61.9%
Crisis	Shown	Welfare	59%

Table 7: Model fit using posterior average of percent correctly predicted, by outcome, treatment and sample (AMCE-like model).

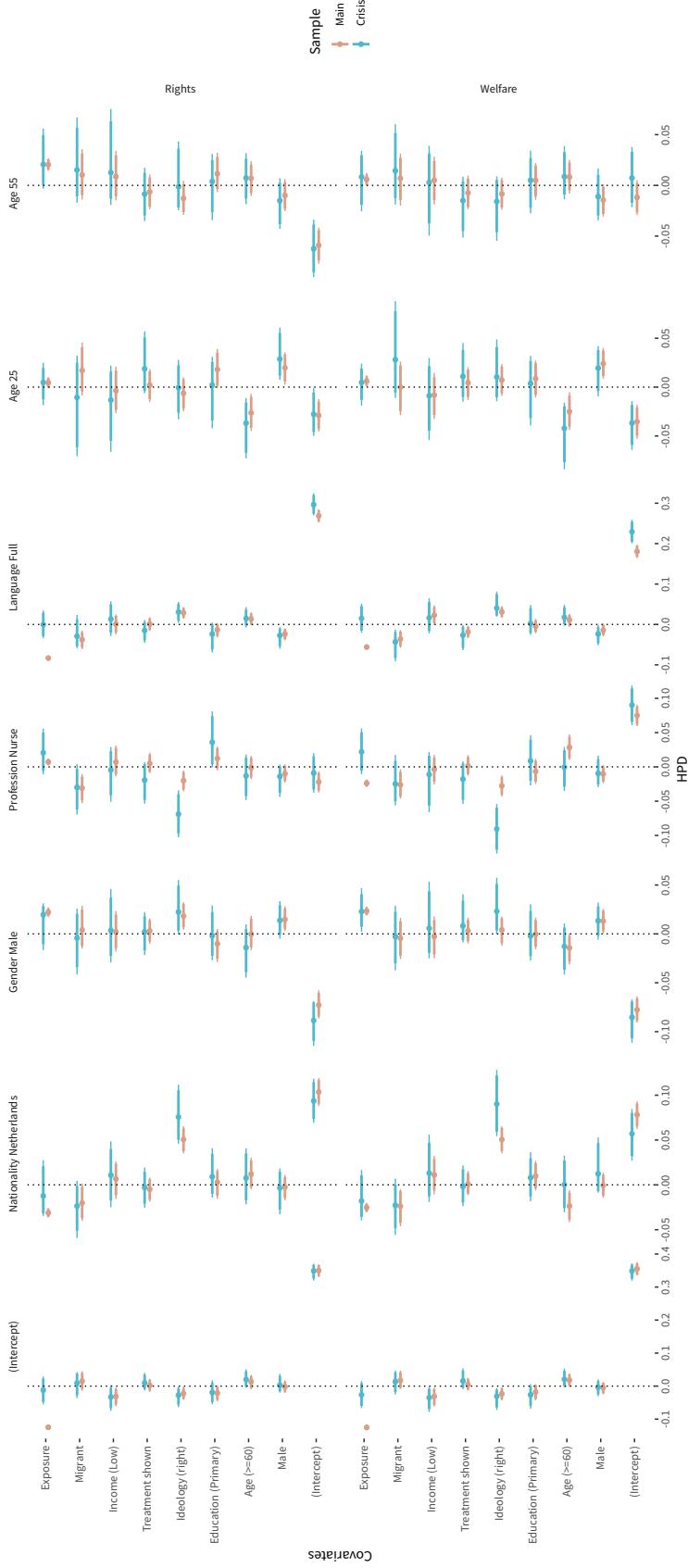


Figure 4: Posterior distributions for the parameters of interest (θ) of the model where individual part-worths are not considered (simplified), but only average marginal component effects are estimated (using a linear model). Dots represent the median effect, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter (Highest Posterior Density, HPD). Colors allow us to compare the effects of the parameters during regular times and during COVID-19 crisis. Welfare/Rights are compared in the rows.

Outcome	Feature	Prob H1
Rights	Language Full	96.8%
Welfare	Nationality Netherlands	6.9%
Rights	Nationality Netherlands	23.5%
Welfare	Language Full	100%

Table 8: Evidence for Hypothesis 1. (AMCE-like model).

Outcome	Feature	Prob H2
Rights	Nationality Netherlands	91.9%
Welfare	Nationality Netherlands	71.7%
Rights	Language Full	100%
Welfare	Language Full	100%

Table 9: Evidence for Hypothesis 2. (AMCE-like model).

Outcome	Feature	Covariate	Prob H3
Welfare	Nationality Netherlands	Age ($>=60$)	8.2%
Welfare	Language Full	Age ($>=60$)	64.1%
Rights	Language Full	Age ($>=60$)	53.1%
Welfare	Nationality Netherlands	Income (Low)	49.3%
Rights	Nationality Netherlands	Income (Low)	47.8%
Rights	Language Full	Income (Low)	41.7%
Welfare	Language Full	Income (Low)	38.5%
Rights	Nationality Netherlands	Age ($>=60$)	36.9%

Table 10: Evidence for Hypothesis 3. (AMCE-like model).

4.3 Logit, non Hierarchical-Bayes model

This model specification is equal to the one in Section 4.2, but using a binary logistic model instead of a linear regression model.

$$Y_o \sim \mathcal{B}(\pi_o) \quad \text{Main data component}$$

$$\pi_o = \text{logit}(\theta_{s,o,f,v} C_{i,v}) \quad \text{Linear relationship}$$

The results are presented in Figure 5 (model parameters), Table 11 (model fit) Table 12, Table 13 and Table 14 (Hypotheses 1, 2 and 3, respectively).

Sample	Treatment	Outcome	Average PCP
Main	Not shown	Rights	67%
Main	Not shown	Welfare	66.1%
Main	Shown	Rights	66.8%
Main	Shown	Welfare	65.9%
Crisis	Not shown	Rights	63.5%
Crisis	Not shown	Welfare	60.2%
Crisis	Shown	Rights	61.9%
Crisis	Shown	Welfare	58.9%

Table 11: Model fit using posterior average of percent correctly predicted, by outcome, treatment and sample (AMCE-like with logit model).

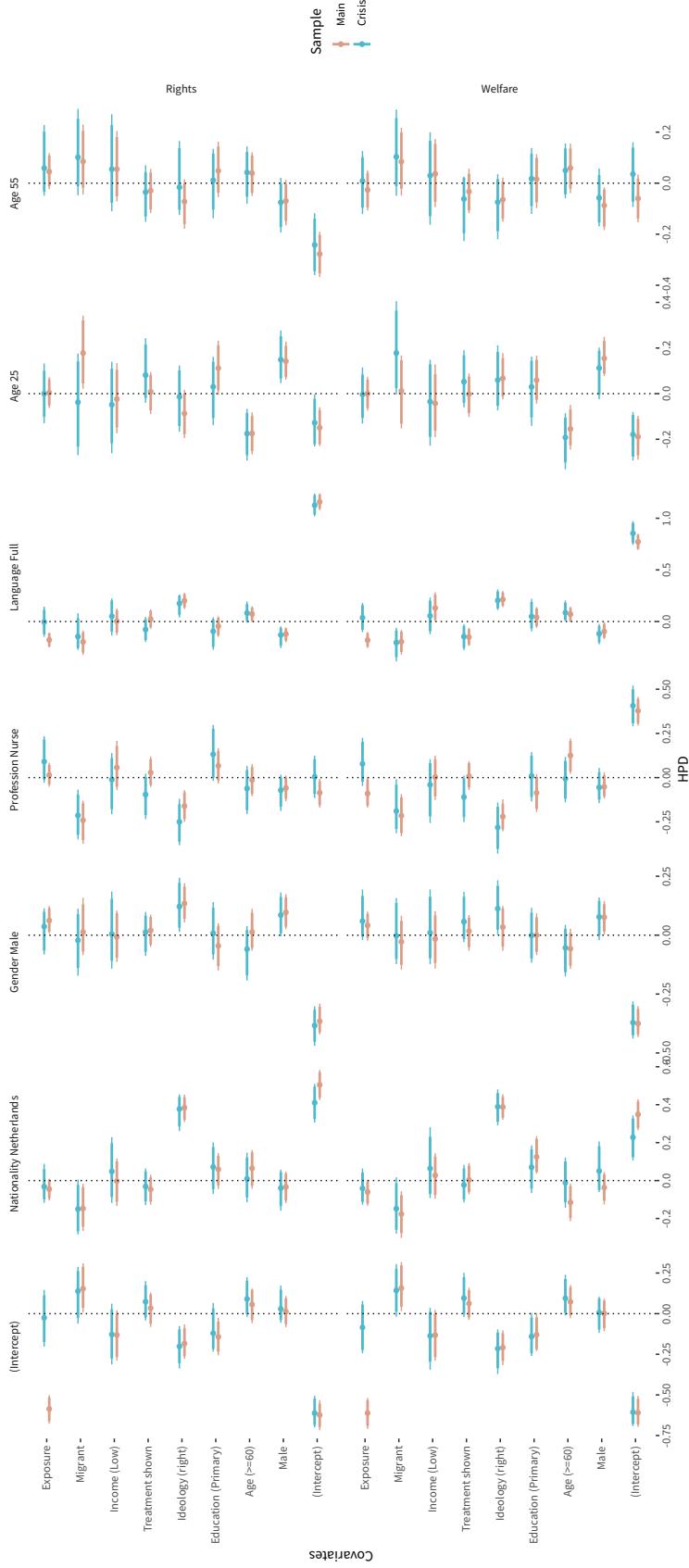


Figure 5: Posterior distributions for the parameters of interest (θ) of the model where individual part-worths are not considered (simplified), but only average marginal component effects are estimated (using a binary logistic model). Dots represent the median loged odds, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter (Highest Posterior Density, HPD). Colors allow us to compare the effects of the parameters during regular times and during COVID-19 crisis. Welfare/Rights are compared in the rows.

Outcome	Feature	Prob H1
Welfare	Language Full	89.1%
Rights	Nationality Netherlands	5.2%
Welfare	Nationality Netherlands	3.5%
Rights	Language Full	29.9%

Table 12: Evidence for Hypothesis 1. (AMCE-like with logit model)

Outcome	Feature	Prob H2
Welfare	Language Full	99.6%
Rights	Language Full	98.1%
Welfare	Nationality Netherlands	64.9%
Rights	Nationality Netherlands	61.9%

Table 13: Evidence for Hypothesis 2. (AMCE-like with logit model)

Outcome	Feature	Covariate	Prob H3
Welfare	Nationality Netherlands	Age ($>=60$)	8.6%
Welfare	Language Full	Age ($>=60$)	60.9%
Rights	Language Full	Age ($>=60$)	54.3%
Welfare	Nationality Netherlands	Income (Low)	46.4%
Rights	Language Full	Income (Low)	38.9%
Rights	Nationality Netherlands	Income (Low)	37.9%
Rights	Nationality Netherlands	Age ($>=60$)	24.1%
Welfare	Language Full	Income (Low)	21.9%

Table 14: Evidence for Hypothesis 3.

4.4 Without technical control for first profile shown

This model specification is equal to the main model presented in the text, except that there is no technical control for the profile first shown. The results are presented in Figure 6 (model parameters) and Table 15 (model fit).

Sample	Treatment	Outcome	Average PCP
Main	Not shown	Rights	77.7%
Main	Not shown	Welfare	77.8%
Main	Shown	Rights	77.6%
Main	Shown	Welfare	77.9%
Crisis	Not shown	Rights	77.4%
Crisis	Not shown	Welfare	78.1%
Crisis	Shown	Rights	78%
Crisis	Shown	Welfare	77.1%

Table 15: Model fit using posterior average of percent correctly predicted, by outcome, treatment and sample (no first shown).

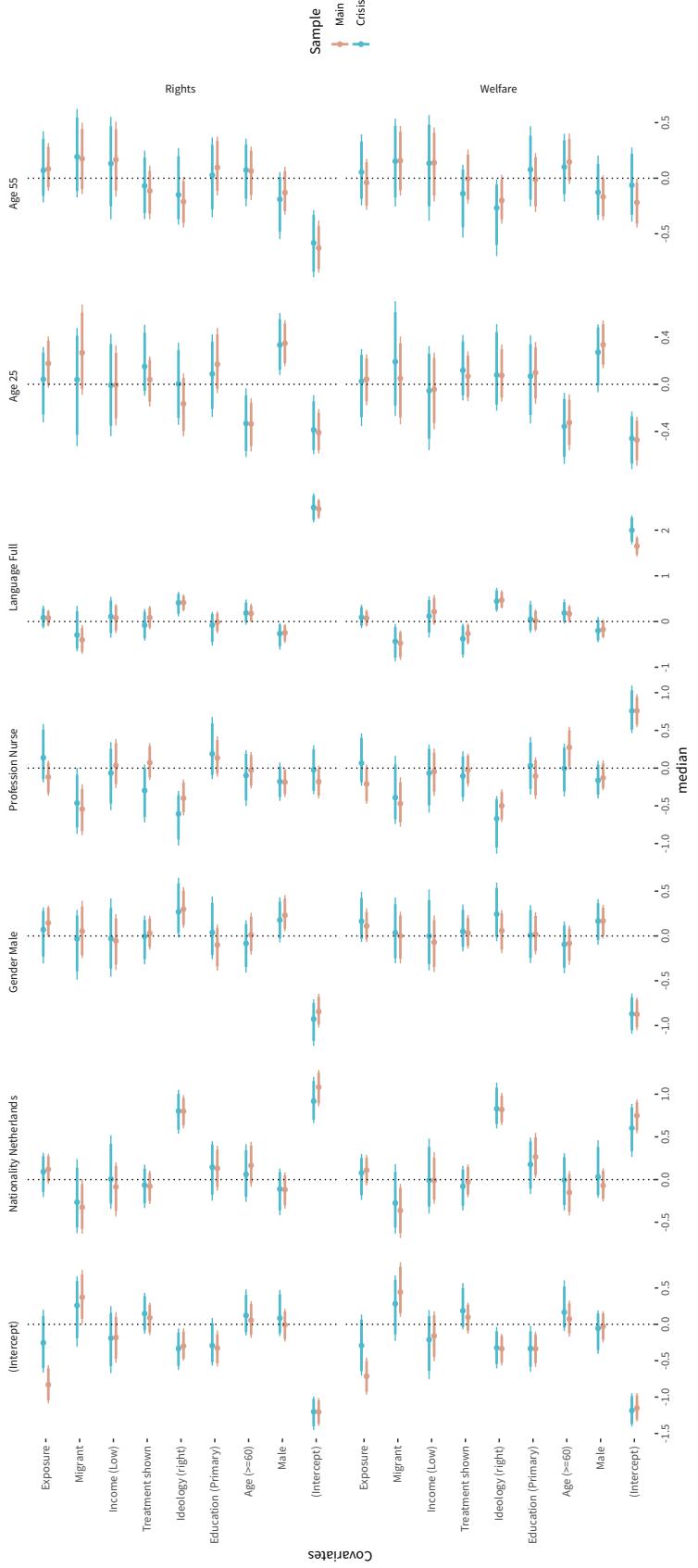


Figure 6: Posterior distributions for the parameters of interest (θ) of the model without the technical control for the first profile shown. Dots represent the median effect, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter. Colors allow us to compare the effects of the parameters during regular times and during COVID-19 crisis (Highest Posterior Density, HPD). Welfare/Rights are compared in the rows.

5 Replication

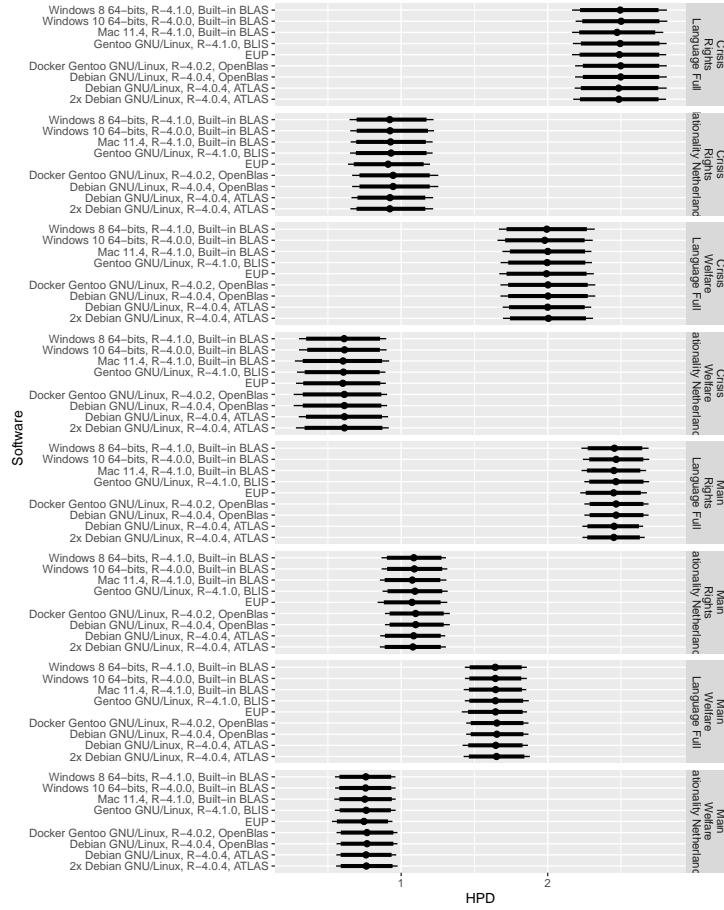


Figure 7: Posterior distributions for the parameters of interest (θ) relevant for producing the results reported in Table 1 in the article, as obtained using different combinations of Operating System and Basic Linear Algebra Subprograms (BLAS) libraries. Dots represent the median of the posterior distribution, while thick and thin lines cover the 90 and 95 percent of the credibility interval of the parameter.

Although the seeds are fixed in the software used to perform the analysis, different BLAS implementations may give slightly different results. These are purely computational differences. Figure 7 presents the posterior distributions of the relevant θ parameters that, once combined, allow us to calculate the probabilities reported in Table 1 in the article (Tables 2 and 3 follow the same logic). The Figure shows that different combinations of operating system and linear algebra libraries produce very similar values, but not bitwise exact values.

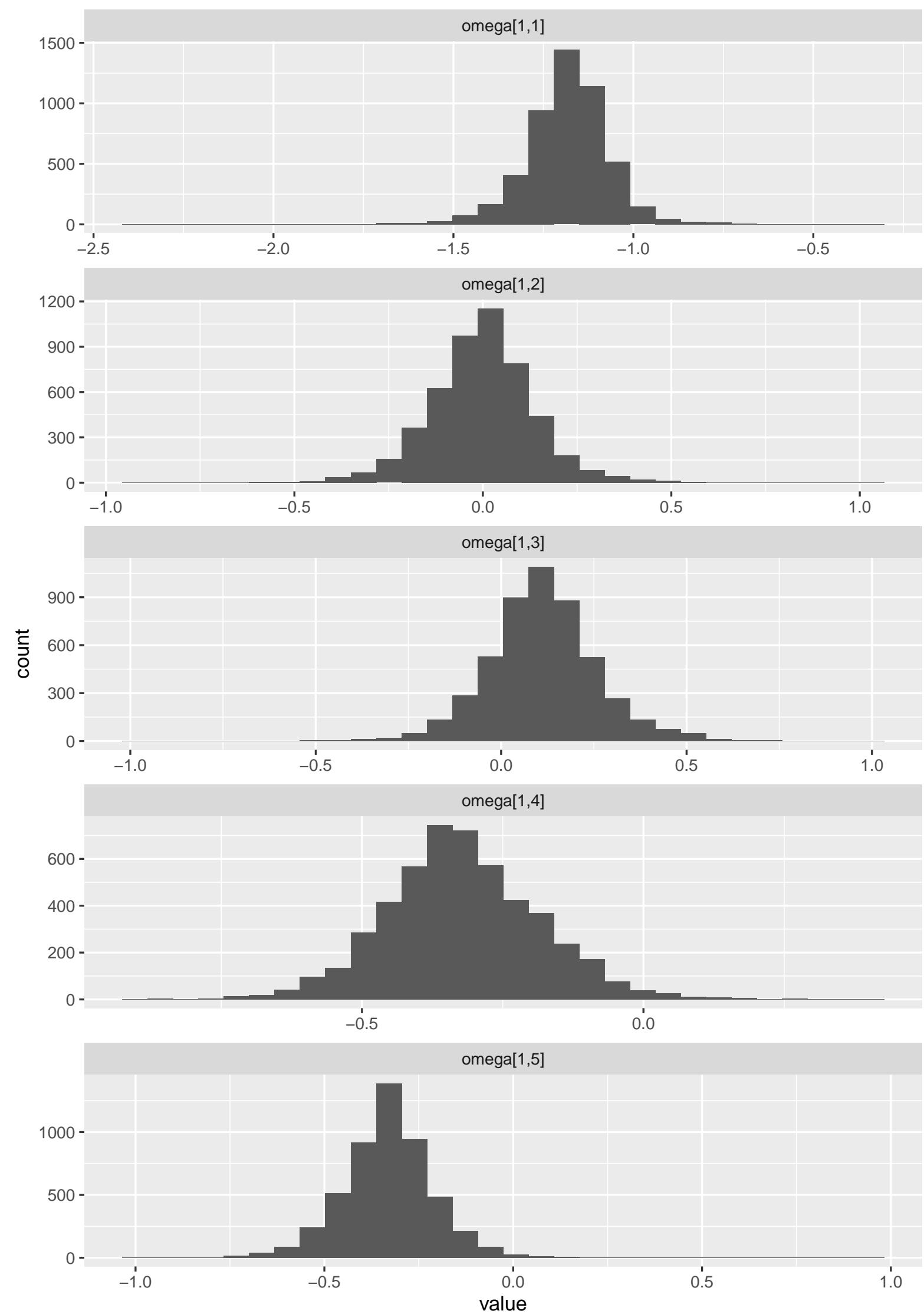
The results presented in the paper have been obtained using a Windows 10 64-bits OS, using R-4.0.0 and the built-in BLAS version, which correspond to the closest values (minimal sum of the squared absolute differences) obtained from the editorial team at *European Union Politics*.

