Supplemental Appendix: Introducing Multilevel Meta-analysis to Experimental Political Science: An Application to Personality and Prosocial Behavior

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1 Summary of the Data

First we present a summary of the variables in our three datasets:

```
library(rjags)

## Loading required package:  coda
## Linked to JAGS 3.4.0
## Loaded modules:  basemod,bugs

library(foreign)
## clear workspace
rm(list = ls())
## Set working directory
setwd("/Users/Reuben/Documents/Projects_current/Personality_meta-analysis/Data/Bayesian-
## load data data for all studies with personality
## data big5/ HEXACO (12 studies)
dl <- read.dta("12-studies_master_benner-fixed.dta")
dl$study <- as.numeric(as.factor(dl$study))
df <- with(dl, data.frame(svo = svo, extro = extro,
    open = open, agree = agree, conscien = conscien,
    neuro = neuro, payment = payment, hilbig = hilbig,
    benner = benner, mbti = mbti, coop = coop, tg = tg,
    study = study))
dl$n <- nrow(df)
## data for big5/ HEXACO studies only (10 studies)
dl2 <- read.dta("10-studies_master_benner-fixed.dta")
dl2$study <- as.numeric(as.factor(dl2$study))
df2 <- with(dl2, data.frame(svo = svo, extro = extro,
    open = open, agree = agree, conscien = conscien,
    neuro = neuro, payment = payment, hilbig = hilbig,
    benner = benner, mbti = mbti, coop = coop, tg = tg,
    study = study))
dl2$n <- nrow(df2)
## data for all of our studies, for
## incentivization-only analysis (15 studies)
dl3 <- read.dta("15-studies_master_benner-fixed.dta")
dl3$study <- as.numeric(as.factor(dl3$study))
df3 <- with(dl3, data.frame(svo = svo, extro = extro,
    open = open, agree = agree, conscien = conscien,
    neuro = neuro, payment = payment, hilbig = hilbig,
    benner = benner, mbti = mbti, coop = coop, tg = tg,
    study = study))
dl3$n <- nrow(df3)
## Summary of dataset For Model 1
summary(df)
```

```
##       svo             extro             open            agree
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.2000   1st Qu.:0.4844   1st Qu.:0.5000   1st Qu.:0.3594
##  Median :0.4960   Median :0.6406   Median :0.6458   Median :0.5200
##  Mean   :0.4797   Mean   :0.5969   Mean   :0.5967   Mean   :0.5167
##  3rd Qu.:0.7000   3rd Qu.:0.7500   3rd Qu.:0.7500   3rd Qu.:0.6800
##  Max.   :1.0500   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##
##     conscien         neuro           payment           hilbig
##  Min.   :0.000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.500   1st Qu.:0.4125   1st Qu.:0.0000   1st Qu.:0.0000
##  Median :0.625   Median :0.5312   Median :0.0000   Median :0.0000
##  Mean   :0.596   Mean   :0.5228   Mean   :0.4321   Mean   :0.4259
##  3rd Qu.:0.750   3rd Qu.:0.6406   3rd Qu.:1.0000   3rd Qu.:1.0000
##  Max.   :1.000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##                  NA's   :576
##      benner            mbti             coop              tg
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.00000
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000
##  Median :0.0000   Median :0.0000   Median :0.0000   Median :0.00000
##  Mean   :0.2026   Mean   :0.2253   Mean   :0.3047   Mean   :0.03676
##  3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.00000
##
##      study
##  Min.   : 1.000
##  1st Qu.: 3.000
##  Median : 5.000
##  Mean   : 5.501
##  3rd Qu.: 7.000
##  Max.   :12.000
##
```