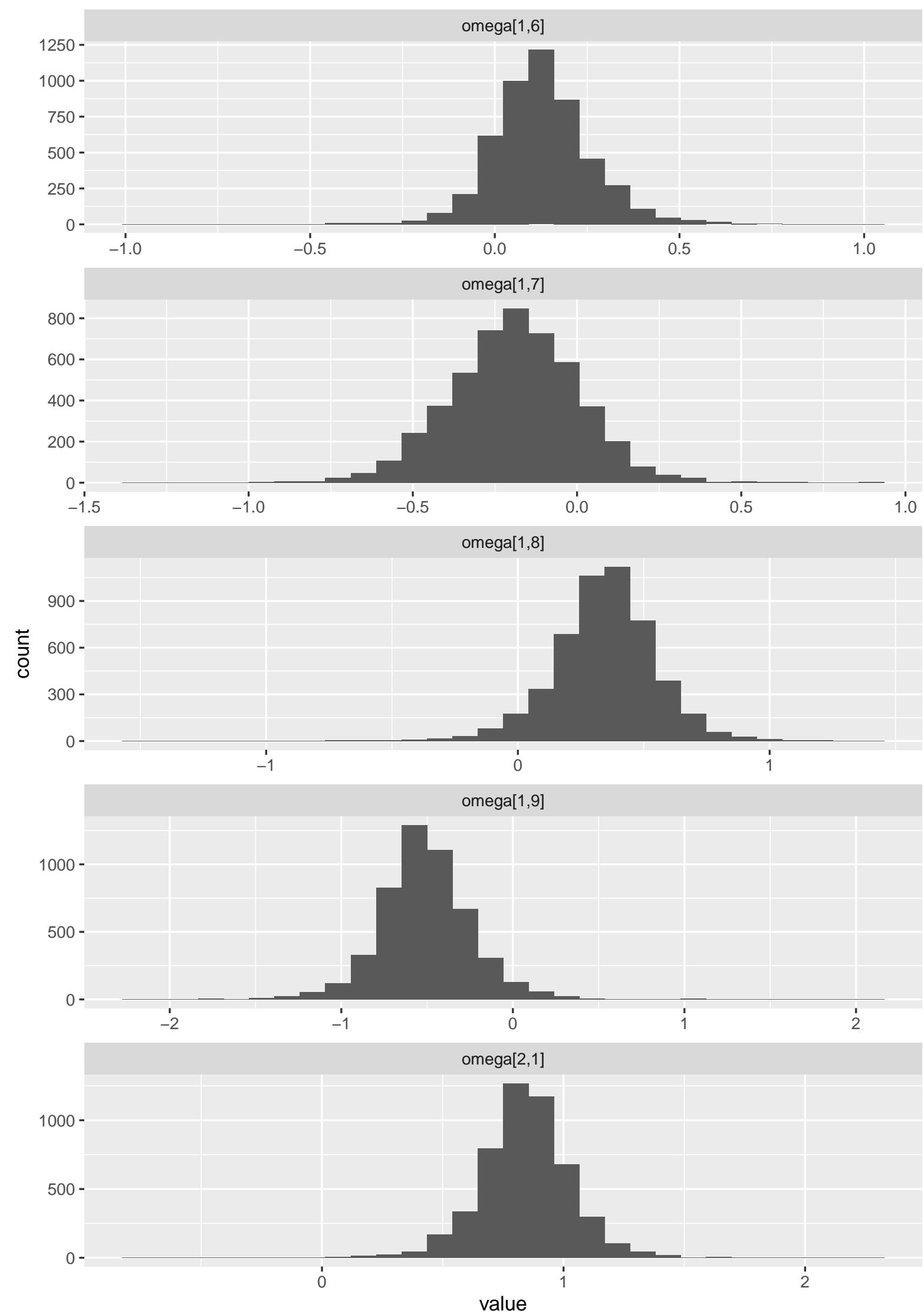
References

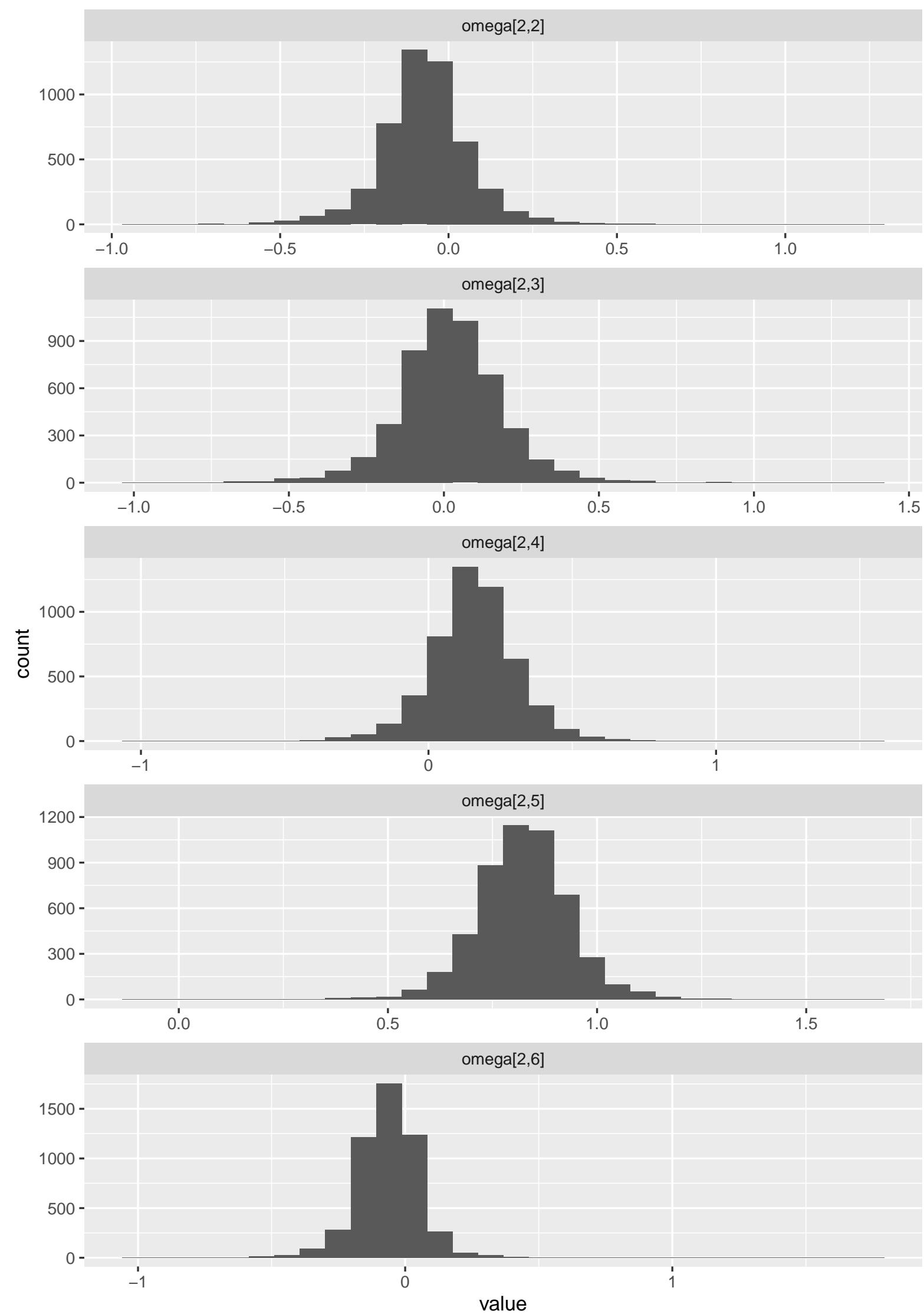
- Hainmueller, Jens, Daniel J Hopkins, and Teppei Yamamoto. "Causal inference in conjoint analysis: Understanding multidimensional choices via stated preference experiments". *Political Analysis* 22, no. 1 (2014): 1–30. <https://doi.org/10.1093/pan/mpt024>.

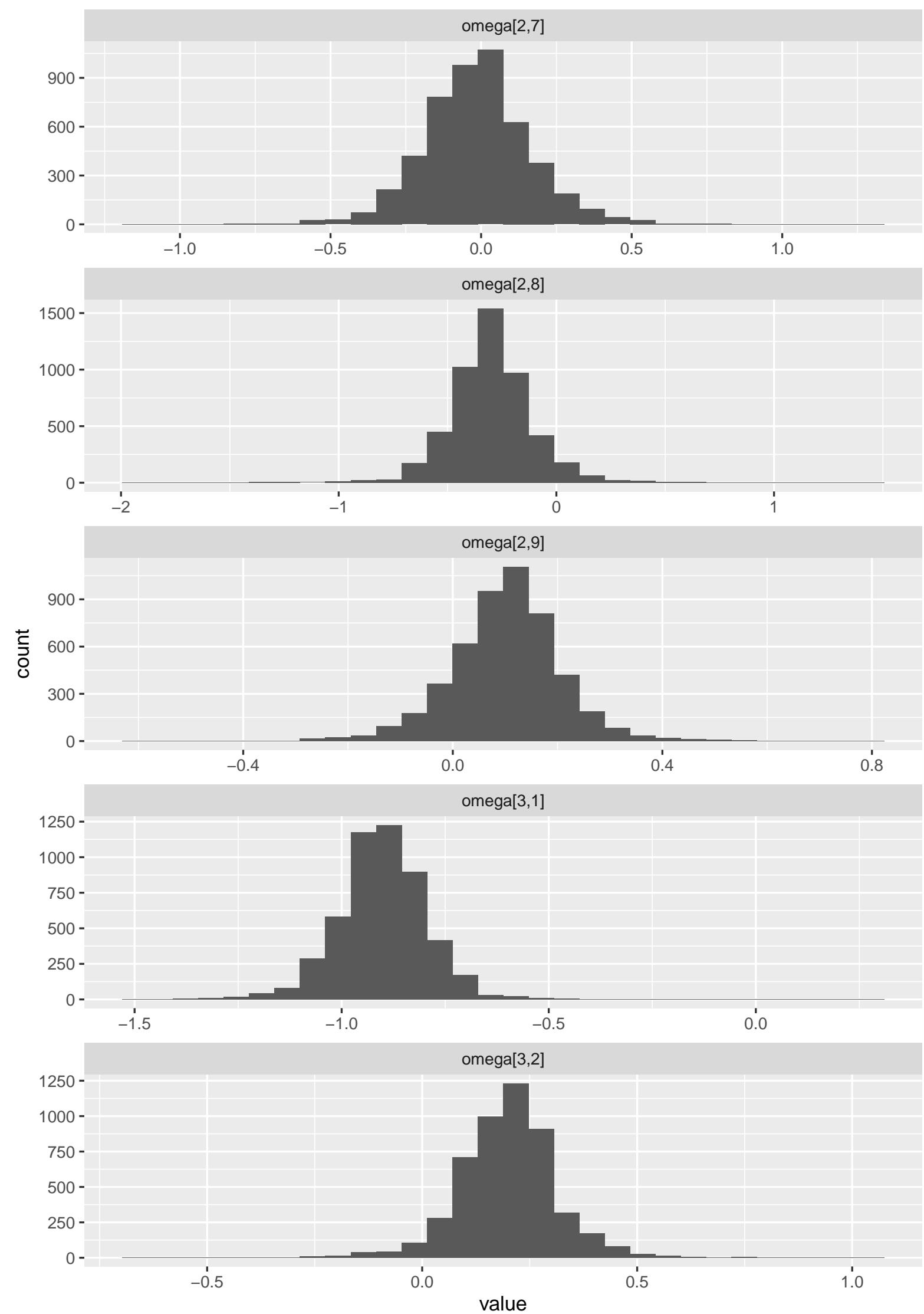
6 Convergence tests

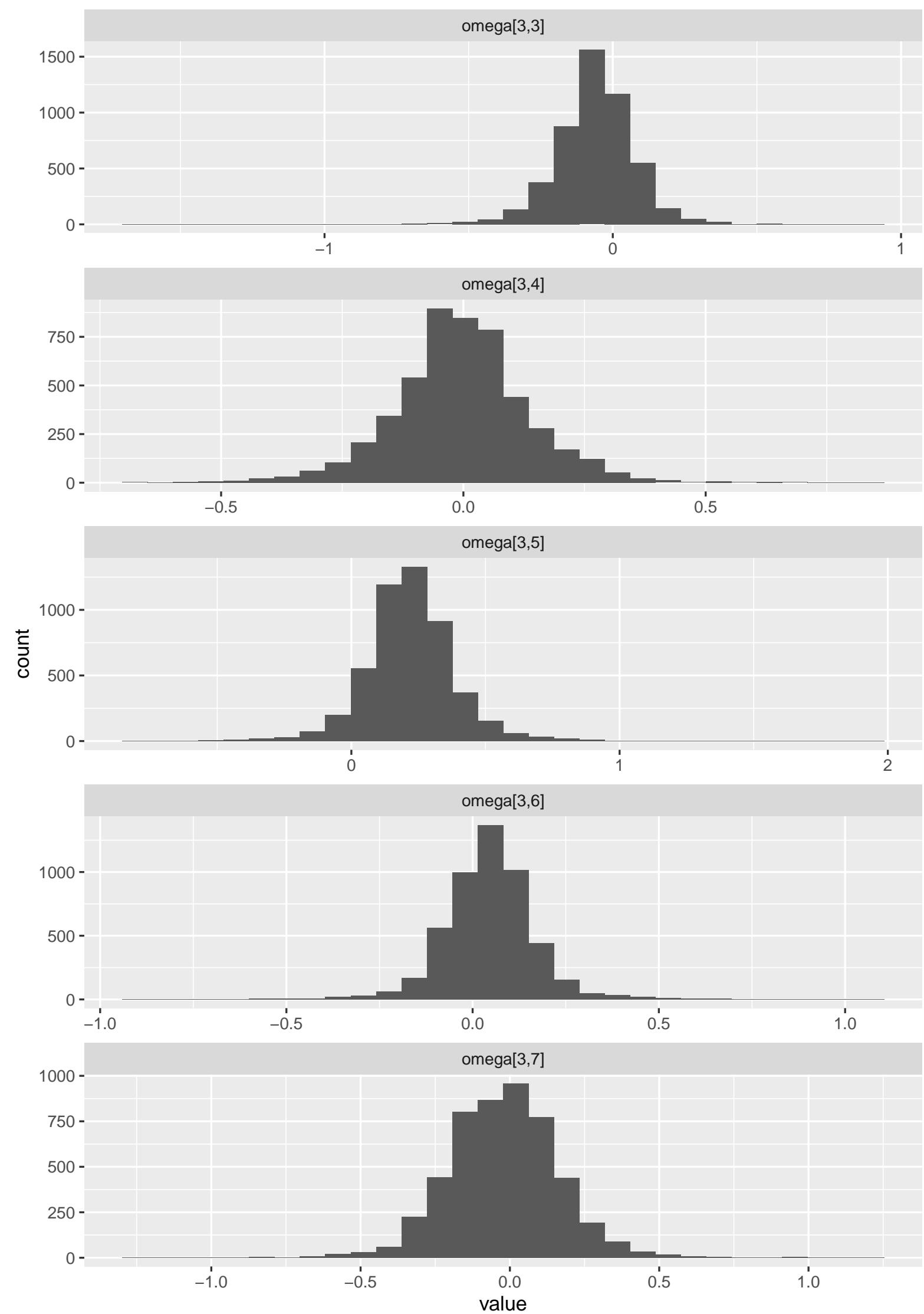
This section includes Bayesian convergence tests for some (due to file size restrictions) of the main parameters of interest (ω). The rest of the parameters can be provided by request.



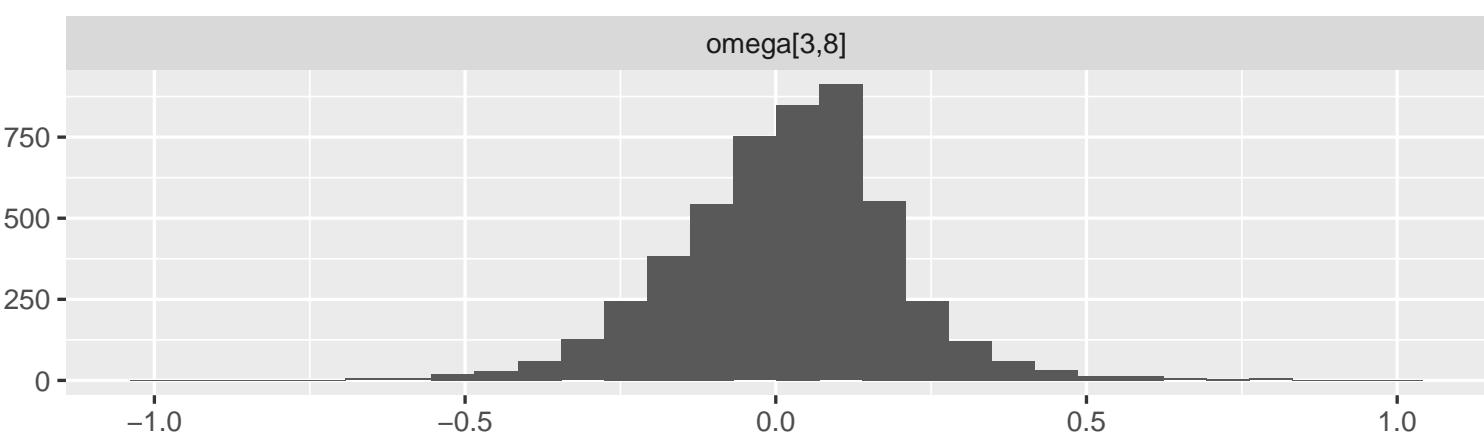




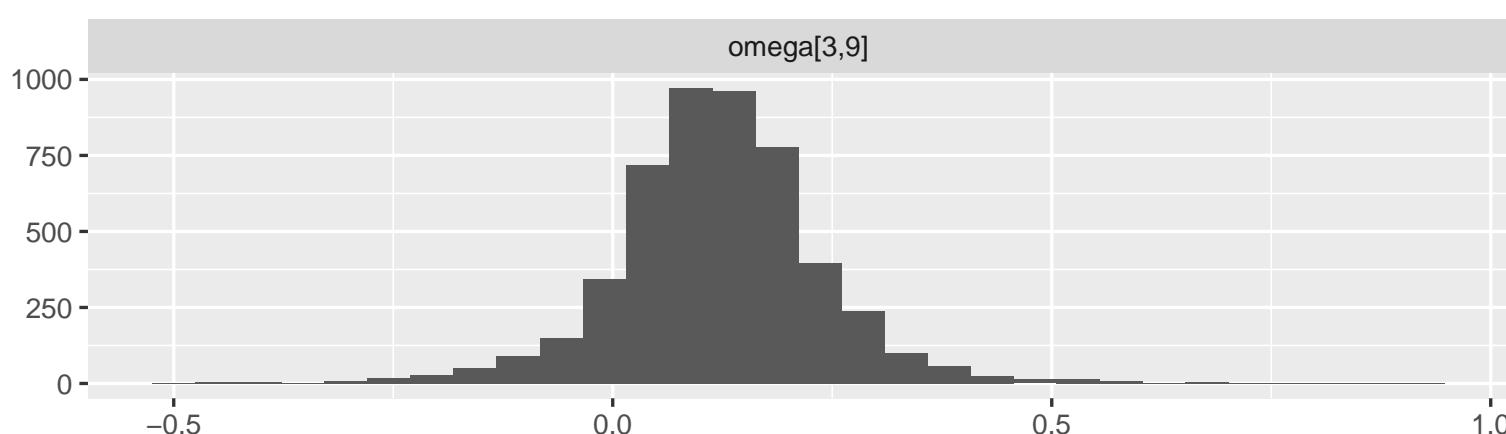




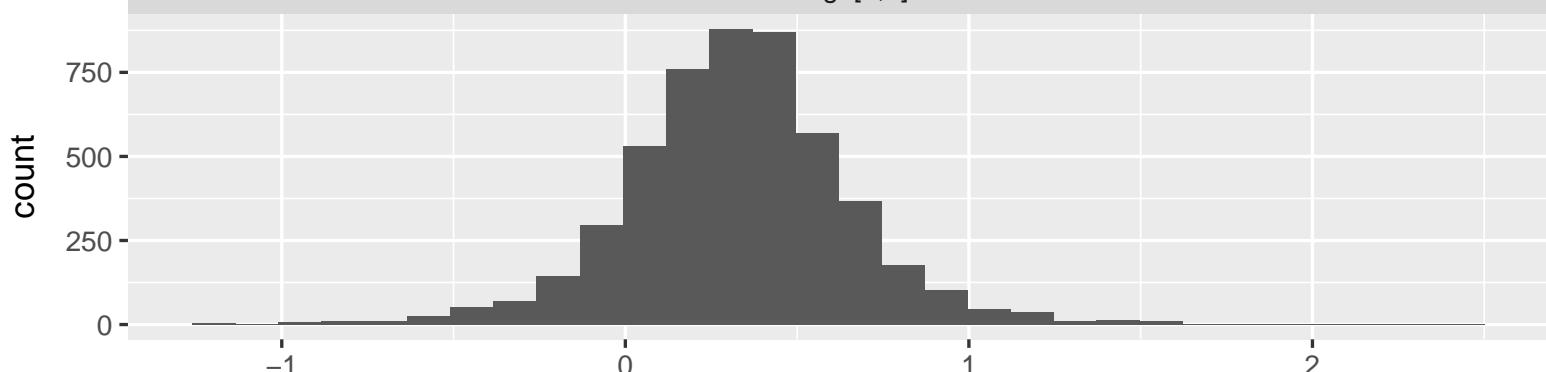
omega[3,8]



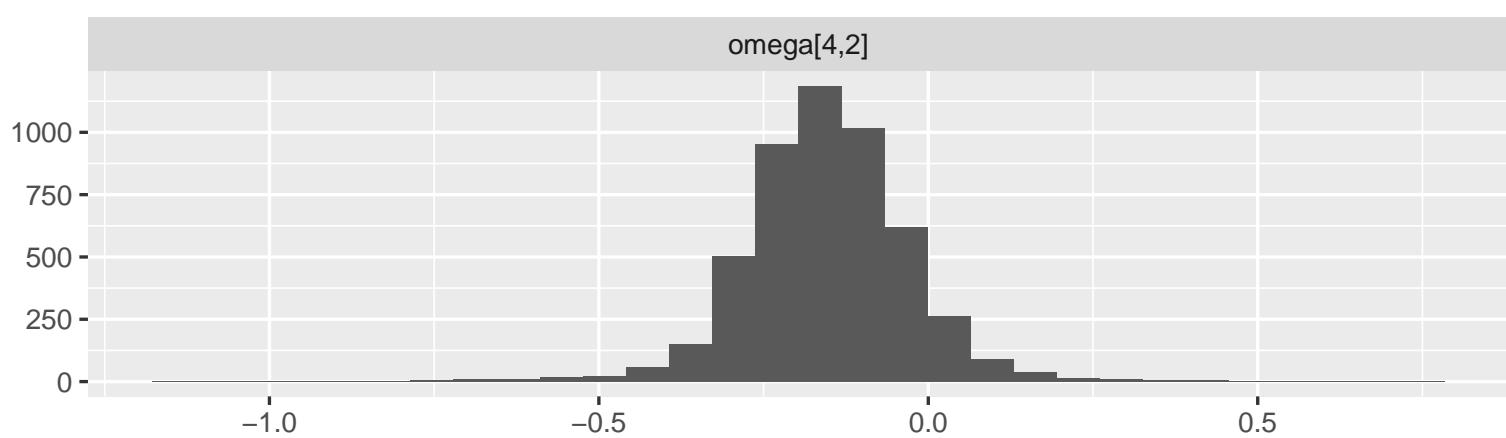
omega[3,9]



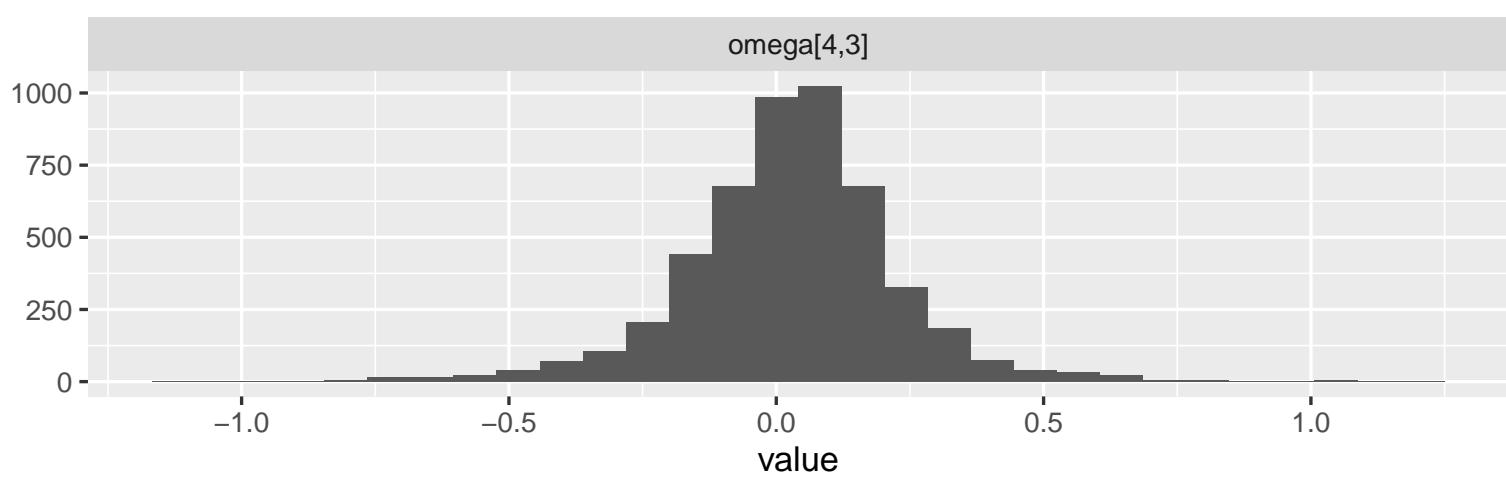
omega[4,1]