```r
## For Model 2
summary(df2)
```

```
##       svo             extro             open            agree
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.1250   1st Qu.:0.5208   1st Qu.:0.5417   1st Qu.:0.4375
##  Median :0.4500   Median :0.6400   Median :0.6458   Median :0.5469
##  Mean   :0.4532   Mean   :0.6215   Mean   :0.6274   Mean   :0.5458
##  3rd Qu.:0.7000   3rd Qu.:0.7292   3rd Qu.:0.7344   3rd Qu.:0.6667
##  Max.   :1.0500   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##     conscien         neuro           payment           hilbig
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.000   Min.   :0.0000
```

```
##  1st Qu.:0.5312   1st Qu.:0.4125   1st Qu.:0.000   1st Qu.:0.0000
##  Median :0.6250   Median :0.5312   Median :0.000   Median :1.0000
##  Mean   :0.6170   Mean   :0.5228   Mean   :0.267   Mean   :0.5497
##  3rd Qu.:0.7188   3rd Qu.:0.6406   3rd Qu.:1.000   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.000   Max.   :1.0000
##      benner            mbti        coop              tg        study
##  Min.   :0.0000   Min.   :0   Min.   :0.000   Min.   :0   Min.   : 1.000
##  1st Qu.:0.0000   1st Qu.:0   1st Qu.:0.000   1st Qu.:0   1st Qu.: 3.000
##  Median :0.0000   Median :0   Median :0.000   Median :0   Median : 4.000
##  Mean   :0.2615   Mean   :0   Mean   :0.369   Mean   :0   Mean   : 4.674
##  3rd Qu.:1.0000   3rd Qu.:0   3rd Qu.:1.000   3rd Qu.:0   3rd Qu.: 6.000
##  Max.   :1.0000   Max.   :0   Max.   :1.000   Max.   :0   Max.   :10.000
```

```r
## For Model 3
summary(df3)
```

```
##       svo             extro             open            agree
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.2000   1st Qu.:0.4844   1st Qu.:0.5000   1st Qu.:0.3594
##  Median :0.4667   Median :0.6406   Median :0.6458   Median :0.5200
##  Mean   :0.4685   Mean   :0.5969   Mean   :0.5967   Mean   :0.5167
##  3rd Qu.:0.6850   3rd Qu.:0.7500   3rd Qu.:0.7500   3rd Qu.:0.6800
##  Max.   :1.0500   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##                   NA's   :247      NA's   :247      NA's   :247
##     conscien          neuro           payment           hilbig
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.5000   1st Qu.:0.4125   1st Qu.:0.0000   1st Qu.:0.0000
##  Median :0.6250   Median :0.5312   Median :0.0000   Median :0.0000
##  Mean   :0.5959   Mean   :0.5228   Mean   :0.4822   Mean   :0.3884
##  3rd Qu.:0.7500   3rd Qu.:0.6406   3rd Qu.:1.0000   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##  NA's   :247      NA's   :823
##      benner            mbti             coop              tg
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.00000
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000
##  Median :0.0000   Median :0.0000   Median :0.0000   Median :0.00000
##  Mean   :0.1847   Mean   :0.2054   Mean   :0.3006   Mean   :0.05742
##  3rd Qu.:0.0000   3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.00000
##
##      study
##  Min.   : 1.000
##  1st Qu.: 4.000
##  Median : 6.000
##  Mean   : 6.633
```

```
##  3rd Qu.: 8.000
##  Max.   :15.000
##
```