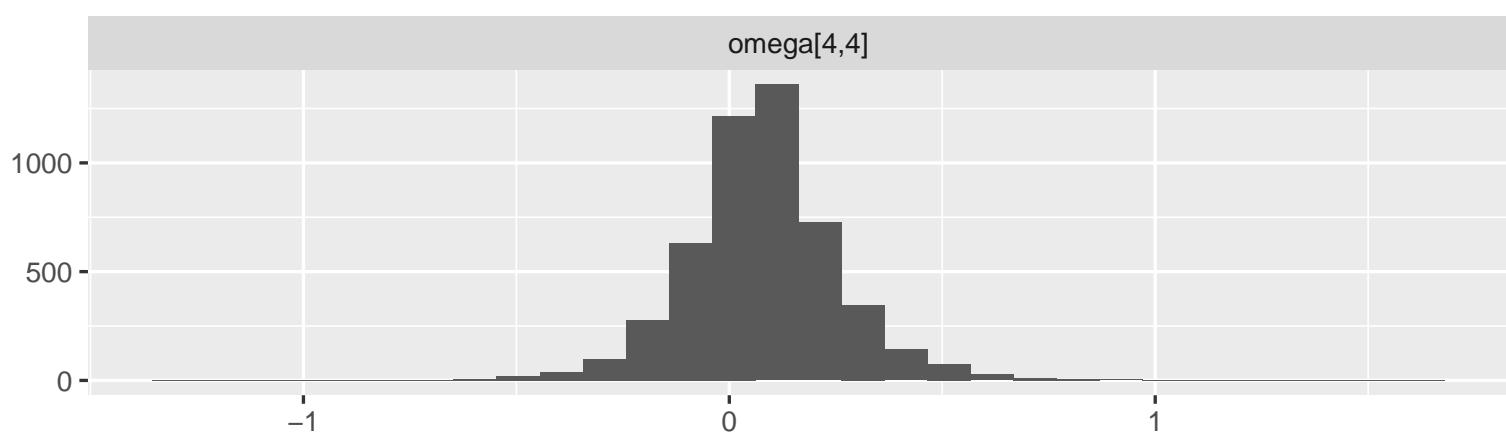
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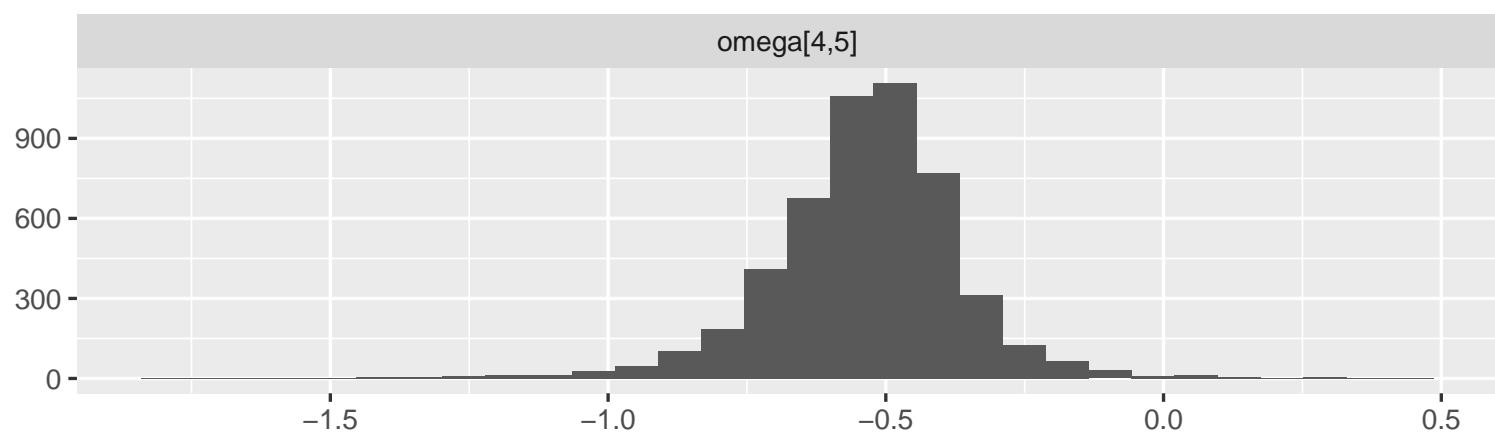
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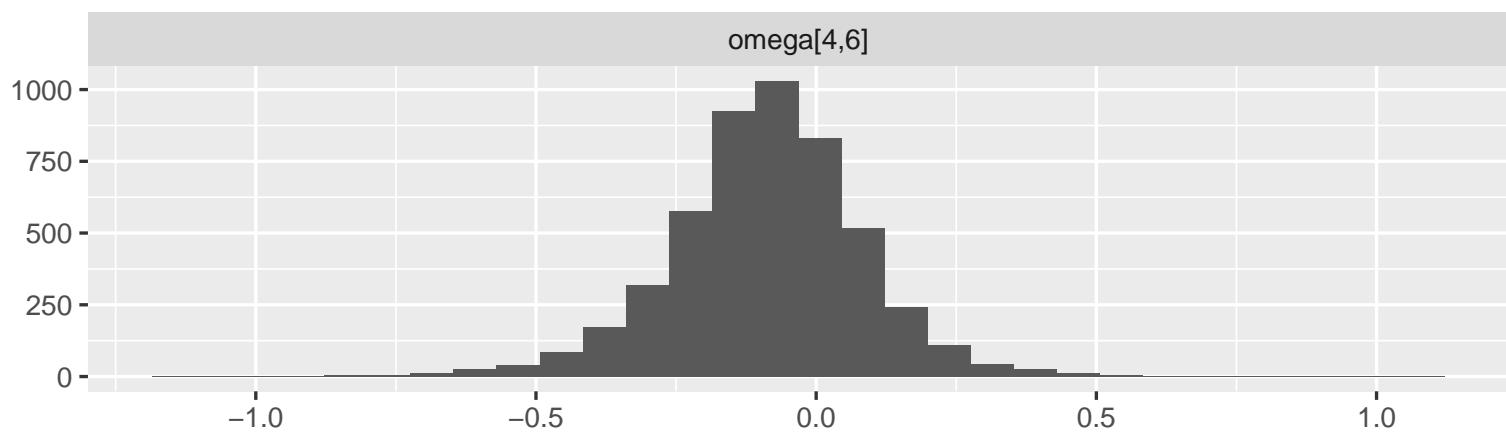
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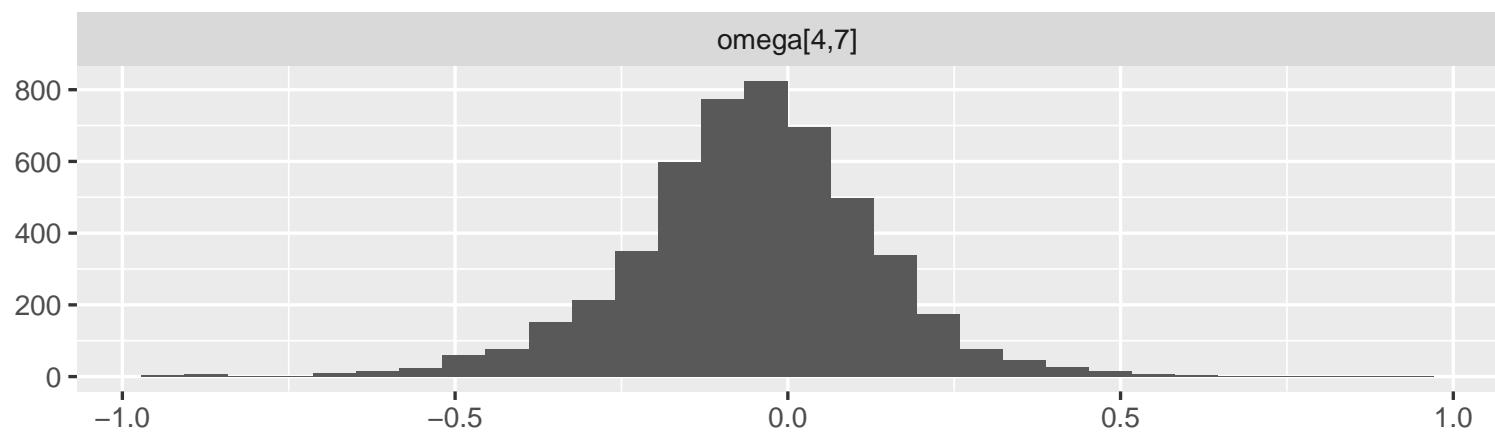
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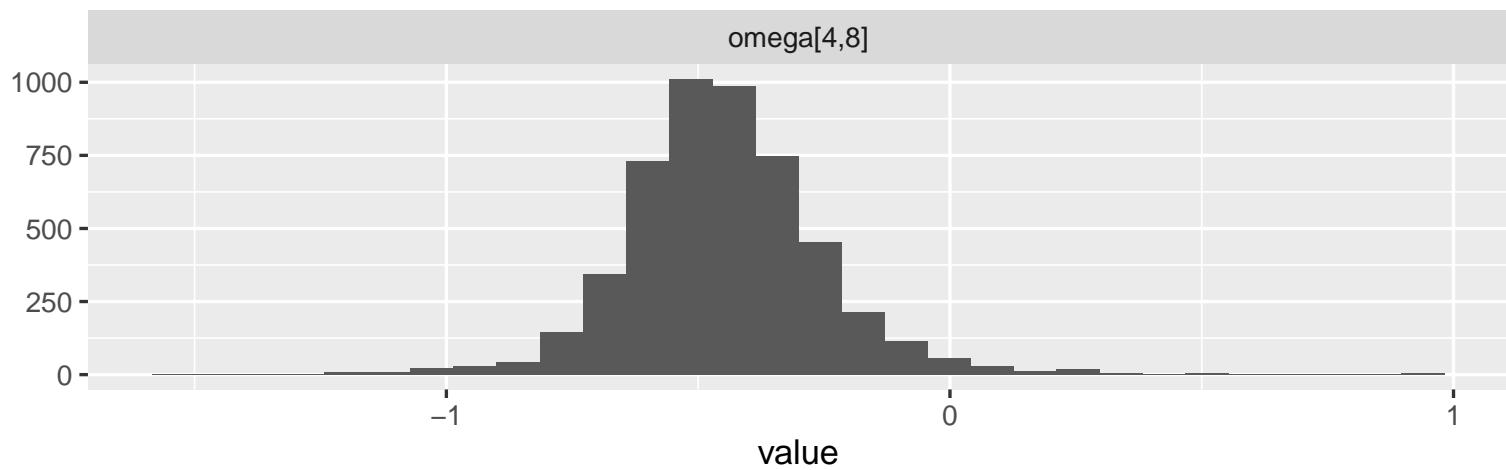
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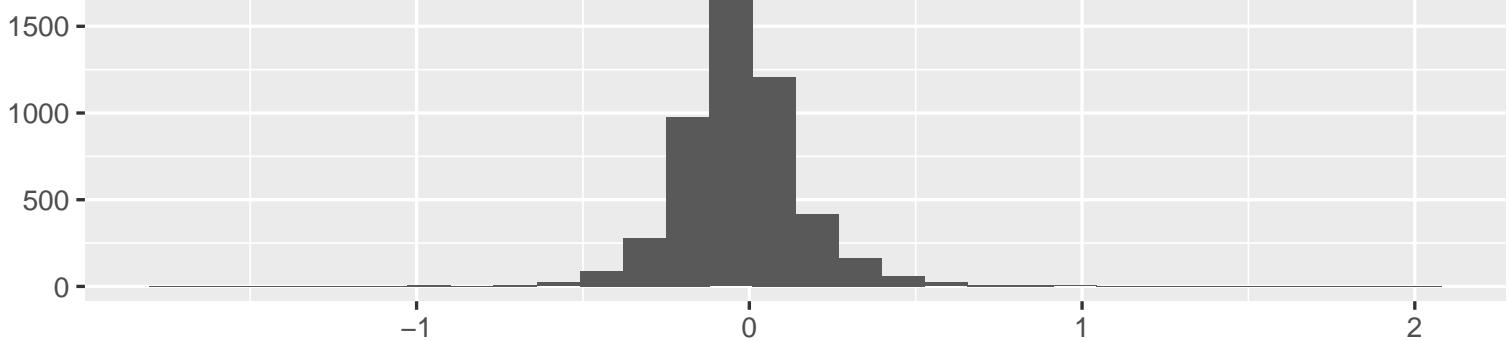
omega[4,7]



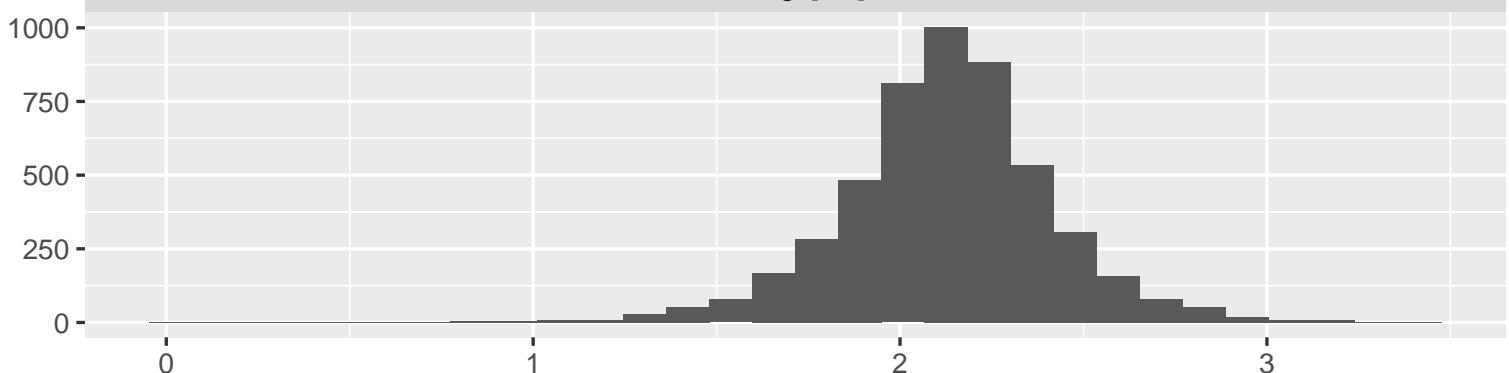
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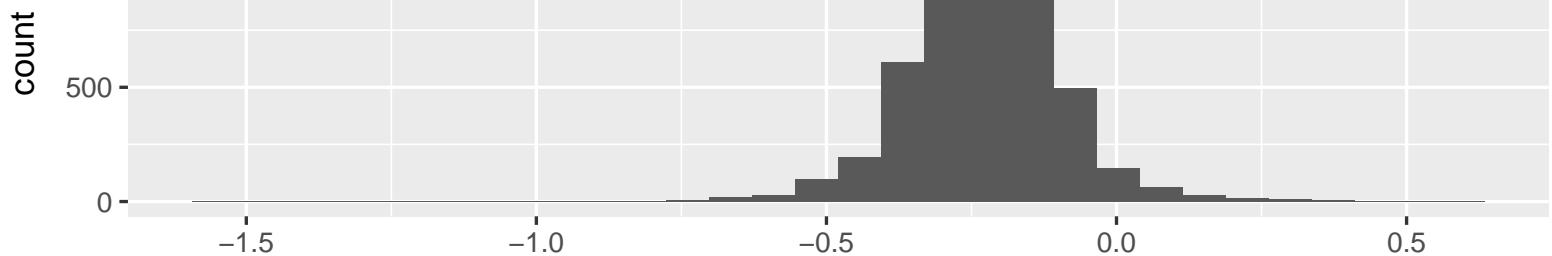
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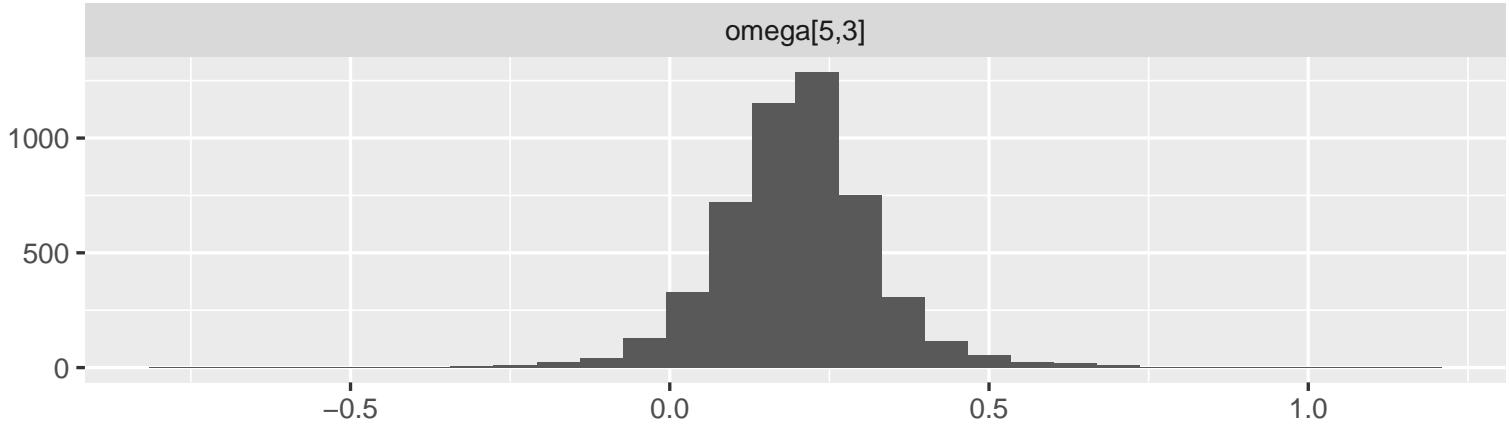
omega[5,1]



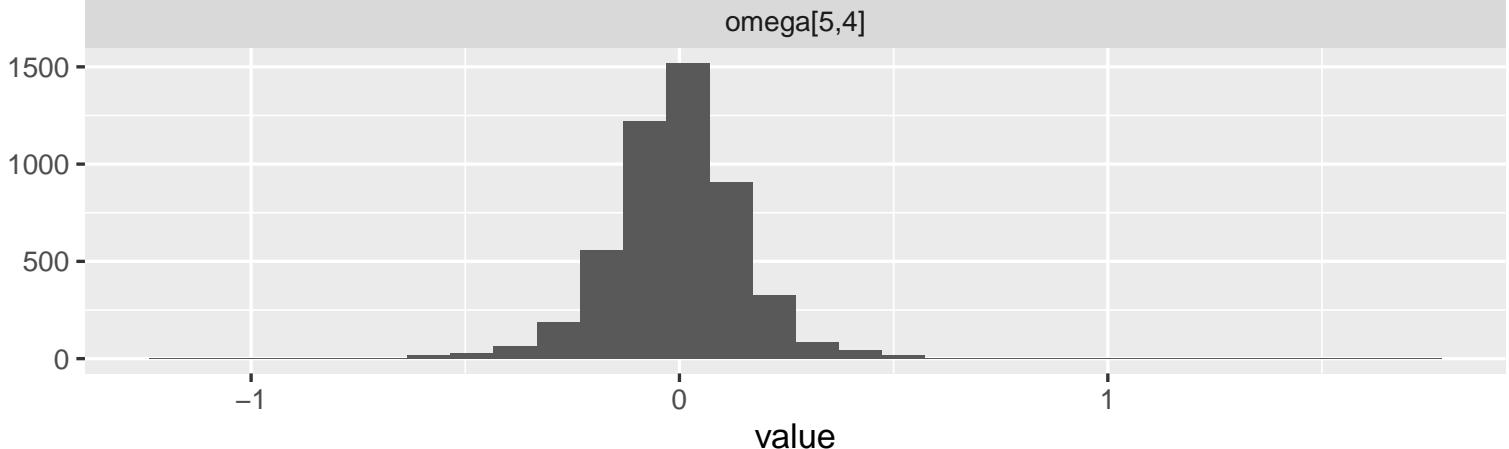
omega[5,2]

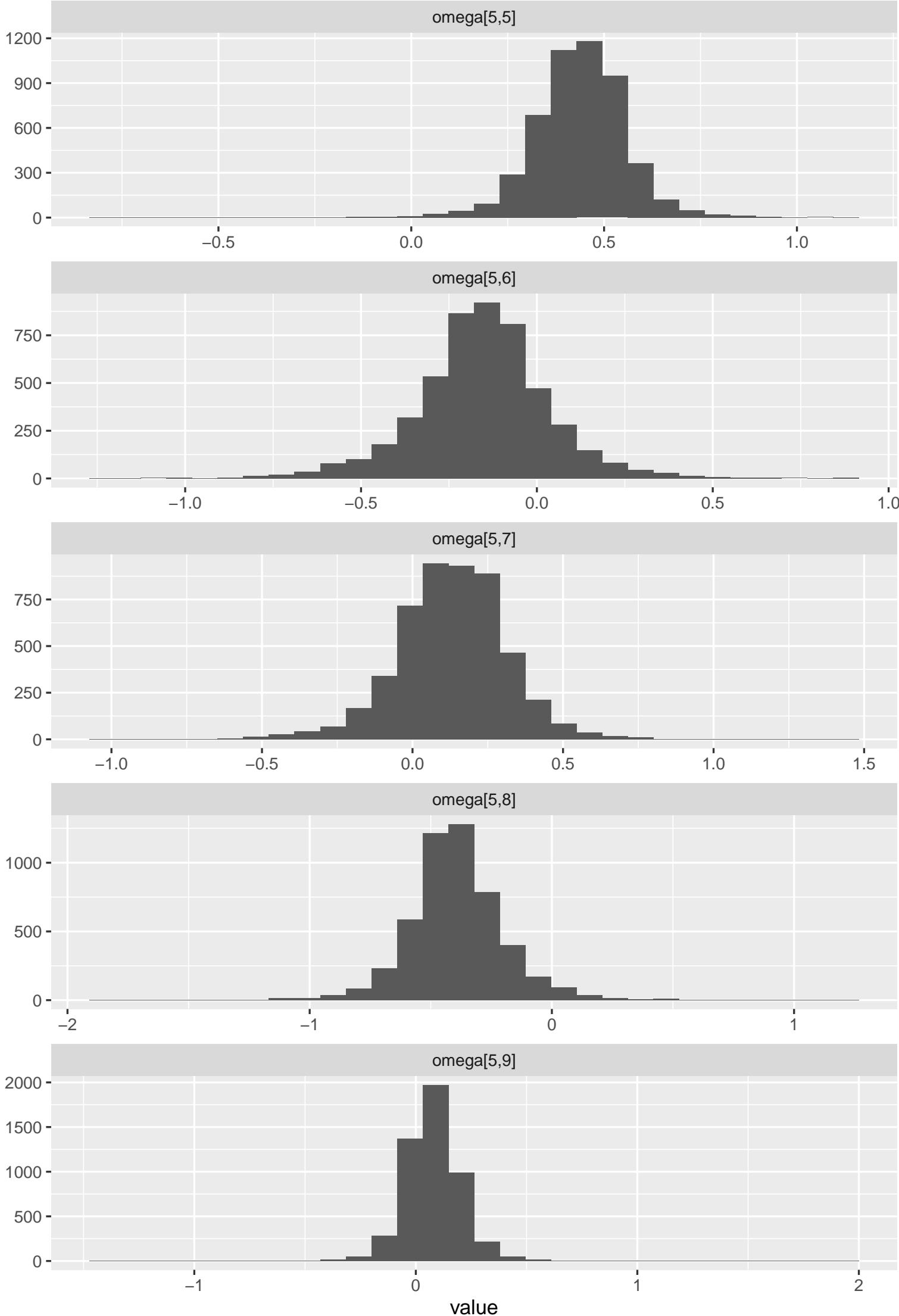


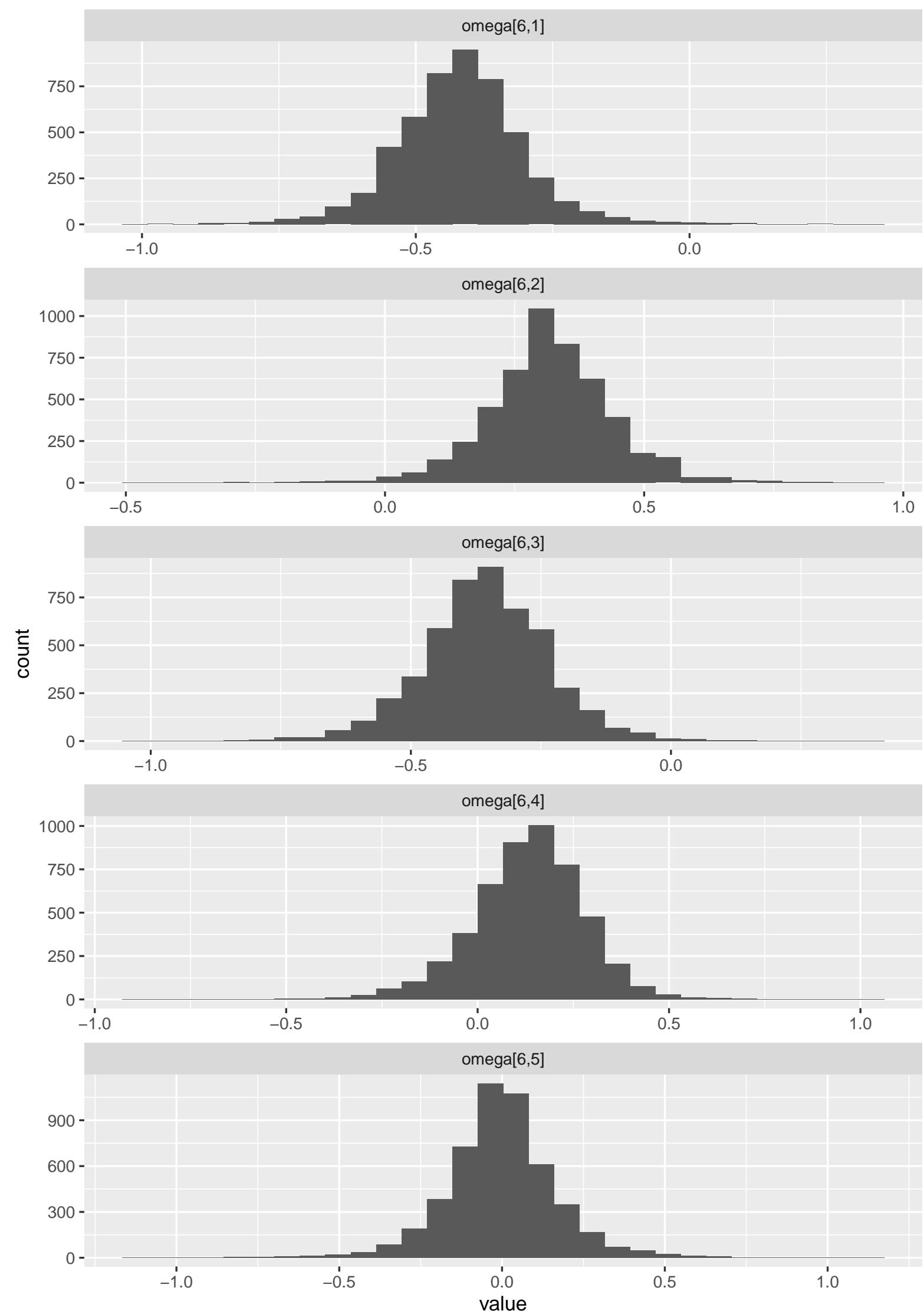
omega[5,3]

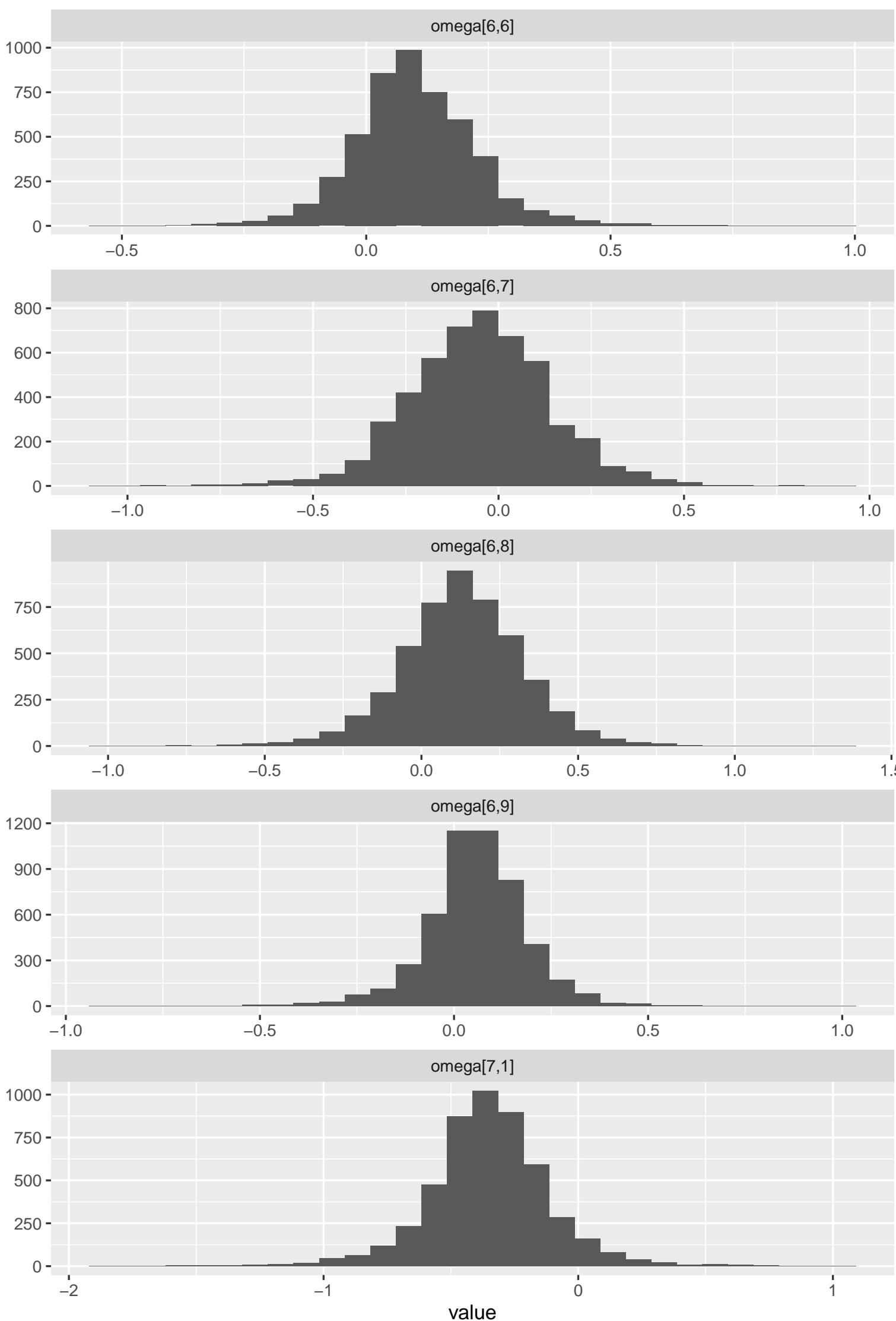


omega[5,4]

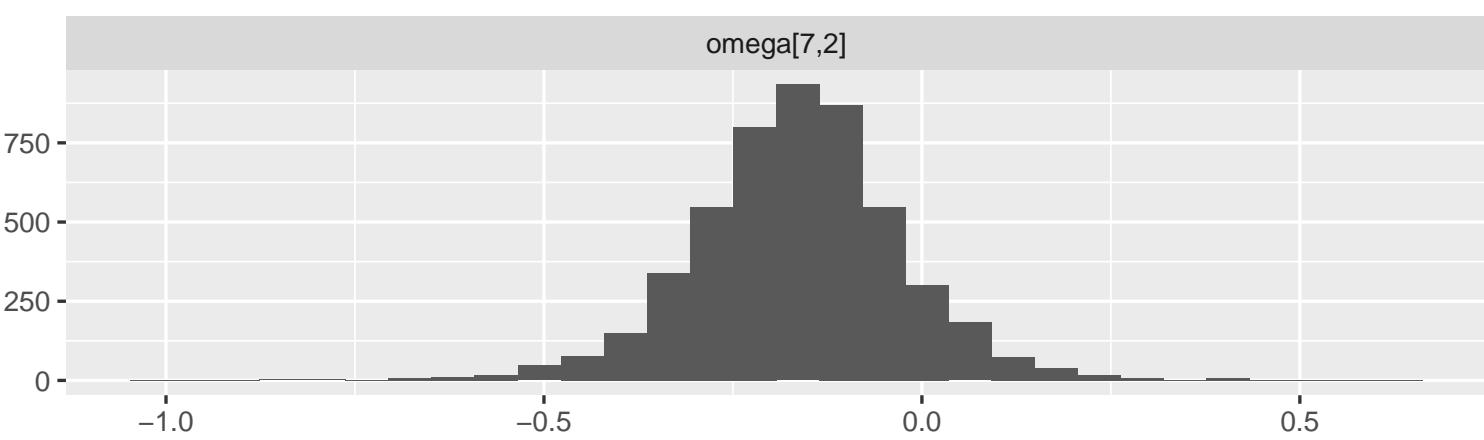




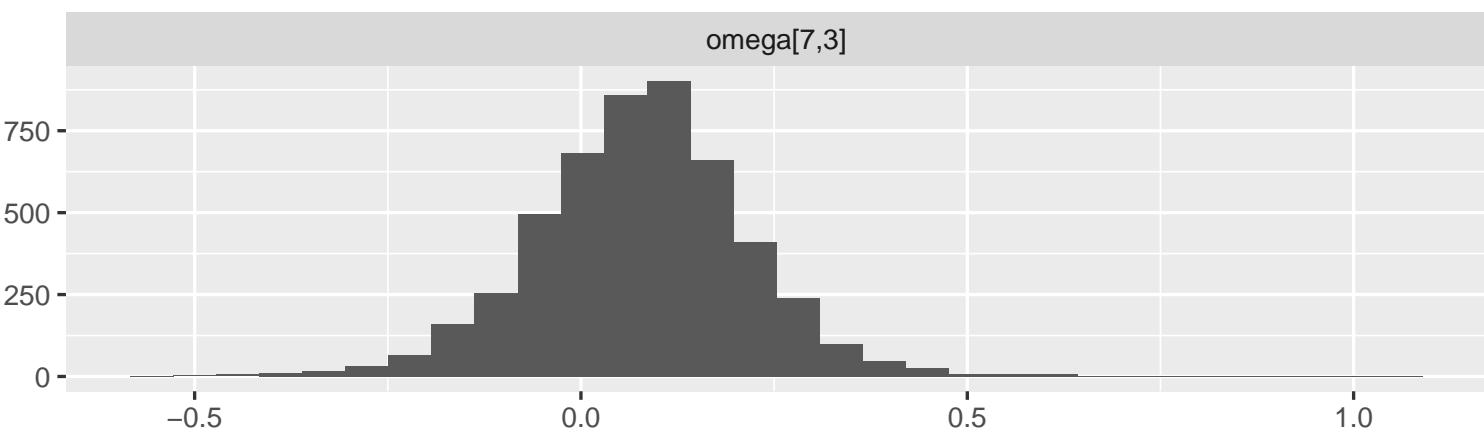




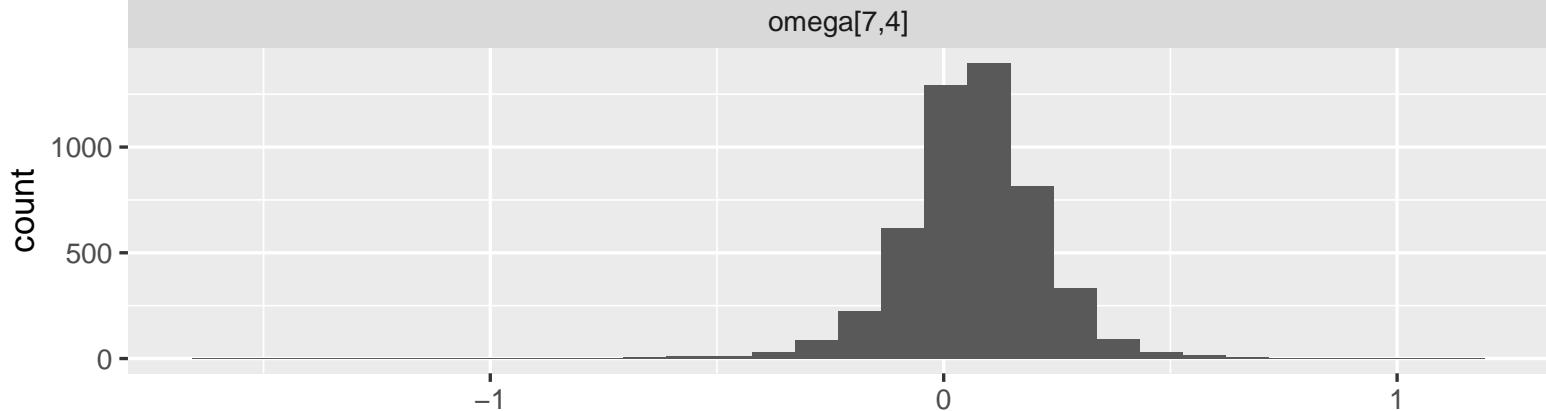
omega[7,2]



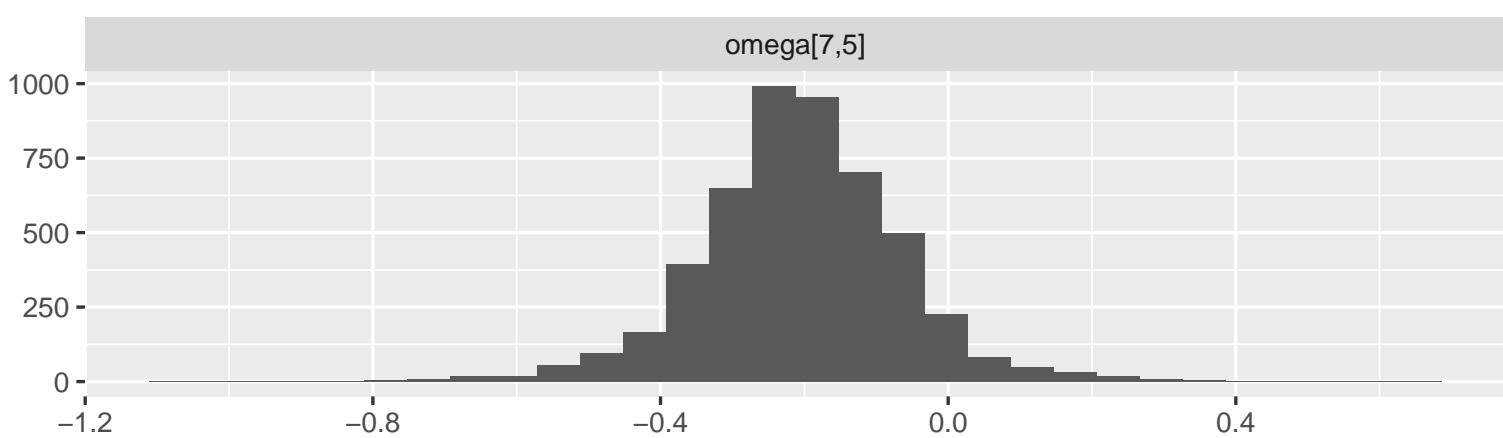
omega[7,3]



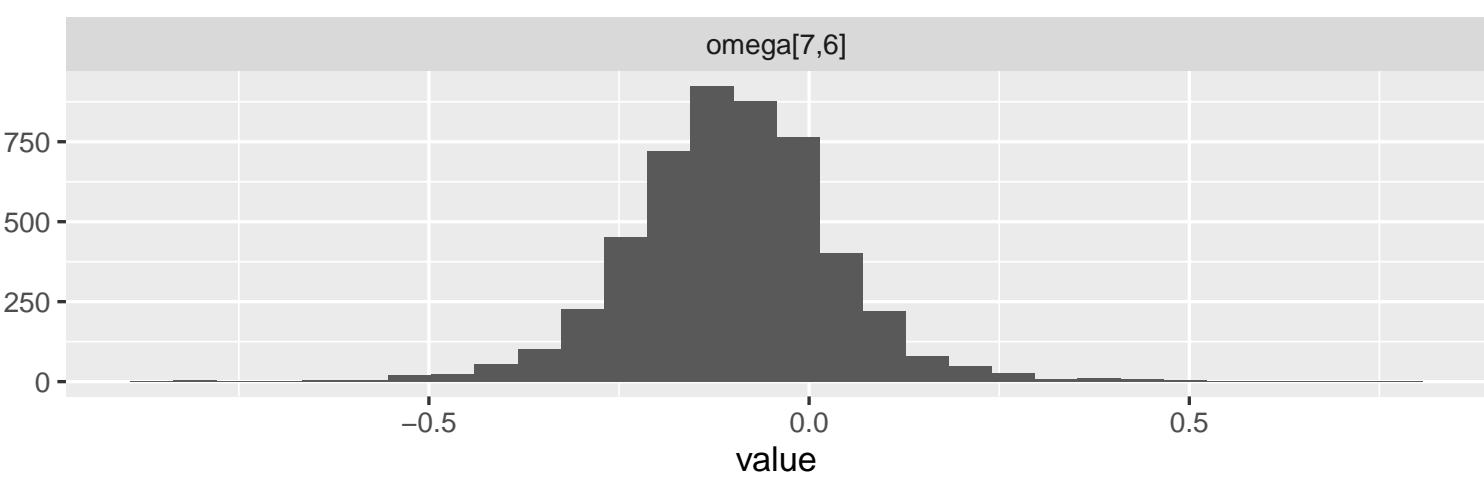
omega[7,4]

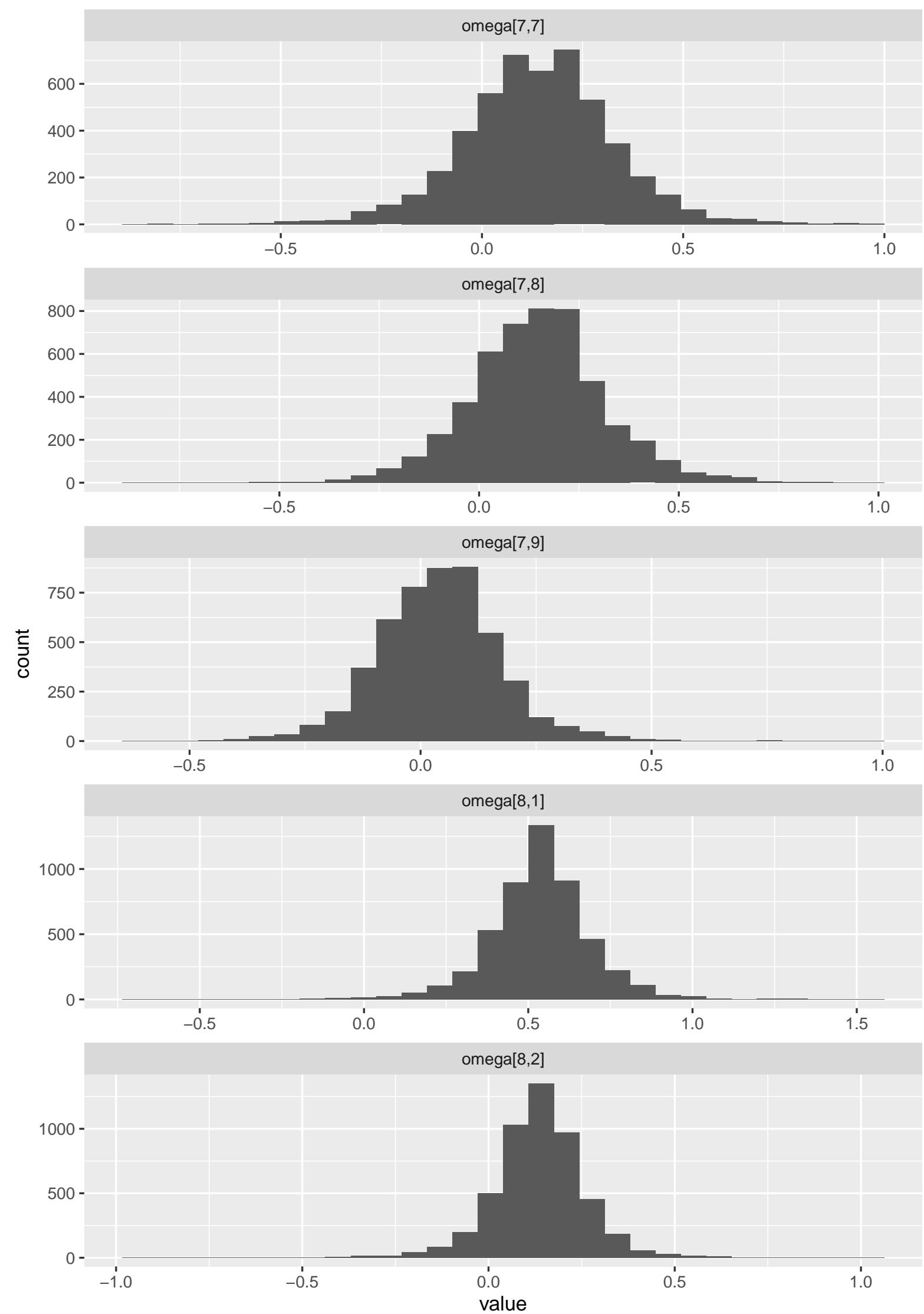


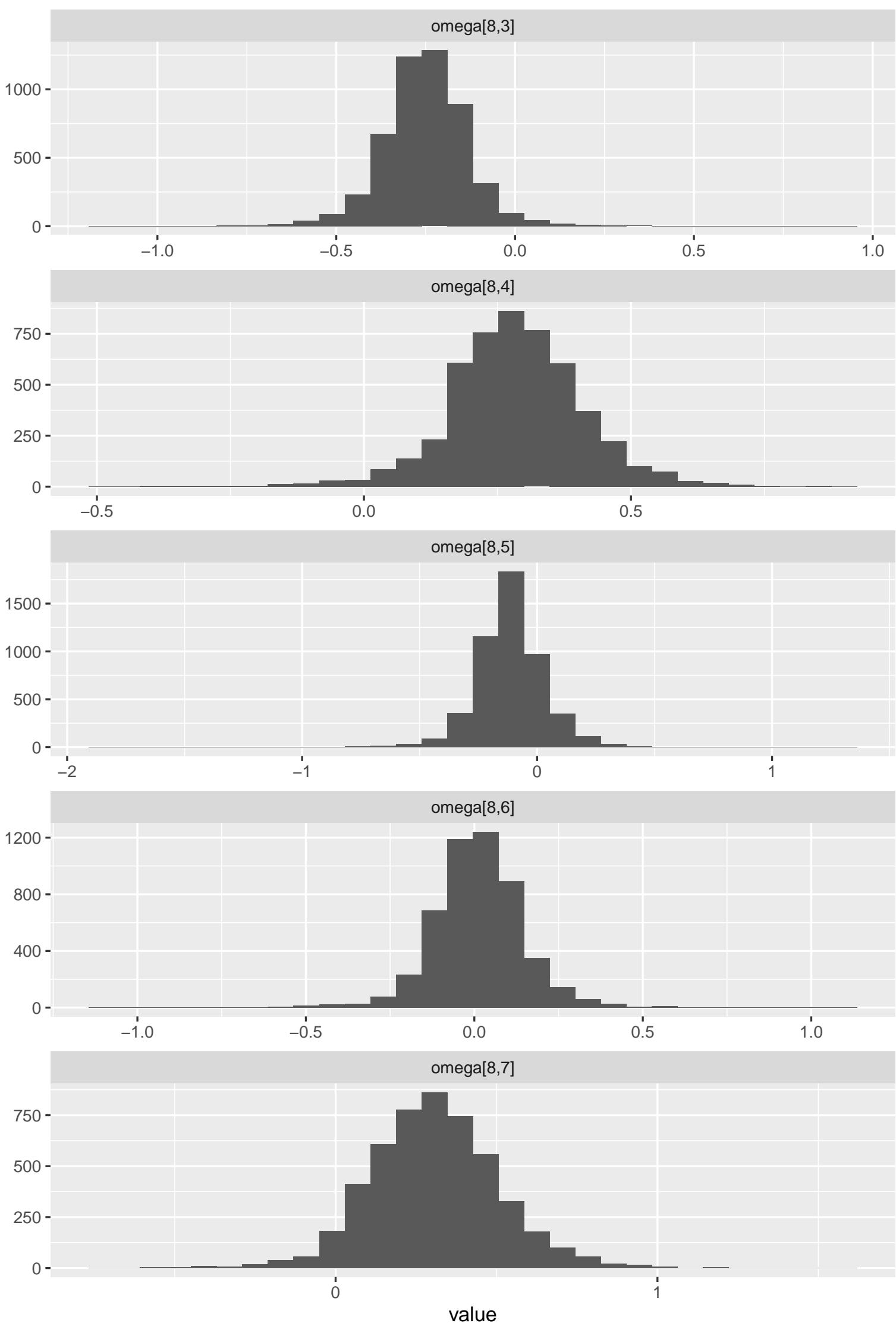
omega[7,5]