2 Replication with Frequentist Models

Here we replicate the results in table 3 with the more standard frequentist approach to multilevel modeling. Here we report 95% *confidence* intervals to be consistent with the presentation in table 3. At the individual level (level 1), the point estimates and even the standard errors for the personality traits are essentially unchanged—in sum, openness and agreeableness are still associated with significantly increased prosocial behavior, whereas the other three personality traits are not. At level 2 however, as [**?**], both the point estimates and the standard errors exhibit more variability between the two methods. In general, and as to be expected, the standard errors for the level 2 variables are much smaller here than in the Bayesian analysis reported in the text. As a result, in both models 1 and 2, the estimates for Hilbig and Payment are different from zero. However, these standard errors are too small, and therefore the Bayesian estimates are more credible. These models were estimated using the `xtmixed` command in Stata.

3 Additional Information on Bayesian Models

For all three models, the BUGS model was specified as follows:

```
model{
# individual-level equation
for (i in 1:n){
    svo[i] ~ dnorm(svo.hat[i], tau.svo)
    svo.hat[i] <- beta0[study[i]] + inprod(beta[],X[i,])
}
# priors for individual-level parameters
tau.svo <- pow(sigma.svo, -2)
sigma.svo ~ dunif(0, 100)
for(b in 1:nX){
    beta[b] ~ dnorm(0,.001)
}

# study-level equation
for (j in 1:m){
    beta0[j] ~ dnorm(beta0.hat[j], tau.beta0)
    beta0.hat[j] <- inprod(gamma[],Z[j,])
}
# priors for study-level parameters
tau.beta0 <- pow(sigma.beta0, -2)
```

Table 1: Prosociality, Personality and Incentivization: Multilevel Regression Results

Variable	Model 1: Big Five & MBTI Studies		Model 2: Big Five Studies		Model 3: Incentivization	
Subject-level variables						
	Mean	95% Conf. Interval	Mean	95% Conf. Interval	Mean	95% Conf. Interval
Extroversion	0.01	[−0.06, 0.075]	−.06	[−0.15, 0.03]	–	–
Openness	0.09	[0.03, 0.16]	0.23	[0.13, 0.33]	–	–
Agreeableness	0.10	[0.03, 0.17]	0.16	[0.06, 0.26]	–	–
Conscientiousness	−0.03	[−0.10, 0.03]	−0.07	[−0.17, 0.02]	–	–
Neuroticism	–	–	−0.06	[−0.15, 0.03]	–	–
Study-level variables						
	Mean	95% Conf. Interval	Mean	95% Conf. Interval	Mean	95% Conf. Interval
(Global) Intercept	0.26	[0.10, 0.42]	0.16	[−0.06, 0.37]	0.43	[0.31, 0.55]
Payment	0.15	[0.01, 0.29]	0.18	[0.03, 0.32]	0.03	[−0.12, 0.18]
Author: Hilbig	0.19	[0.03, 0.36]	0.25	[0.07, 0.43]	–	–
Author: Ben-Ner	−0.15	[−0.32, 0.02]	−0.09	[−0.29, 0.11]	–	–
MBTI Personality Measure	0.10	[−0.07, 0.27]	–	–	–	–
Cooperative	−0.06	[−0.14, 0.02]	0.03	[−0.13, 0.18]	−0.06	[−0.14, 0.02]
# Observations		2,557		1,981		2,804
# Studies		12		10		15

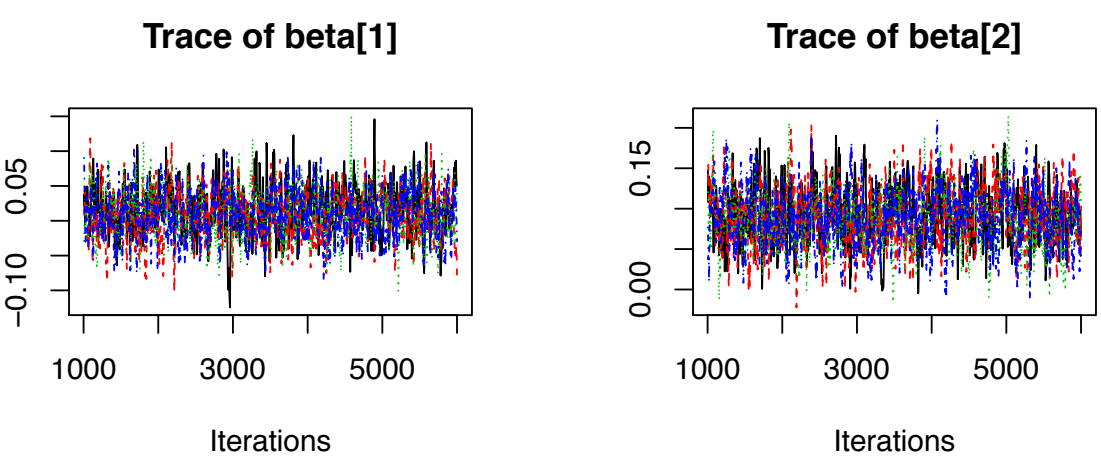
```
sigma.beta0 ~ dunif(0, 100)
for (g in 1:nZ){
    gamma[g] ~ dnorm(0,.001)
}
}
```