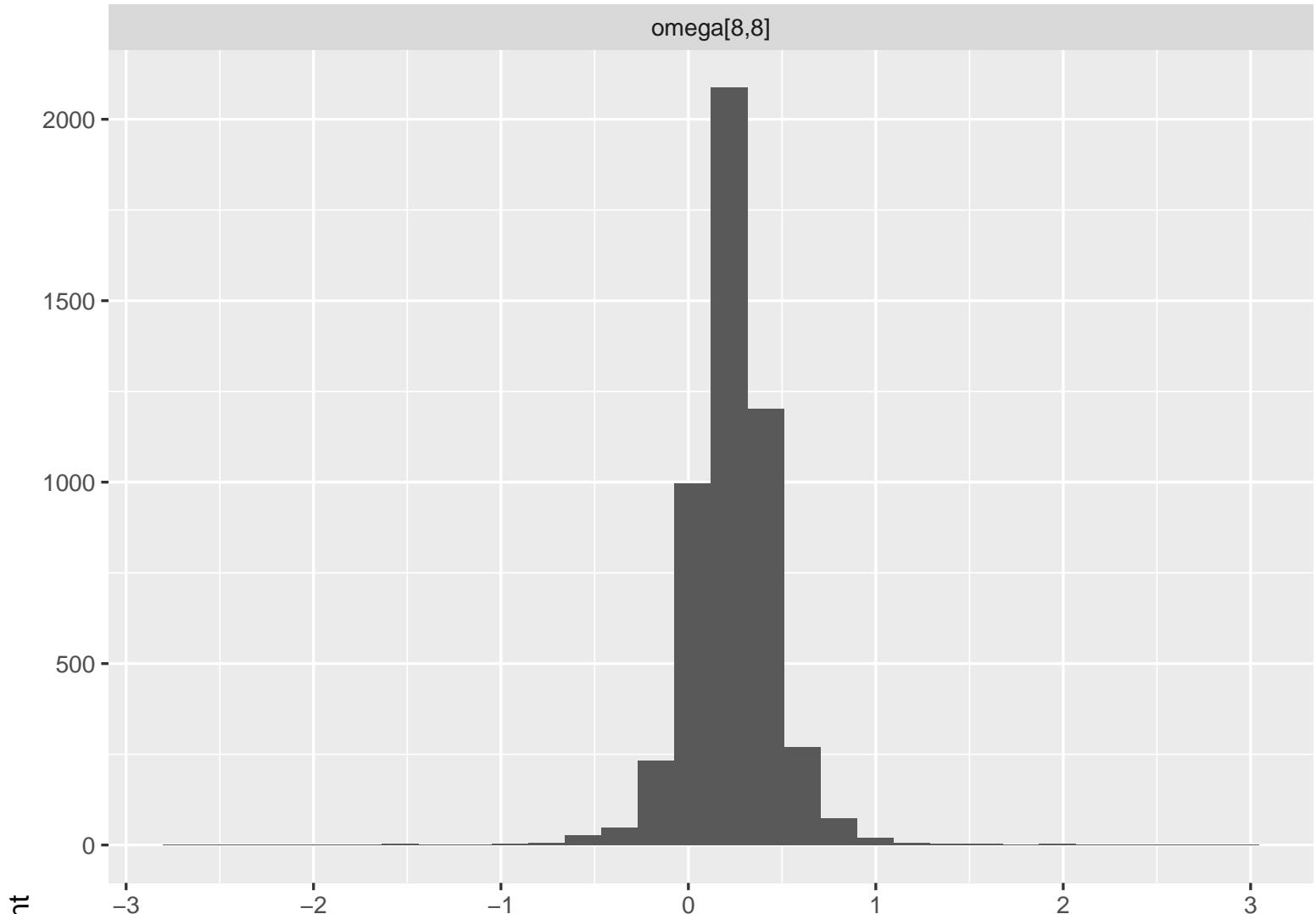
omega[7,6]



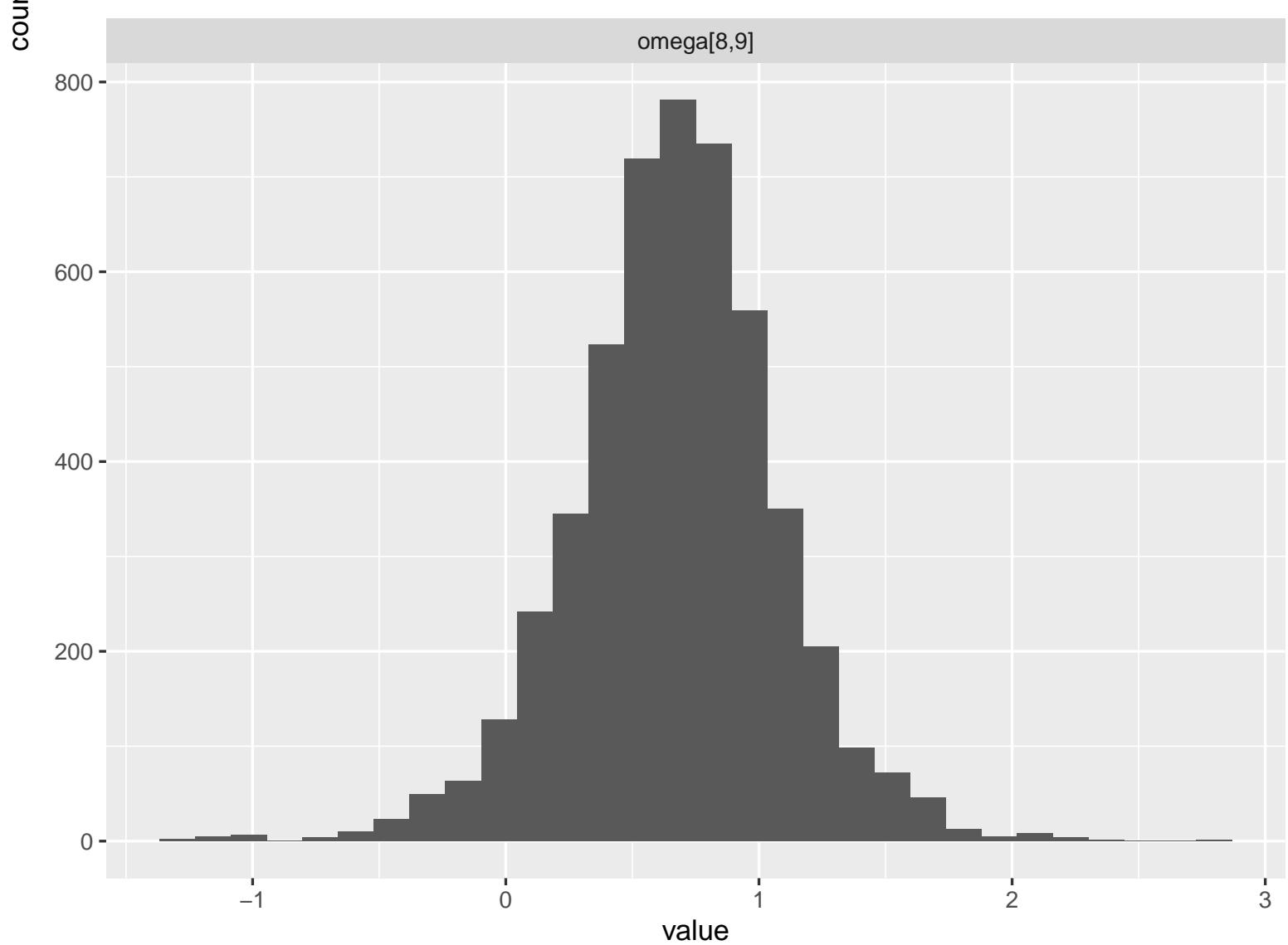


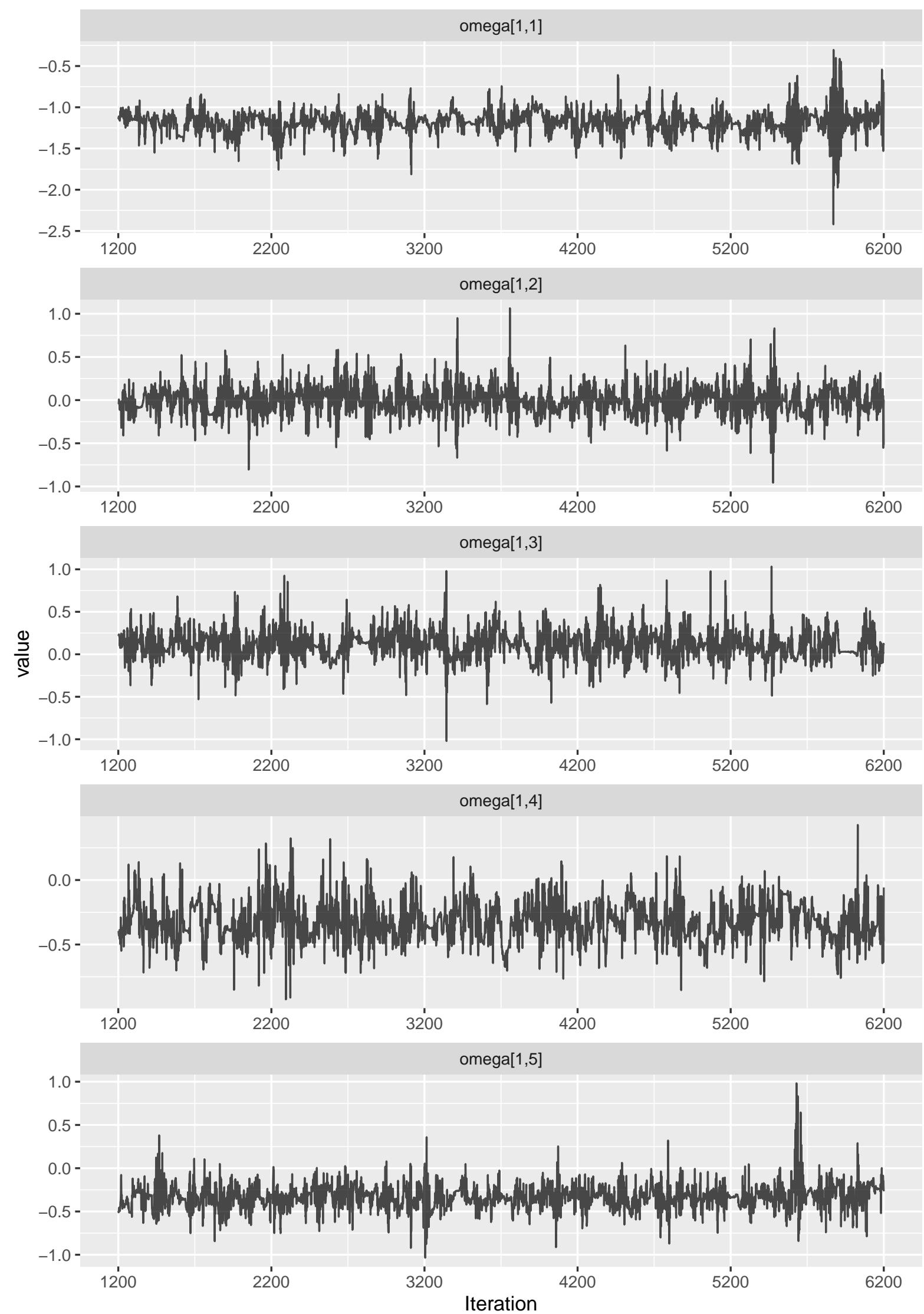


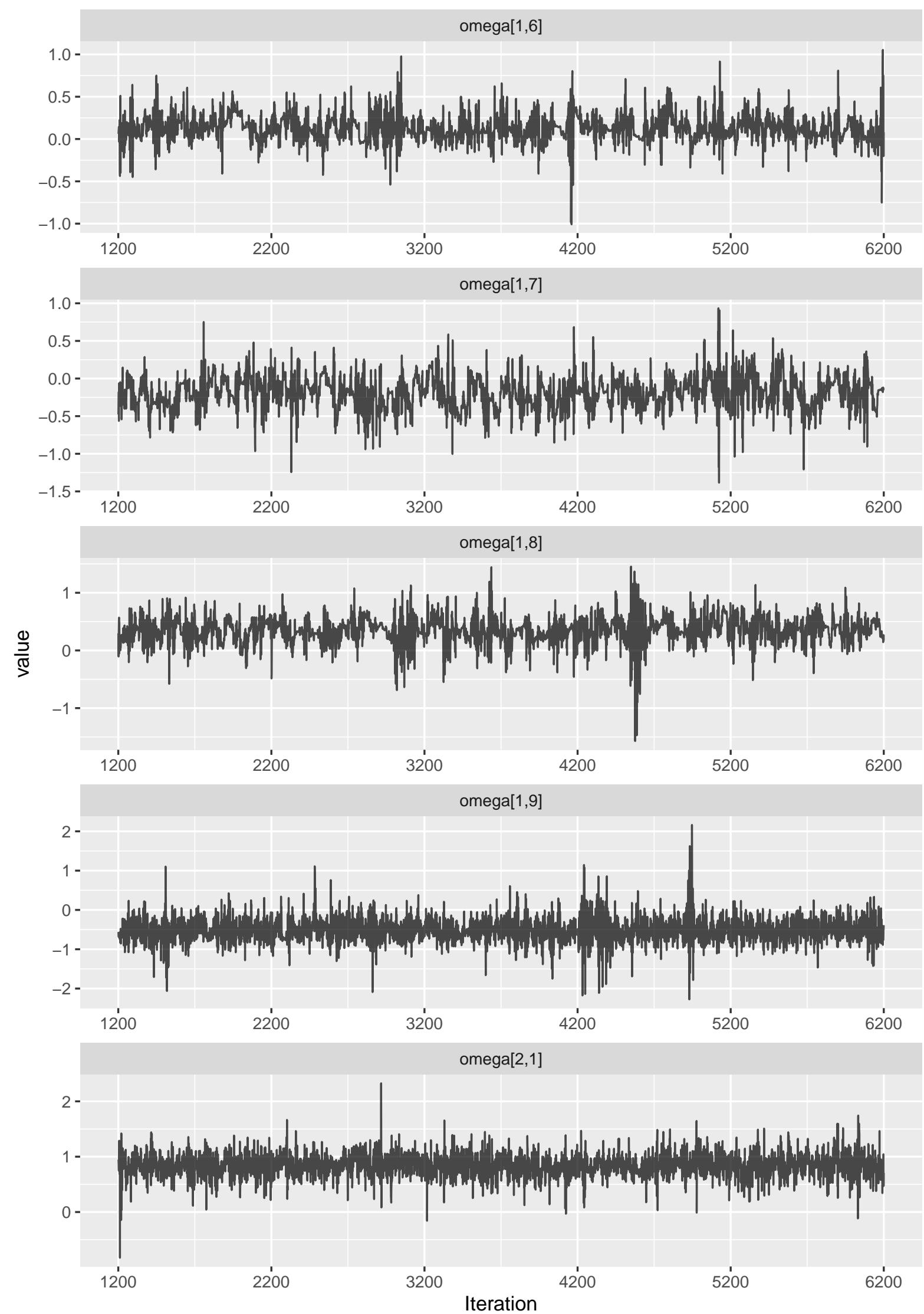
omega[8,8]

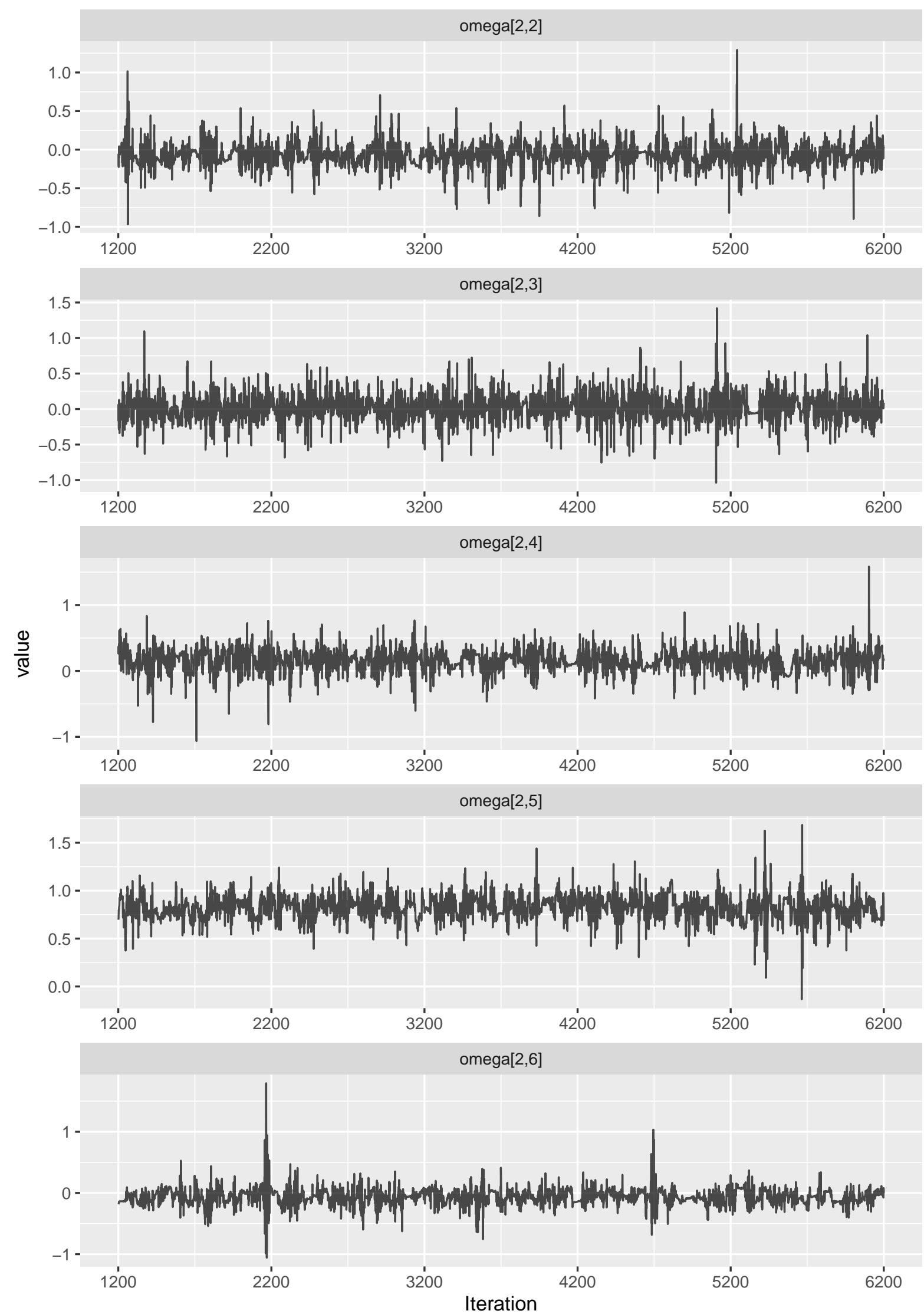


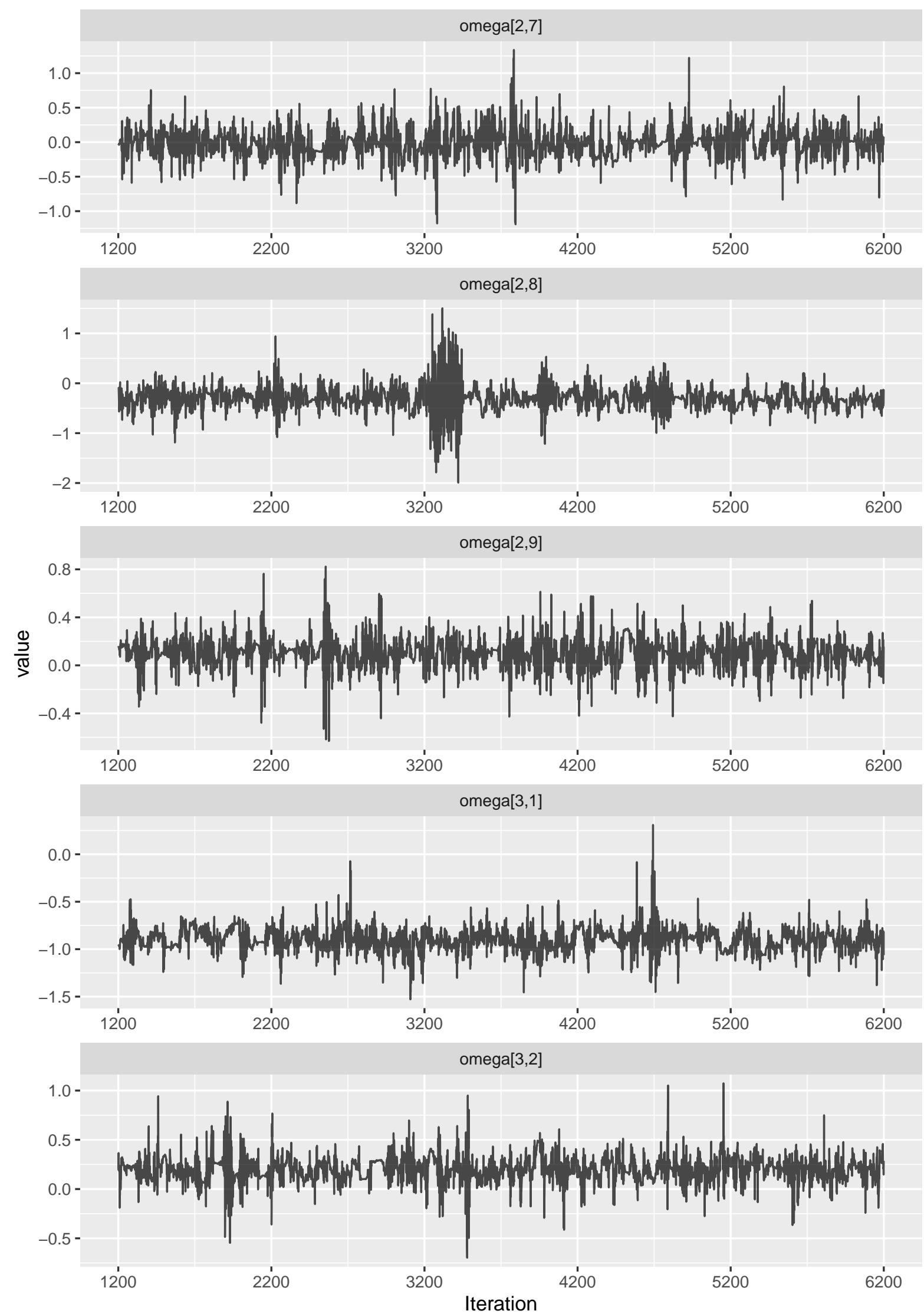
omega[8,9]

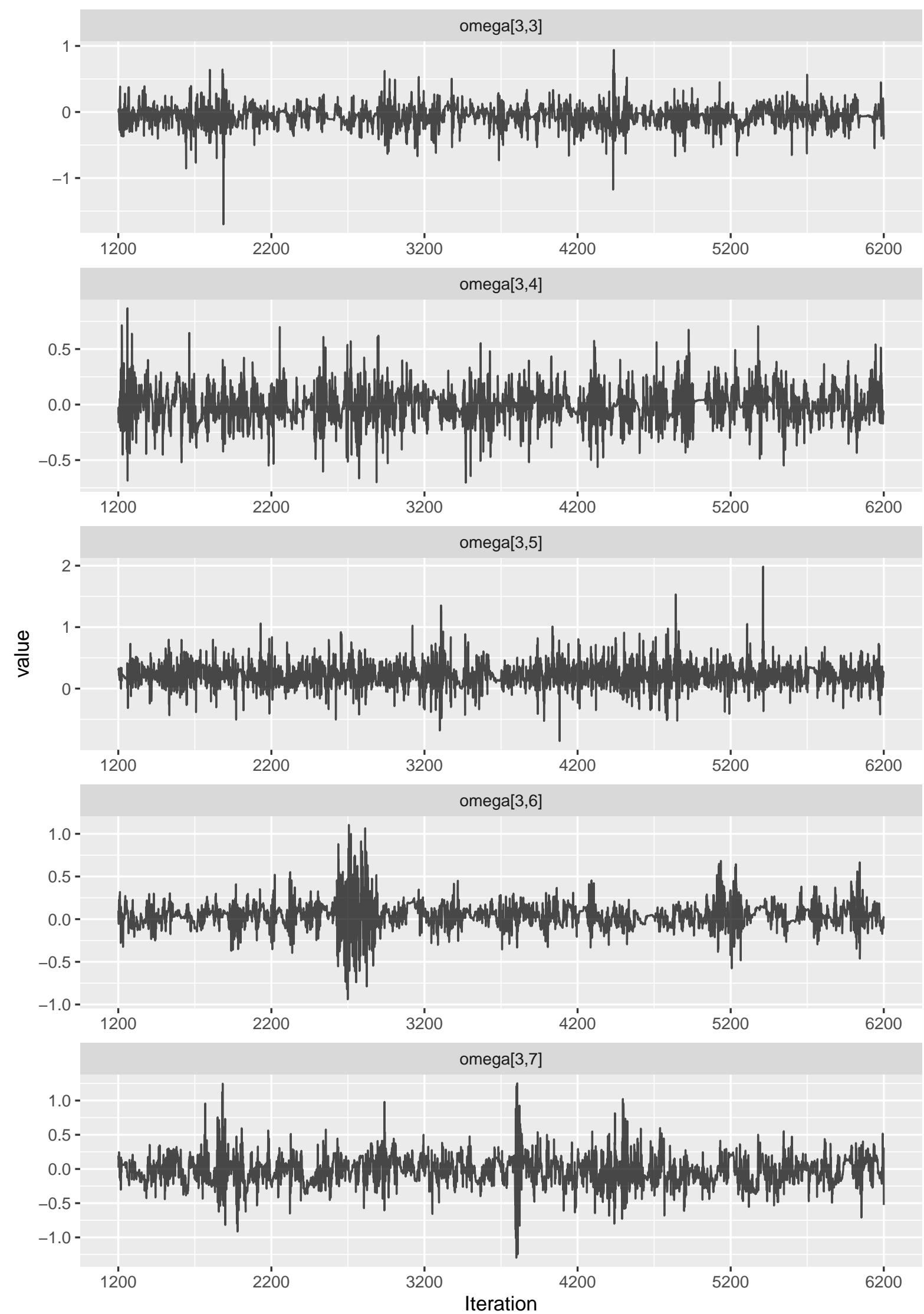


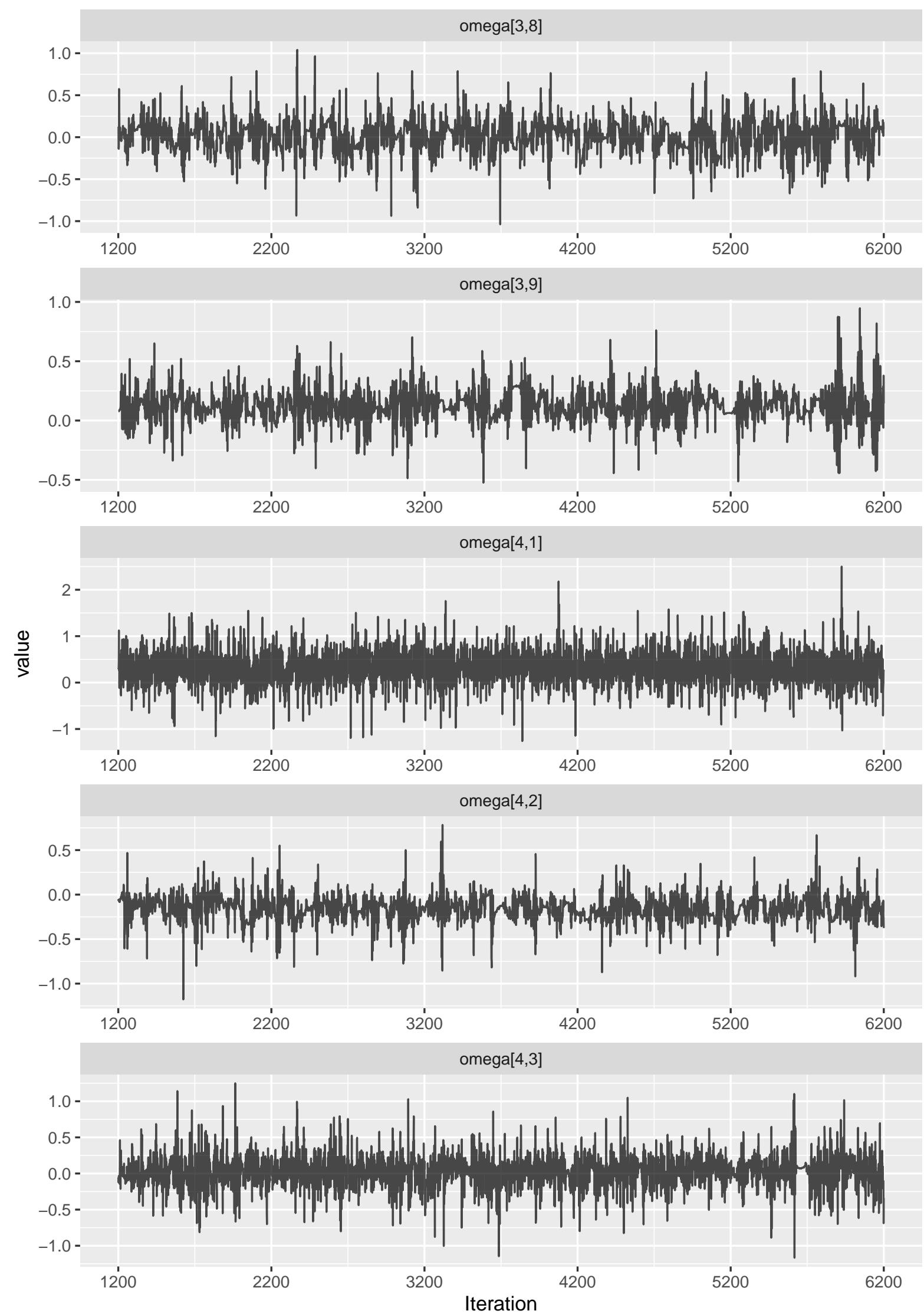




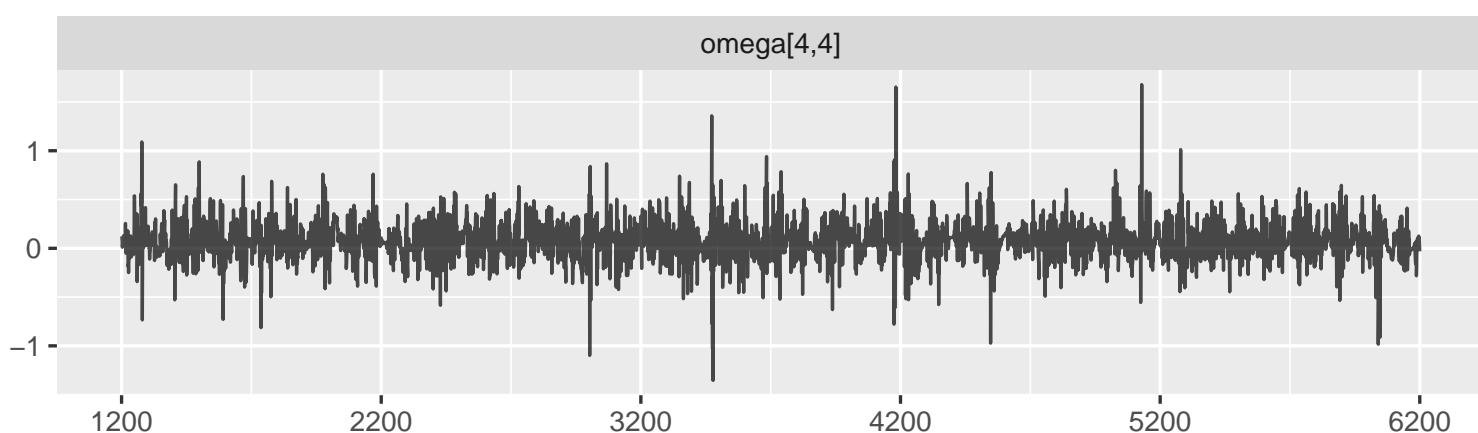




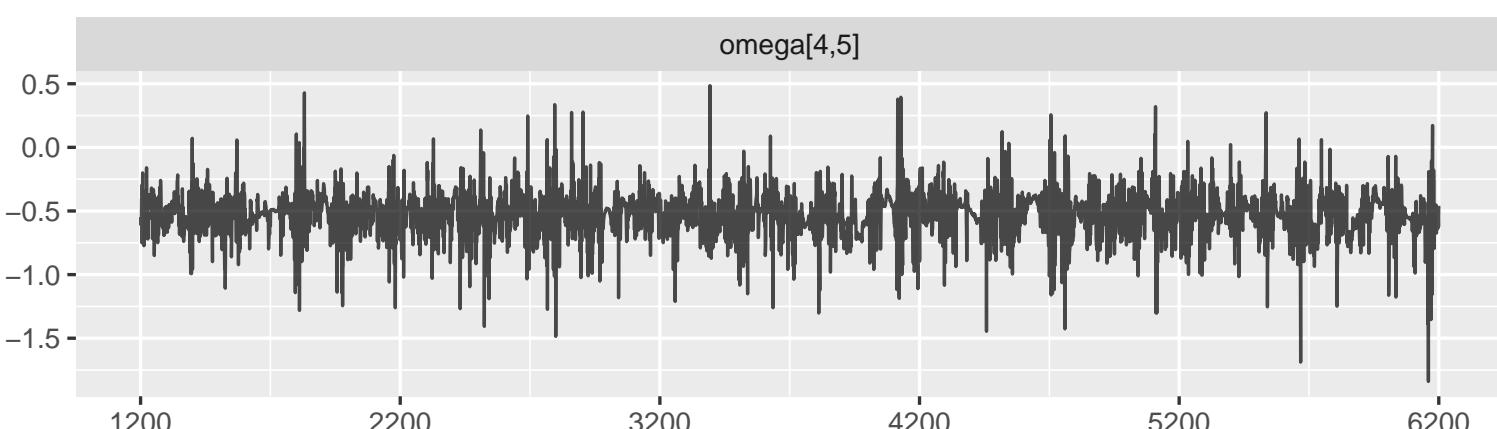




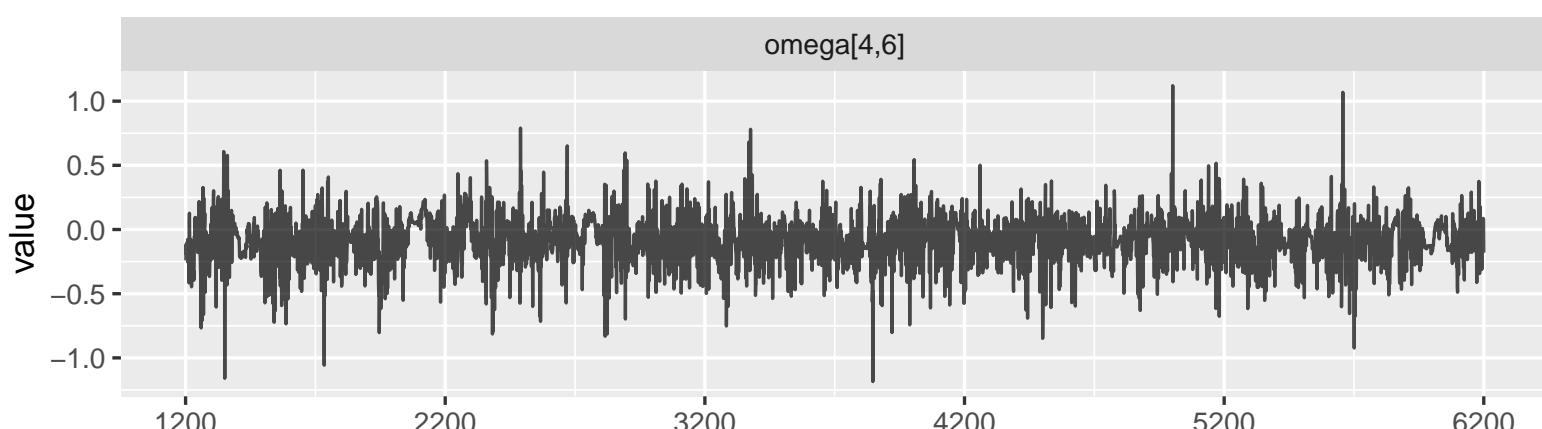
omega[4,4]



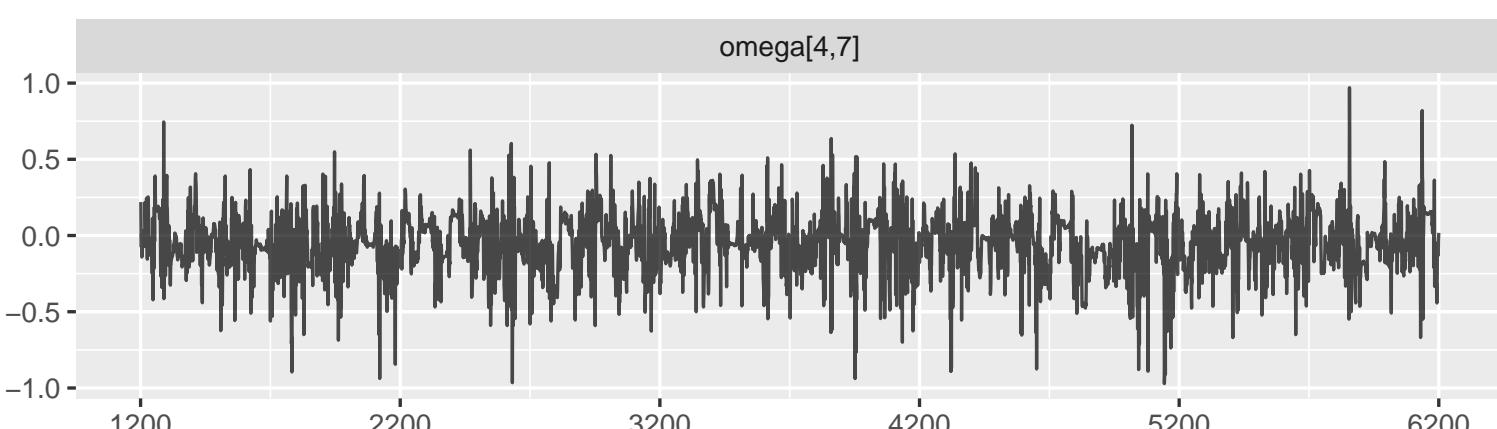
omega[4,5]



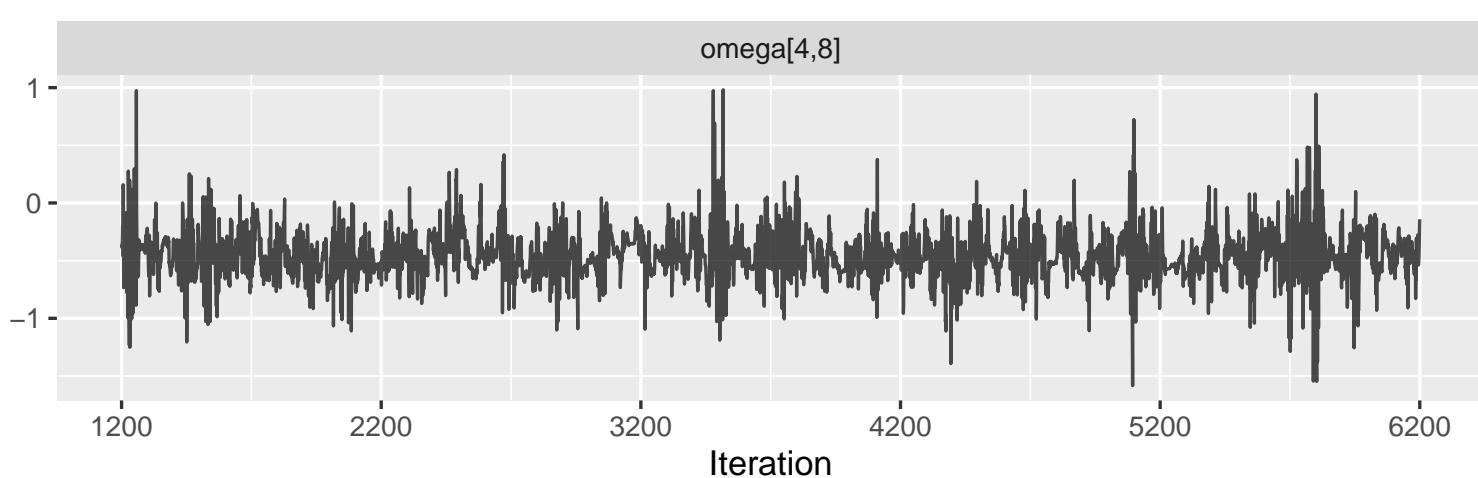
omega[4,6]



omega[4,7]



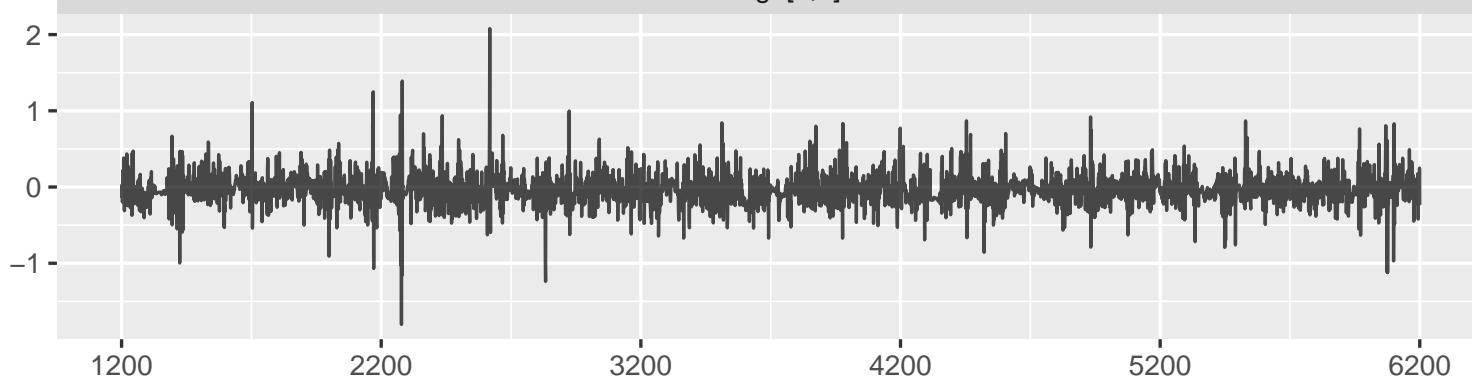
omega[4,8]



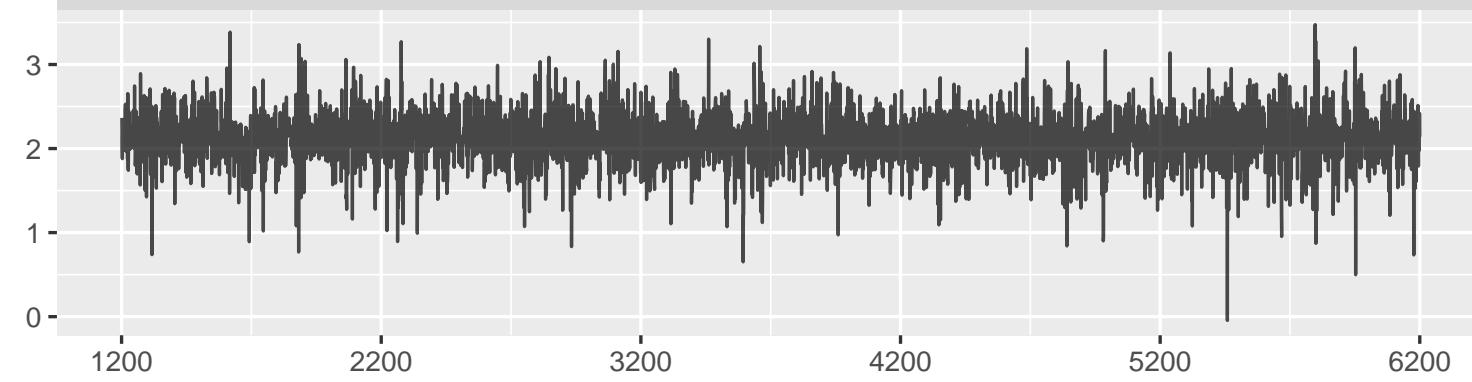
Iteration

value

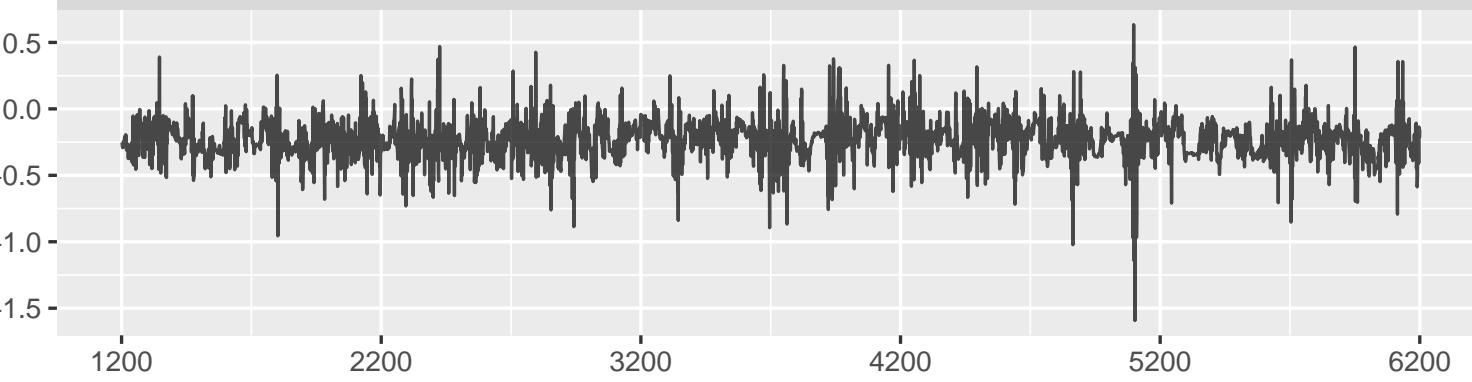
omega[4,9]



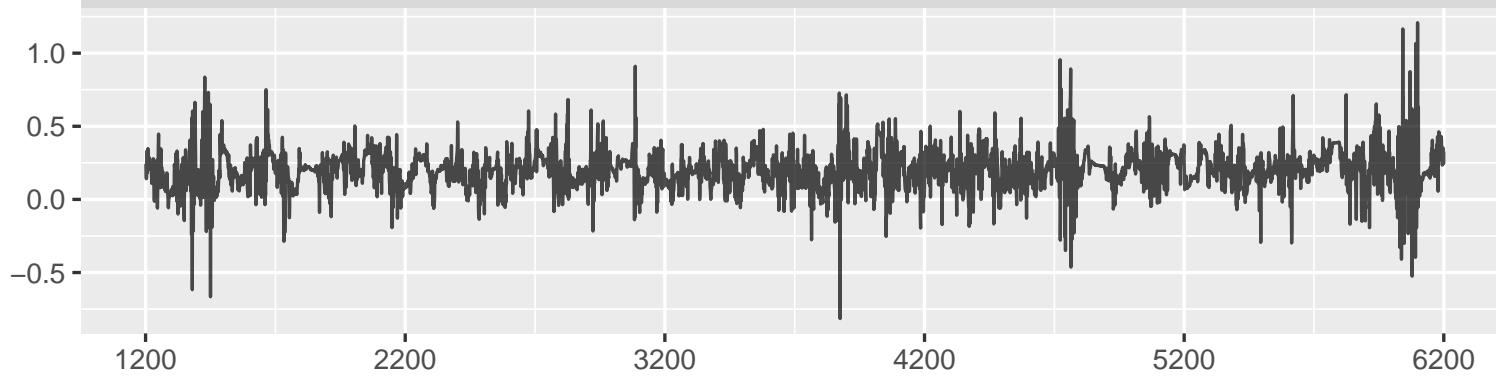
omega[5,1]