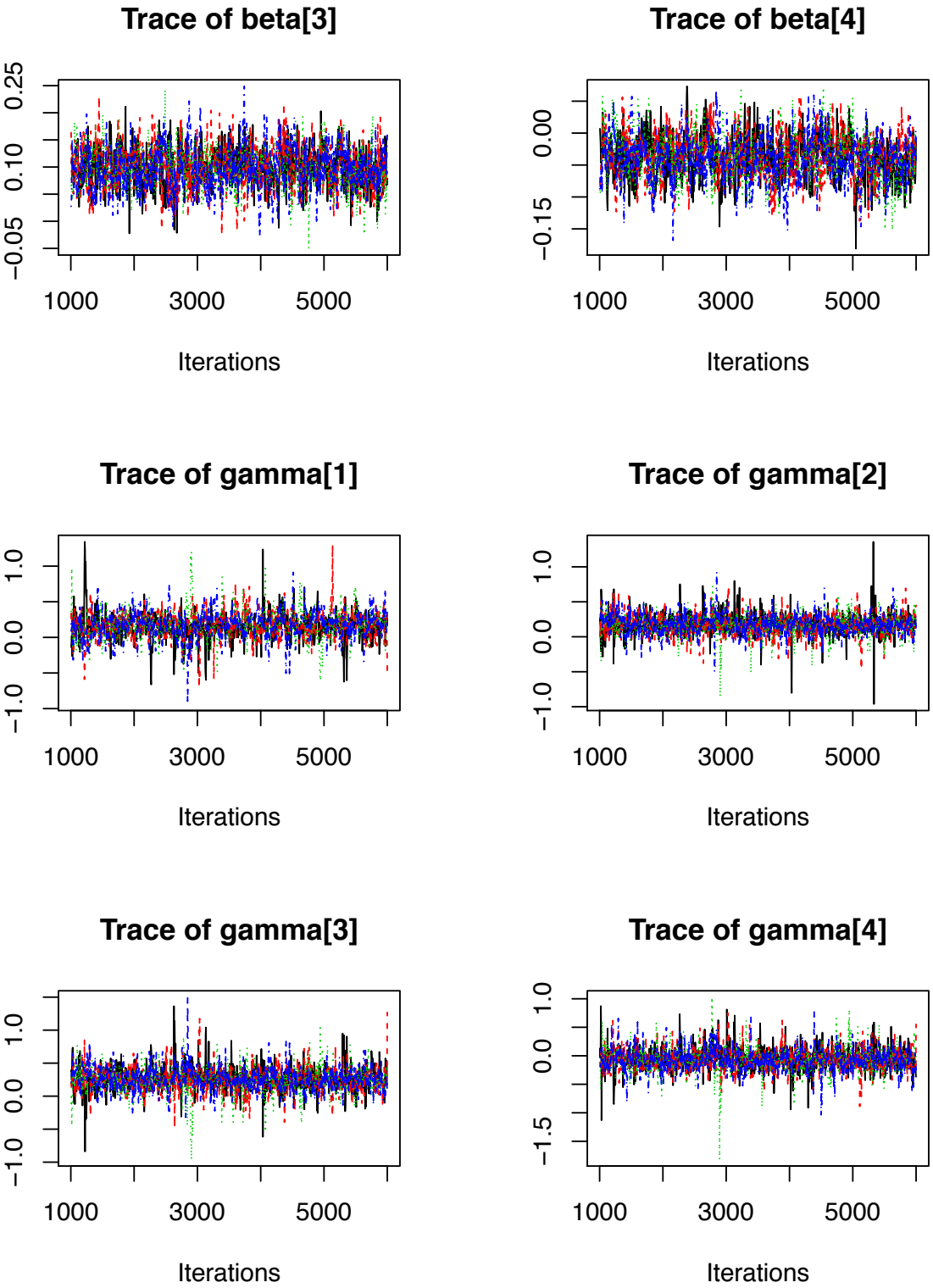
Below is the R code, for the esetimation of models 1, 2 and 3, in the text, for which we used the rjags package.