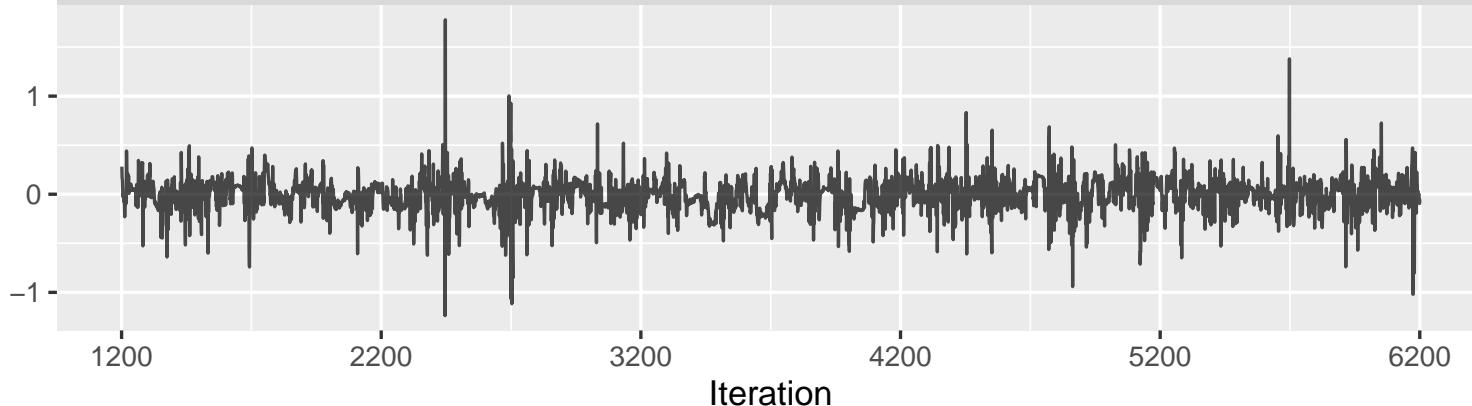
omega[5,2]



omega[5,3]



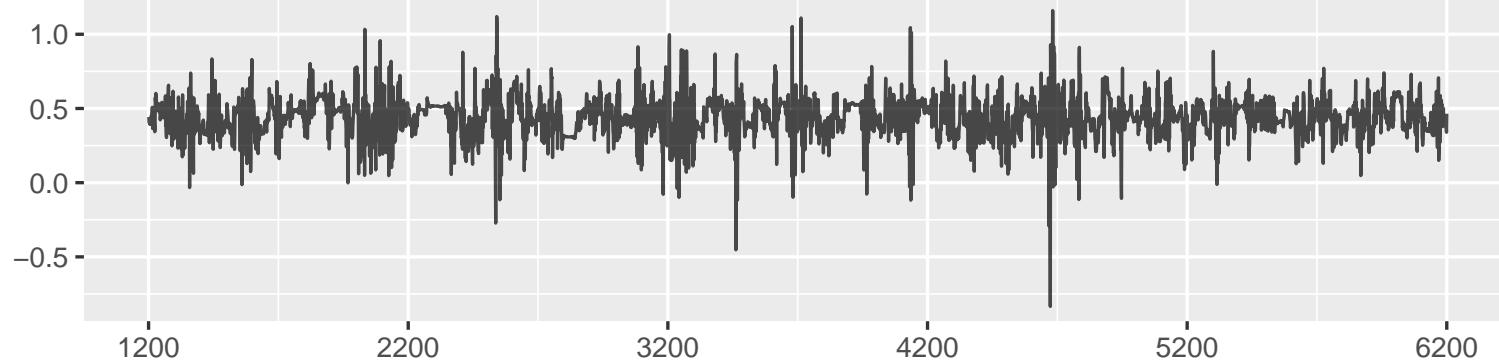
omega[5,4]



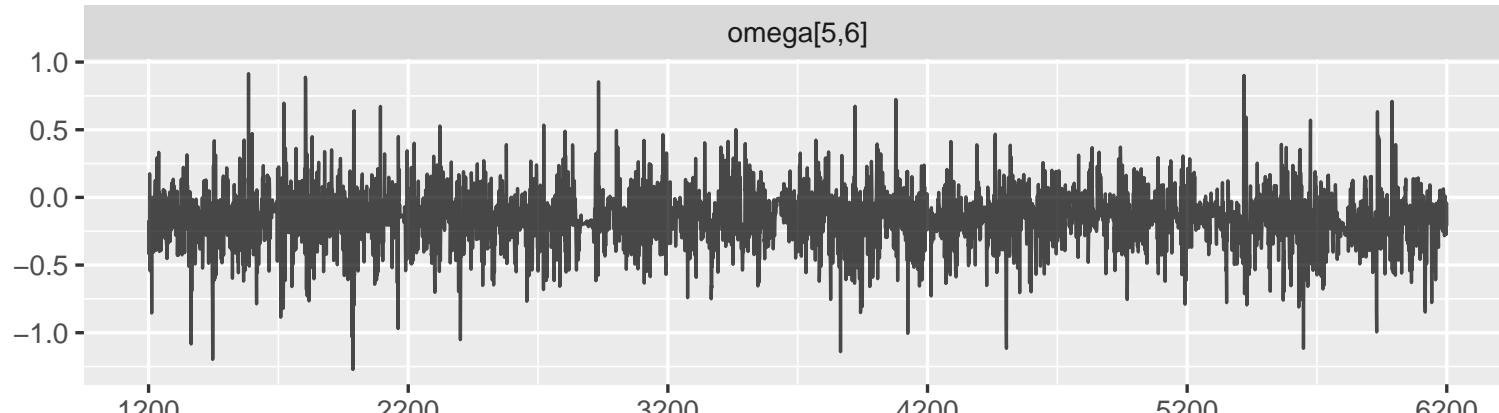
Iteration

value

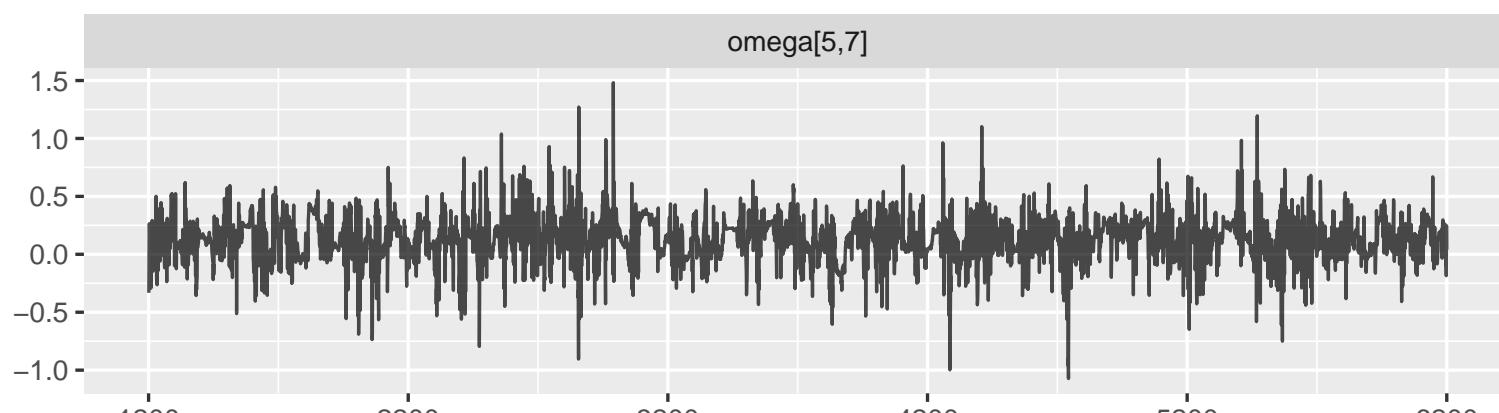
omega[5,5]



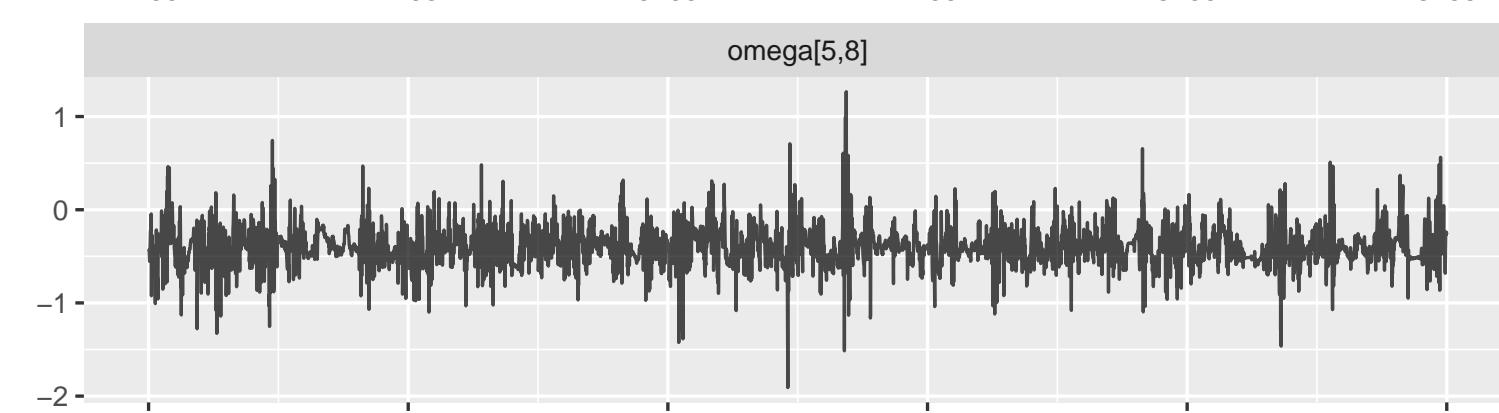
omega[5,6]



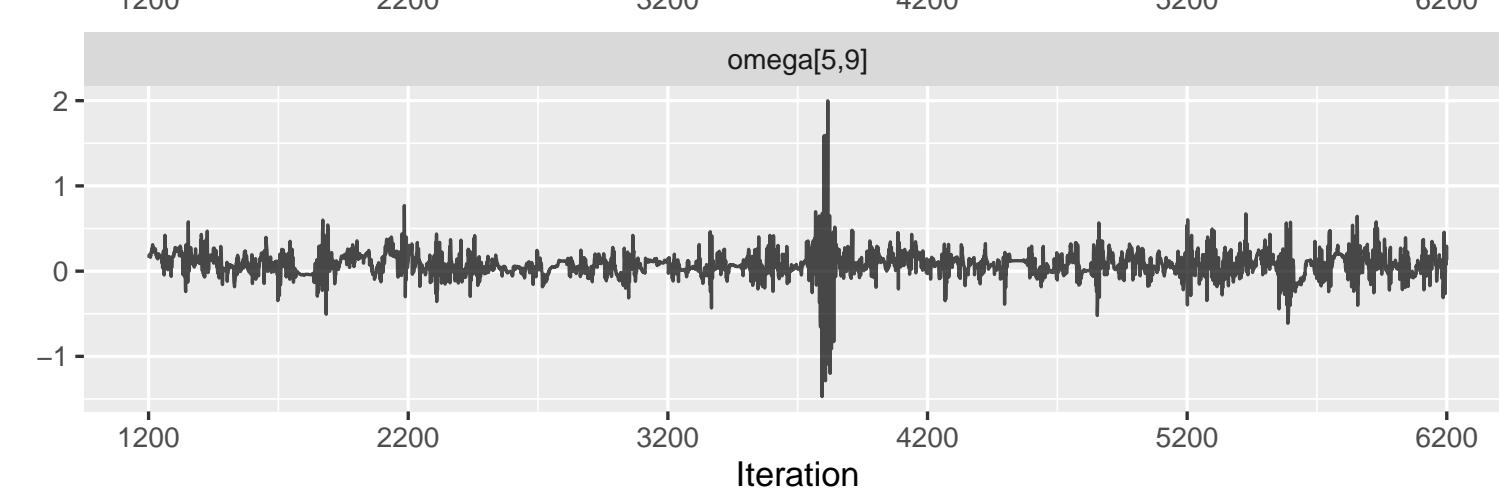
omega[5,7]



omega[5,8]

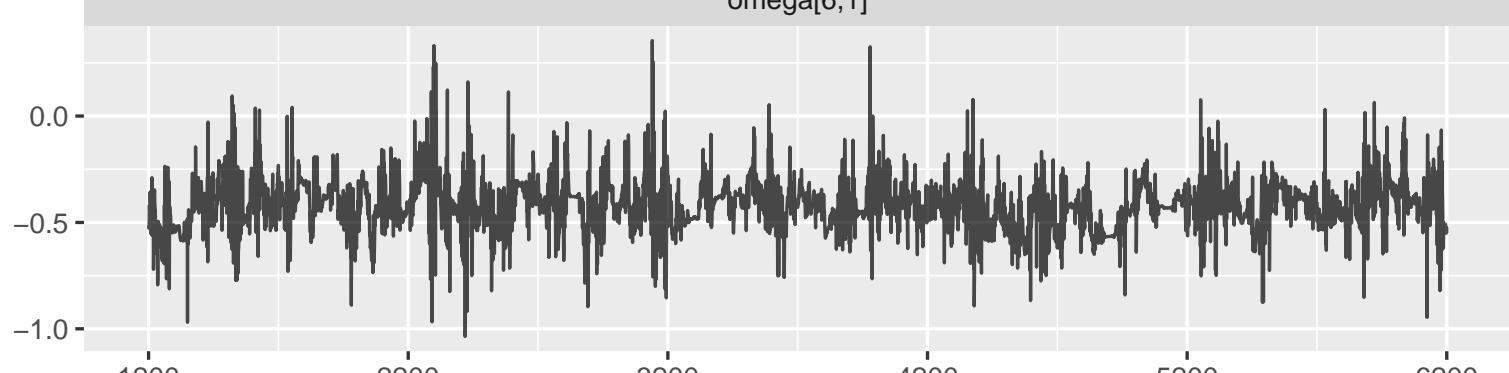


omega[5,9]

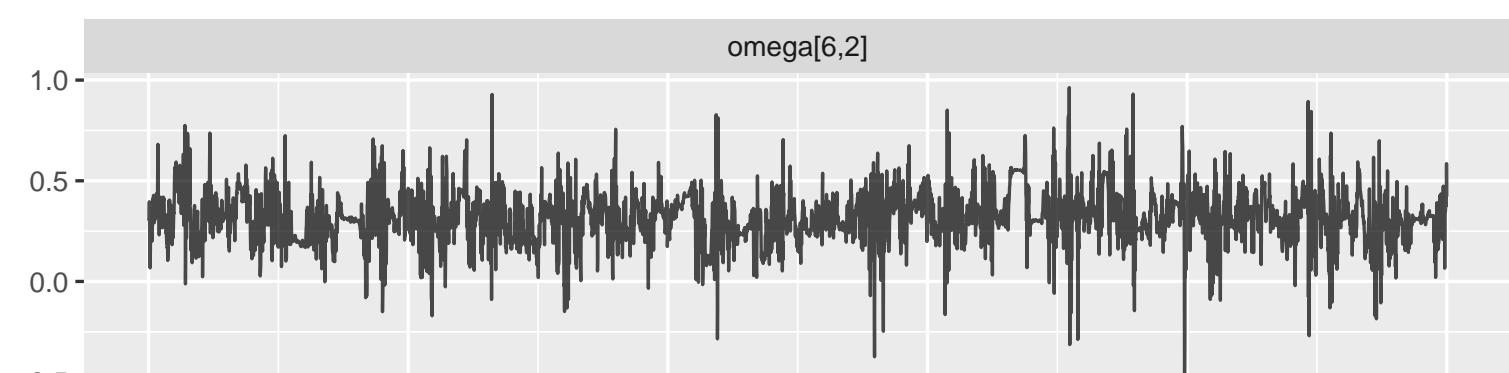


Iteration

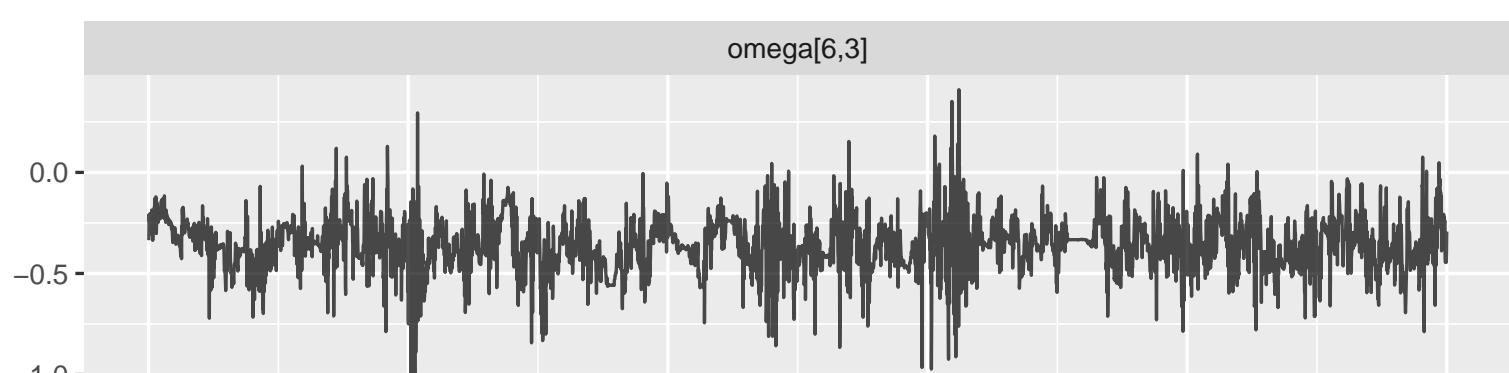
omega[6,1]



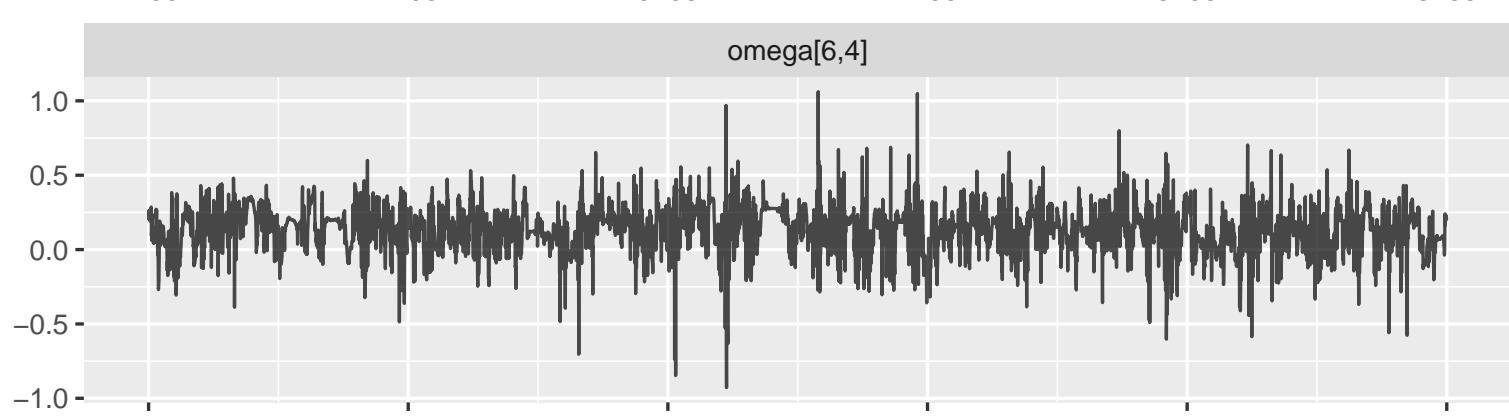
omega[6,2]



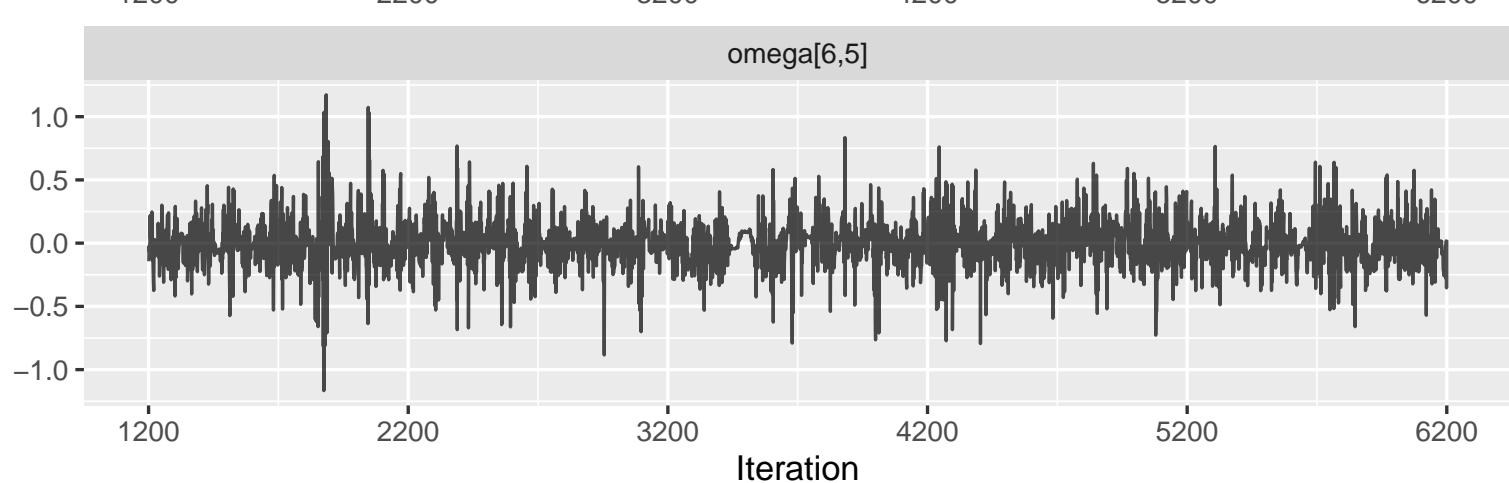
omega[6,3]



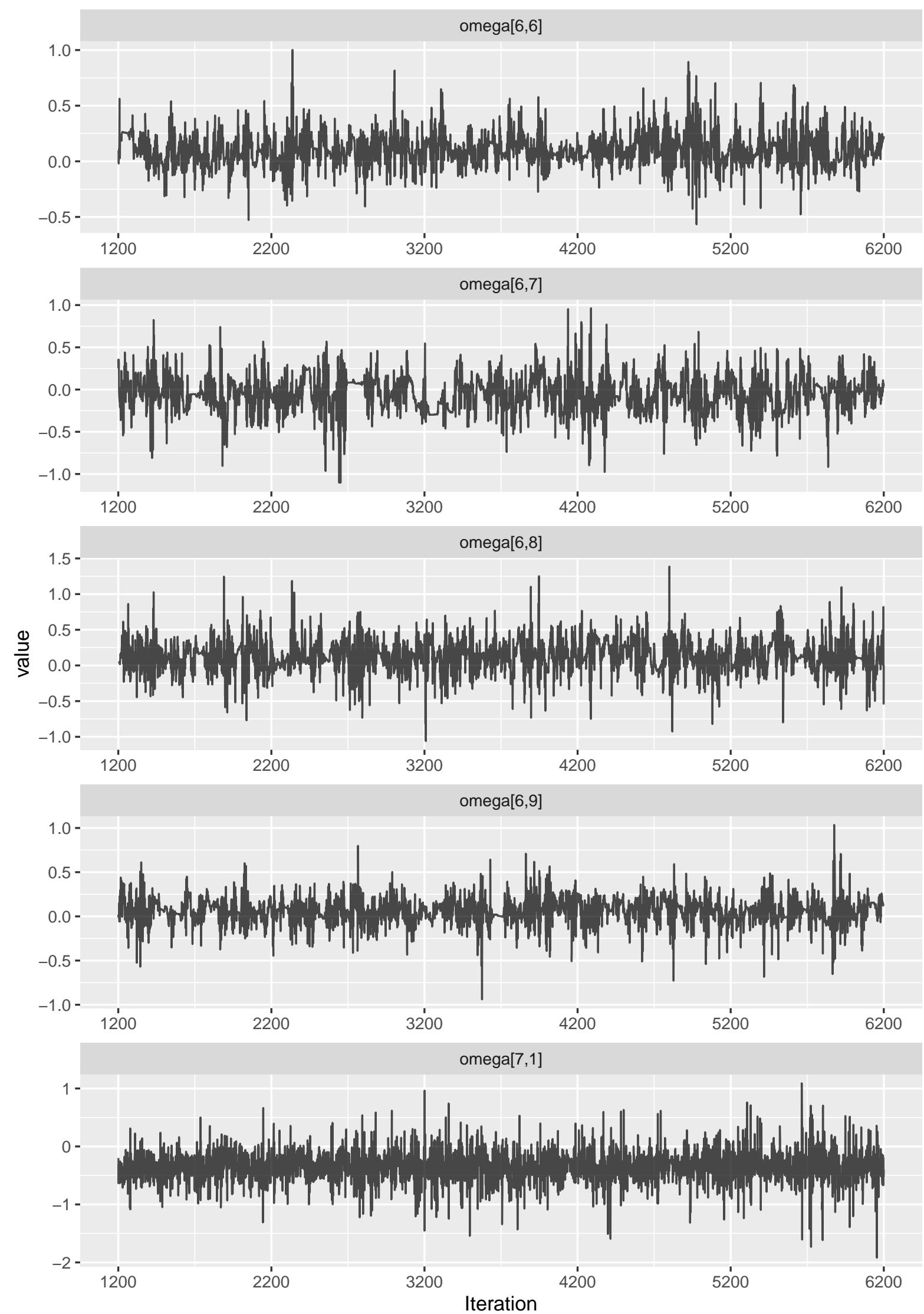
omega[6,4]



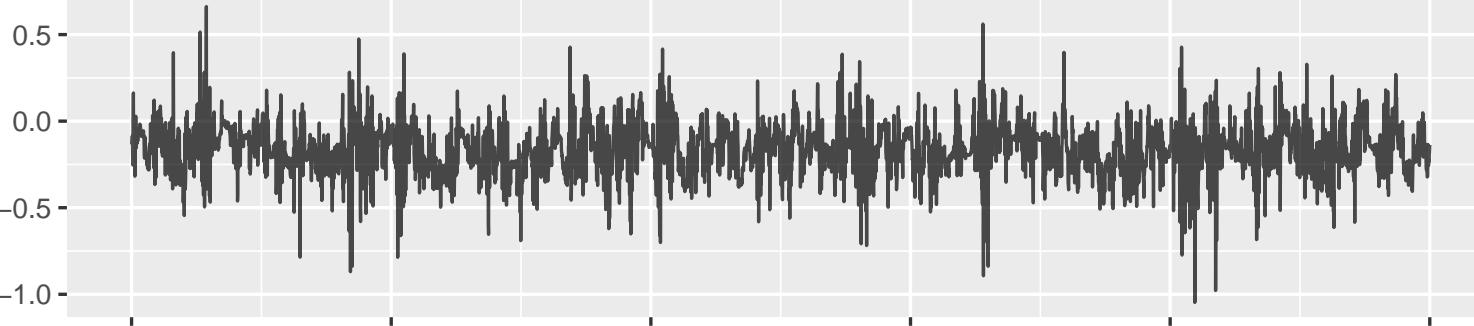
omega[6,5]



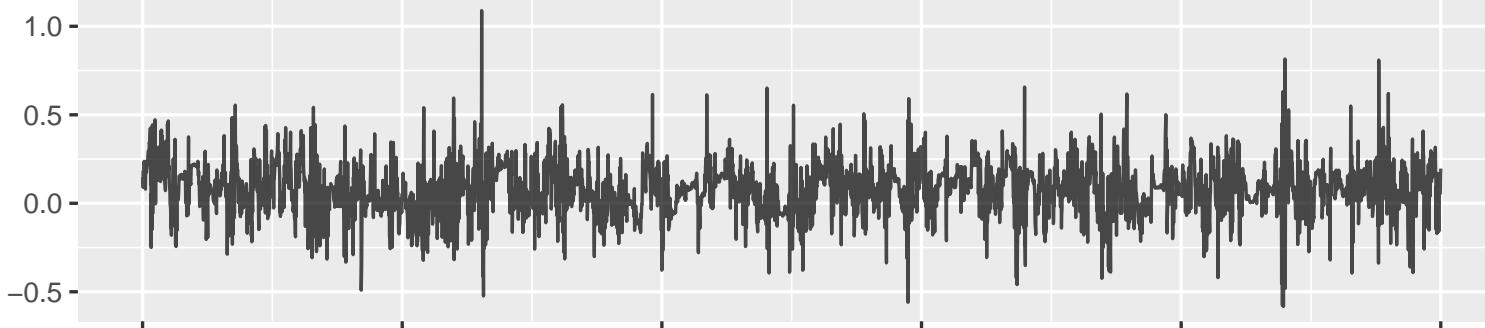
Iteration



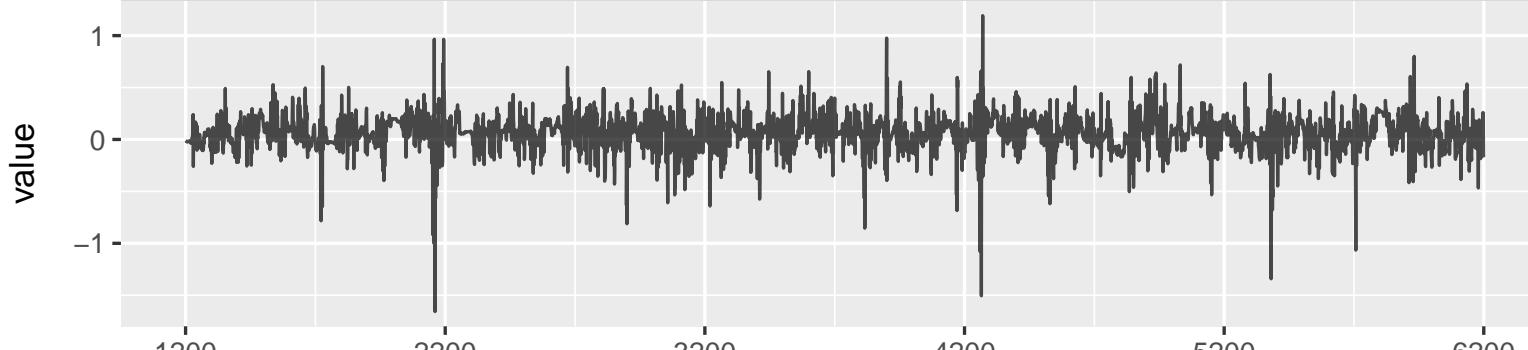
omega[7,2]



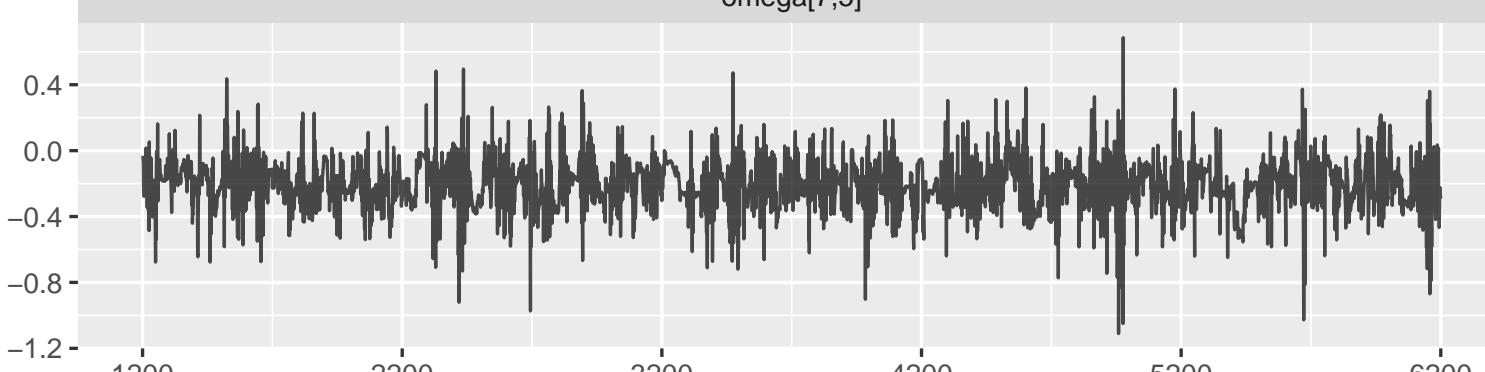
omega[7,3]



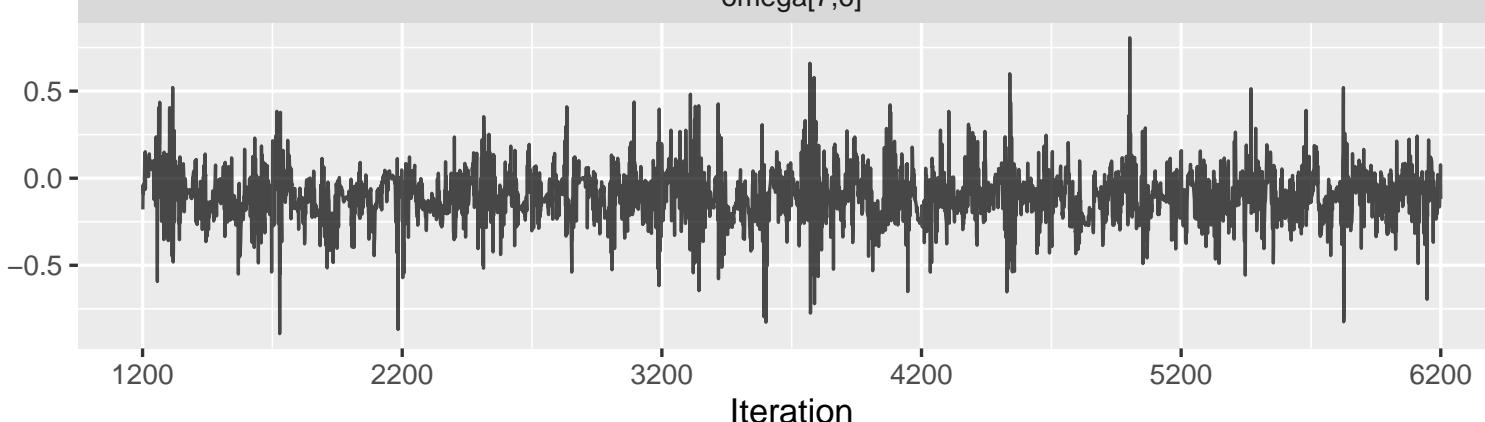
omega[7,4]



omega[7,5]

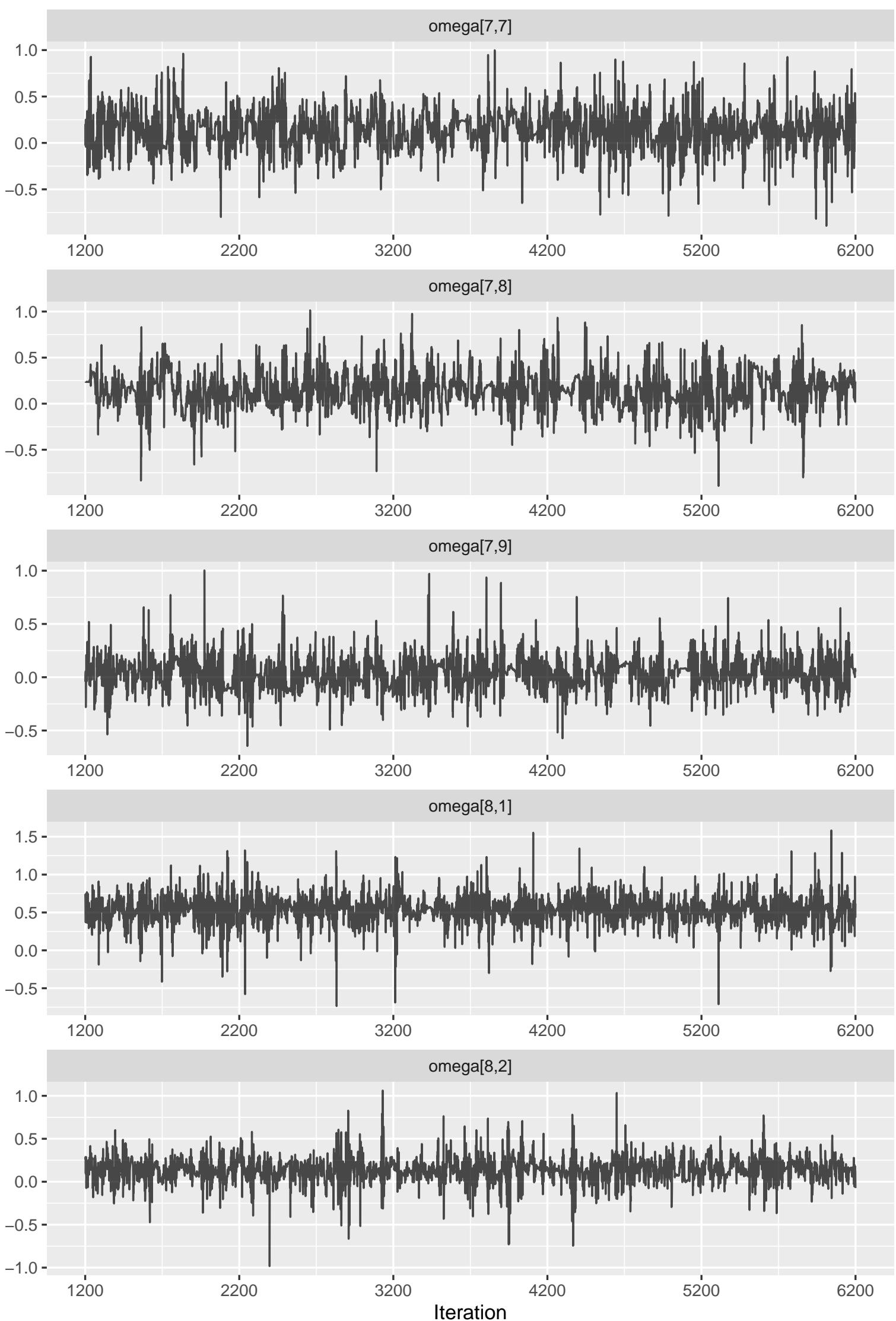


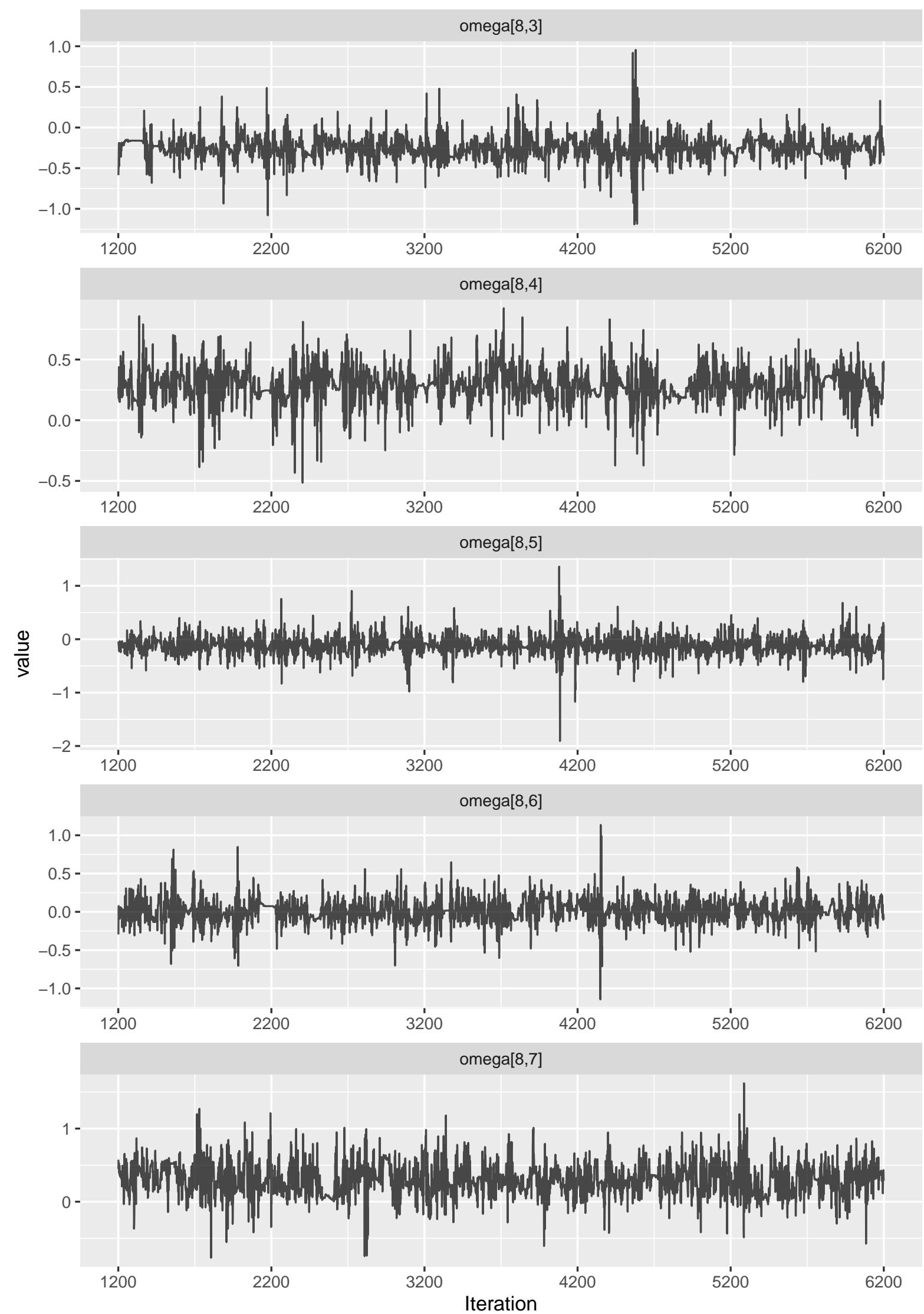
omega[7,6]



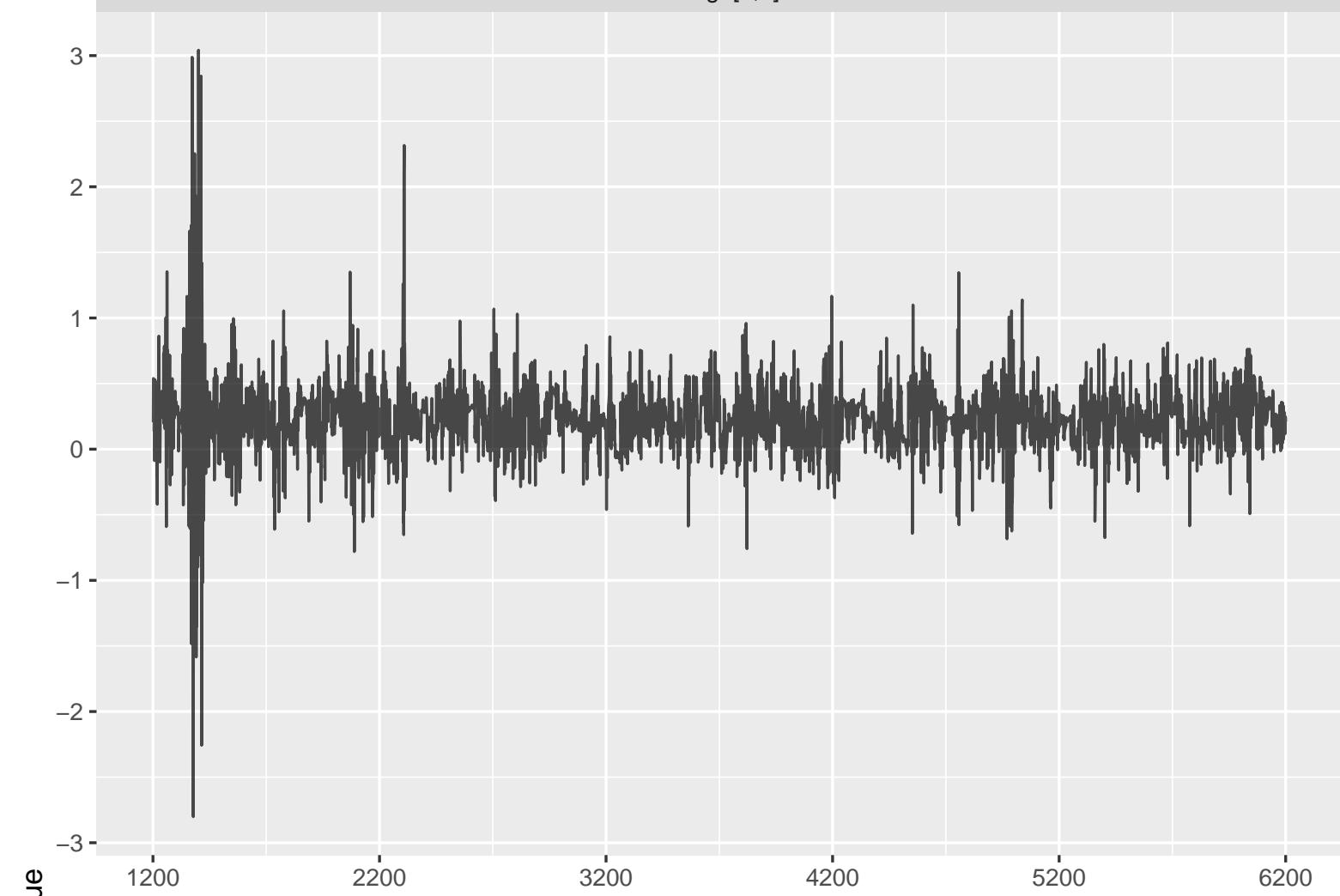
Iteration

value

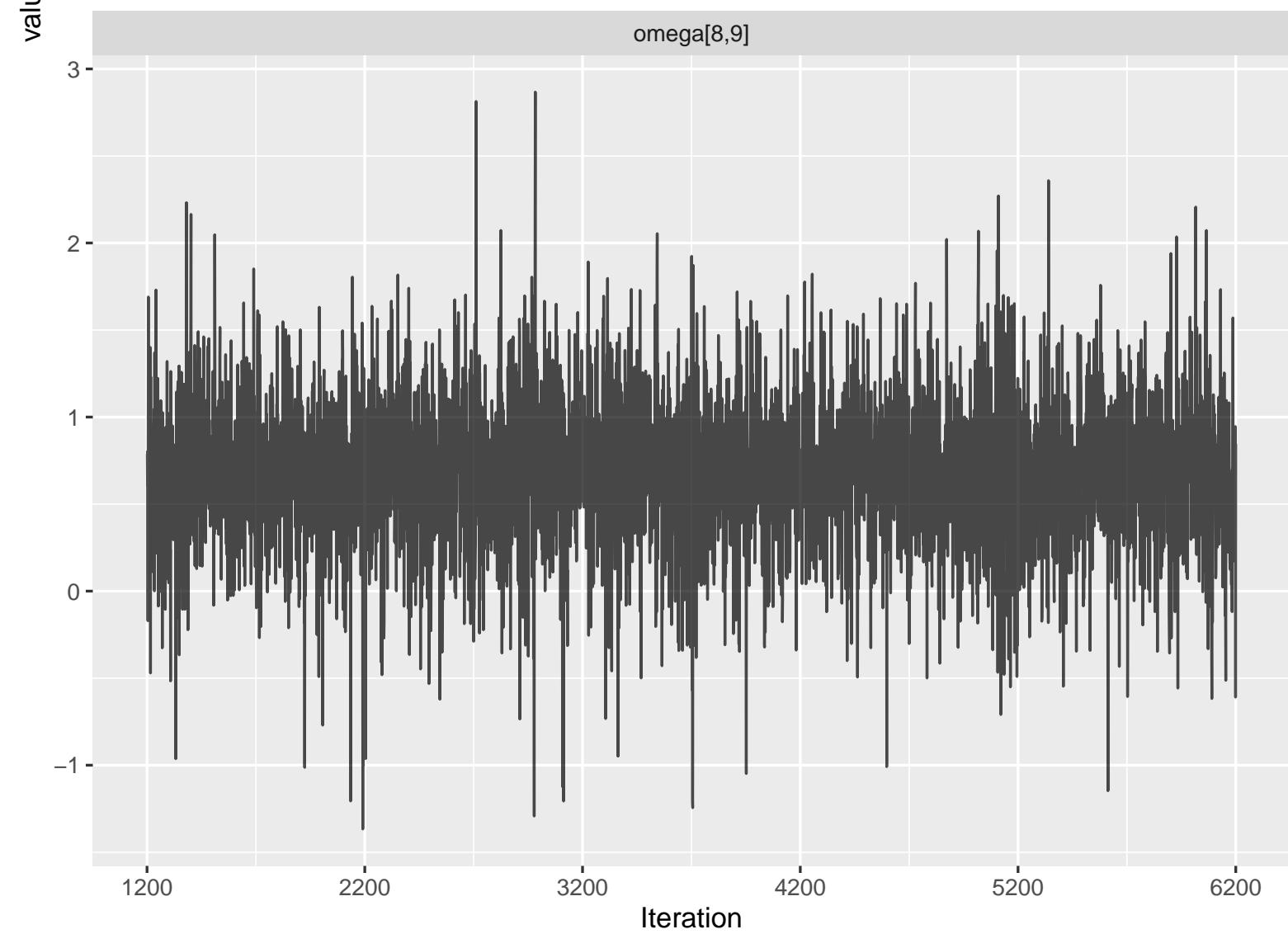




omega[8,8]



omega[8,9]



Geweke Diagnostics