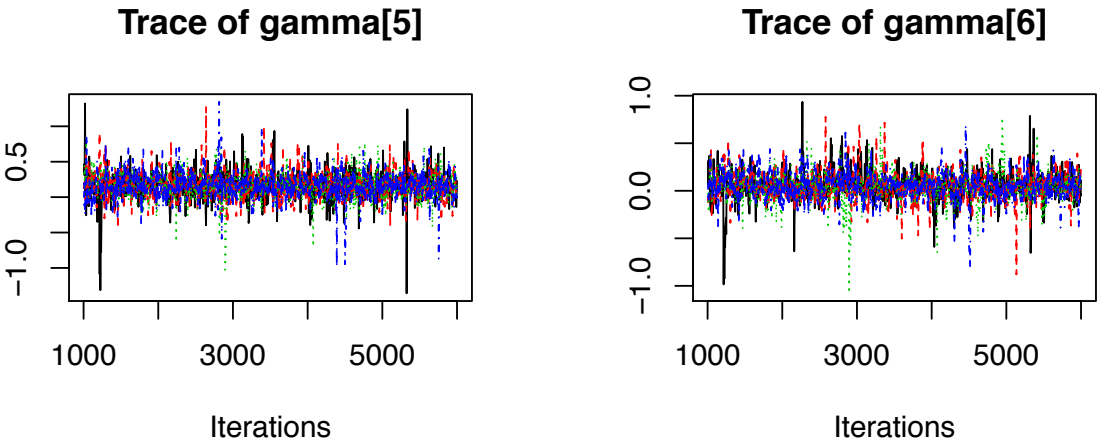
We also present the "trace plots" for each estimation. These figures plot the value of the estimated parameter over each of the 5,000 iterations in our simulation. The plots plot iterations from 1,000 to 6,000 because the first 1,000 iterations are the "adaptation period. The numbering of the parameters follows the order they are entered in the models above, with the "betas" representing the level 1 coefficients in the order that they enter the models above, and the "gammas" representing the level 2 coefficients in the order that they enter the models above.

```r
## Model 1
m1dl <- with(df, list(svo = svo, study = study, n = length(svo),
    m = length(unique(study)), X = cbind(extro, open,
        agree, conscien), nX = 4, Z = aggregate(cbind(1,
        payment, hilbig, benner, mbti, coop), by = list(study = study),
        FUN = mean)[, -1], nZ = 6))
m1jmod <- jags.model("mlma.bugs", data = m1dl, n.chains = 4,
    quiet = TRUE)
m1jags <- coda.samples(model = m1jmod, n.iter = 5000,
    thin = 5, progress.bar = "none", variable.names = c("beta",
        "gamma"))
```

```r
par(mfrow = c(1,2))
coda::traceplot(m1jags)
```

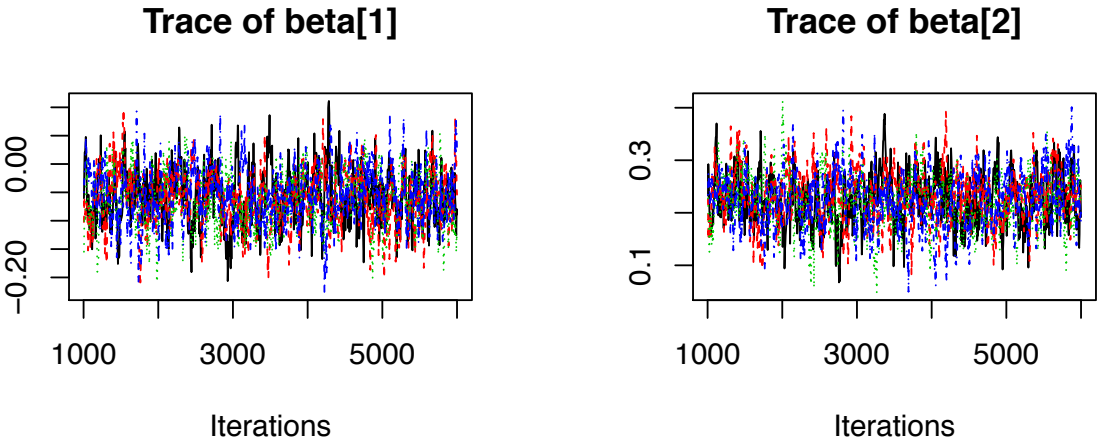


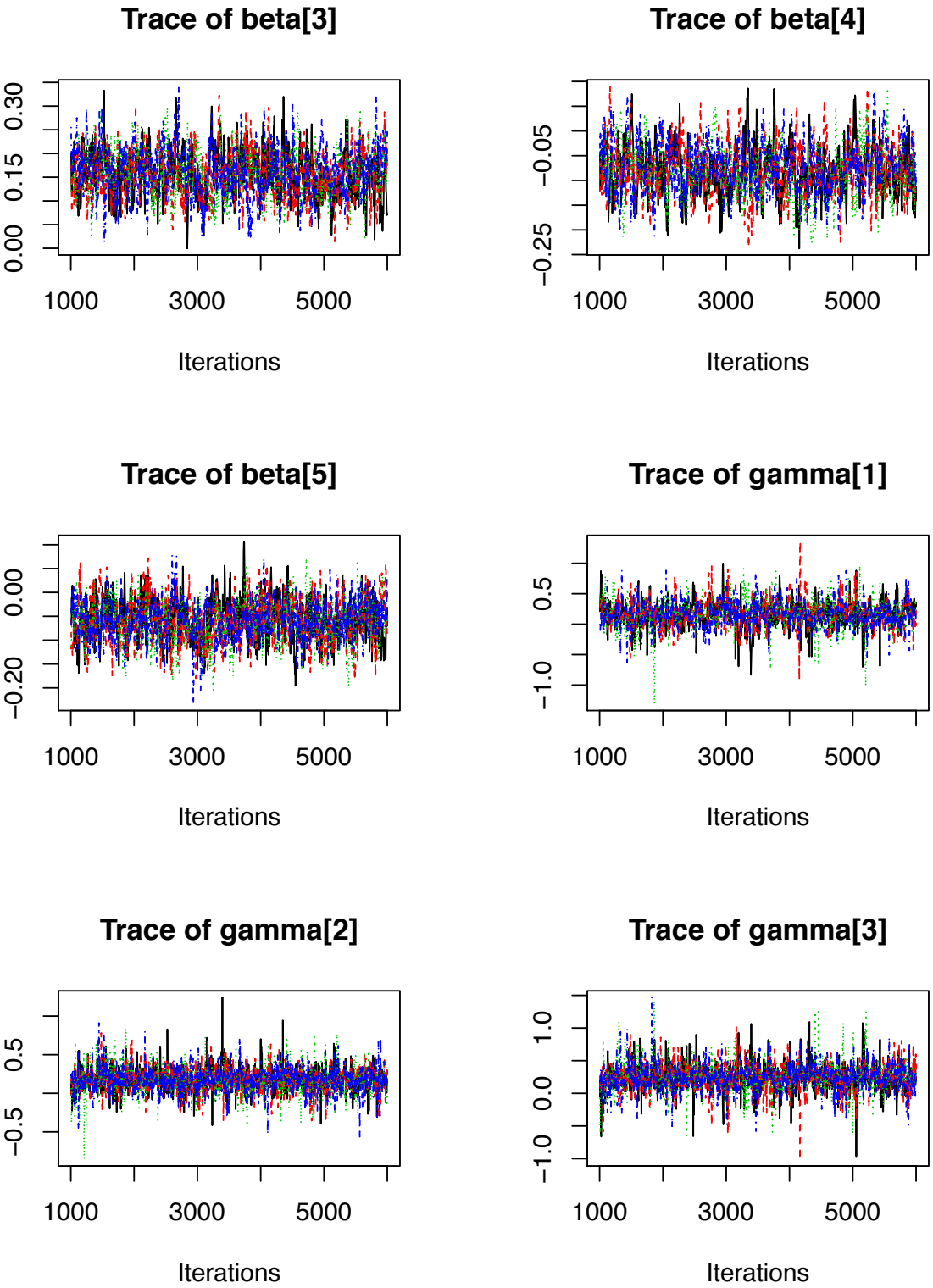

Trace of beta[3]
0.25
0.10
−0.05
1000
3000
5000
Iterations
Trace of beta[4]
0.00
−0.15
1000
3000
5000
Iterations
Trace of gamma[1]
1.0
0.0
−1.0
1000
3000
5000
Iterations
Trace of gamma[2]
1.0
0.0
−1.0
1000
3000
5000
Iterations
Trace of gamma[3]
1.0
0.0
−1.0
1000
3000
5000
Iterations
Trace of gamma[4]
1.0
0.0
−1.5
1000
3000
5000
Iterations

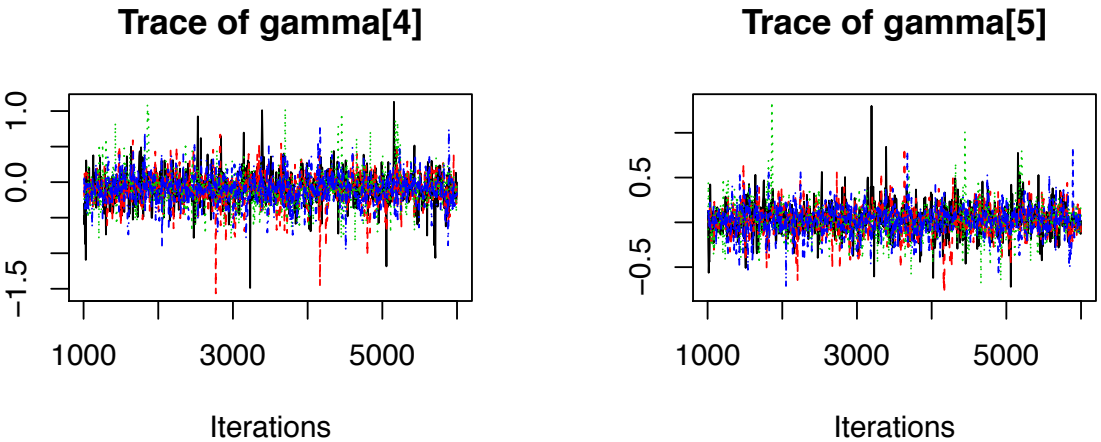



```
## Model 2
m2dl <- with(na.omit(df2), list(svo = svo, study = as.numeric(as.factor(study)),
    n = length(svo), m = length(unique(study)), X = cbind(extro,
        open, agree, conscien, neuro), nX = 5, Z = aggregate(cbind(1,
        payment, hilbig, benner, coop), by = list(study = study),
        FUN = mean)[, -1], nZ = 5))
m2jmod <- jags.model("mlma.bugs", data = m2dl, n.chains = 4,
    quiet = TRUE)
m2jags <- coda.samples(model = m2jmod, n.iter = 5000,
    thin = 5, progress.bar = "none", variable.names = c("beta",
        "gamma"))
```

```
par(mfrow = c(1,2))
coda::traceplot(m2jags)
```

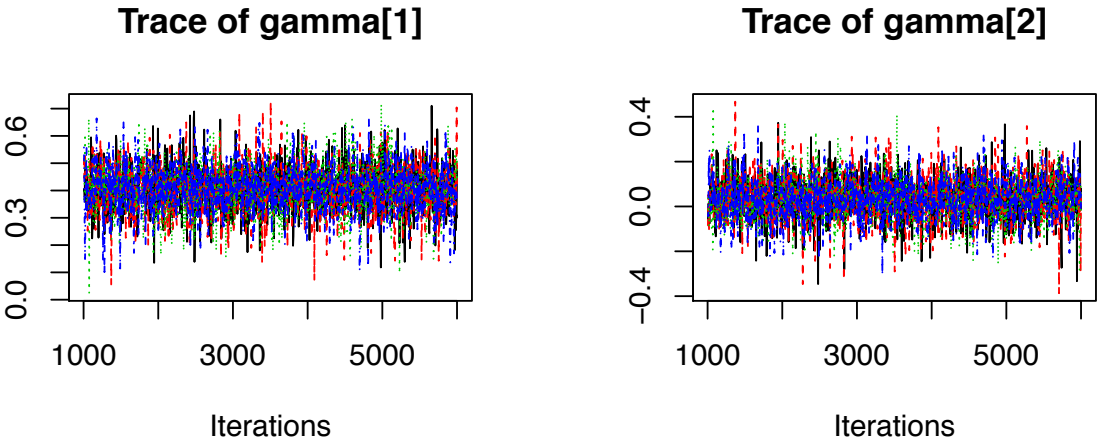


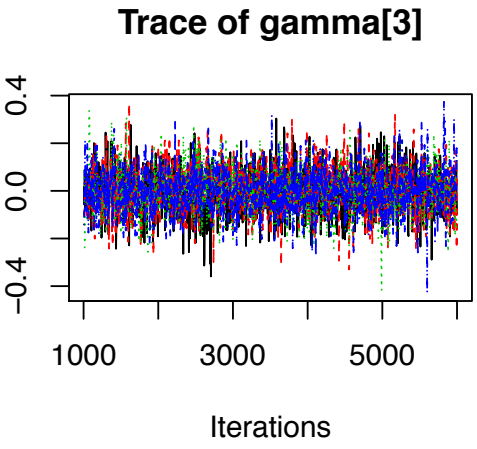

Trace of beta[3]
0.00
0.15
0.30
1000
3000
5000
Iterations
Trace of beta[4]
−0.25
−0.05
1000
3000
5000
Iterations
Trace of beta[5]
−0.20
0.00
1000
3000
5000
Iterations
Trace of gamma[1]
−1.0
0.5
1000
3000
5000
Iterations
Trace of gamma[2]
−0.5
0.5
1000
3000
5000
Iterations
Trace of gamma[3]
−1.0
0.0
1.0
1000
3000
5000
Iterations




```
## Model 3
m3dl <- with(df3, list(svo = svo, study = study, n = length(svo),
    m = length(unique(study)), X = as.matrix(rep(0,
        length(svo))), nX = 1, Z = aggregate(cbind(1,
        payment, coop), by = list(study = study), FUN = mean)[,
        -1], nZ = 3))
m3jmod <- jags.model("mlma.bugs", data = m3dl, n.chains = 4,
    quiet = TRUE)
m3jags <- coda.samples(model = m3jmod, n.iter = 5000,
    thin = 5, progress.bar = "none", variable.names = c("gamma"))
```

```
par(mfrow = c(1,2))
coda::traceplot(m3jags)
```





As expected, in most all of the cases in all three models, the variability is higher for the γ-parameters (level 2) than for the β parameneters (level 1).