

analysis_2-24

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```
library(ggplot2)
library(coda)
library(runjags)
library(fastDummies)
data = data.frame(read.csv("CEdata.csv",header=TRUE))
```

The original slides has scale(), but I removed it to better interpret the results.

```
data$log_TotalExpSTD <- log(data$Expenditure)
data$log_TotalIncomeSTD <- log(data$Income)
```

Create the binary columns and rows for each categorical variable:

```
data$Rural = fastDummies::dummy_cols(data$UrbanRural)[,names(fastDummies::dummy_cols(data$UrbanRural))]=
data$Race_Black = fastDummies::dummy_cols(data$Race)[,names(fastDummies::dummy_cols(data$Race)) == ".data_
data$Race_NA = fastDummies::dummy_cols(data$Race)[,names(fastDummies::dummy_cols(data$Race)) == ".data_
data$Race_Asian = fastDummies::dummy_cols(data$Race)[,names(fastDummies::dummy_cols(data$Race)) == ".da
data$Race_PI = fastDummies::dummy_cols(data$Race)[,names(fastDummies::dummy_cols(data$Race)) == ".data_
data$Race_M = fastDummies::dummy_cols(data$Race)[,names(fastDummies::dummy_cols(data$Race)) == ".data_6
```

Same parameters from slides:

```
modelString <-"
model {
  ## sampling
  for (i in 1:N){
    y[i] ~ dnorm(beta0 + beta1*x_income[i] + beta2*x_rural[i] +
    beta3*x_race_B[i] + beta4*x_race_N[i] +
    beta5*x_race_A[i] + beta6*x_race_P[i] +
    beta7*x_race_M[i], invsigma2)
  }
  ## priors
  beta0 ~ dnorm(mu0, g0)
  beta1 ~ dnorm(mu1, g1)
  beta2 ~ dnorm(mu2, g2)
  beta3 ~ dnorm(mu3, g3)
  beta4 ~ dnorm(mu4, g4)
  beta5 ~ dnorm(mu5, g5)
  beta6 ~ dnorm(mu6, g6)
  beta7 ~ dnorm(mu7, g7)
  invsigma2 ~ dgamma(a, b)
  sigma <- sqrt(pow(invsigma2, -1))
}
"
```

```
y = as.vector(data$log_TotalExpSTD)
x_income = as.vector(data$log_TotalIncomeSTD)
x_rural = as.vector(data$Rural)
x_race_B = as.vector(data$Race_Black)
x_race_N = as.vector(data$Race_NA)
```

```
x_race_A = as.vector(data$Race_Asian)
x_race_P = as.vector(data$Race_PI)
x_race_M = as.vector(data$Race_M)
N = length(y)
```

Same parameter values from slides:

```
the_data <- list("y" = y, "x_income" = x_income,
  "x_rural" = x_rural, "x_race_B" = x_race_B,
  "x_race_N" = x_race_N, "x_race_A" = x_race_A,
  "x_race_P" = x_race_P, "x_race_M" = x_race_M,
  "N" = N,
  "mu0" = 0, "g0" = 1, "mu1" = 0, "g1" = 1,
  "mu2" = 0, "g2" = 1, "mu3" = 0, "g3" = 1,
  "mu4" = 0, "g4" = 1, "mu5" = 0, "g5" = 1,
  "mu6" = 0, "g6" = 1, "mu7" = 0, "g7" = 1,
  "a" = 1, "b" = 1)
```

```
initsfunction <- function(chain){
  .RNG.seed <- c(1,2)[chain]
  .RNG.name <- c("base::Super-Duper",
    "base::Wichmann-Hill")[chain]
  return(list(.RNG.seed=.RNG.seed,
    .RNG.name=.RNG.name))
}
```

Thinning of 50 is needed, otherwise beta0 and beta1 have very high lag

```
posterior_MLR <- run.jags(modelString,
  n.chains = 1,
  data = the_data,
  monitor = c("beta0", "beta1", "beta2",
    "beta3", "beta4", "beta5",
    "beta6", "beta7", "sigma"),
  adapt = 1000,
  burnin = 5000,
  sample = 5000,
  thin = 50,
  inits = initsfunction)
```

```
## Loading required namespace: rjags
## Compiling rjags model...
## Calling the simulation using the rjags method...
## Note: the model did not require adaptation
## Burning in the model for 5000 iterations...
## Running the model for 250000 iterations...
## Simulation complete
## Calculating summary statistics...

## Warning: Convergence cannot be assessed with only 1 chain

## Finished running the simulation

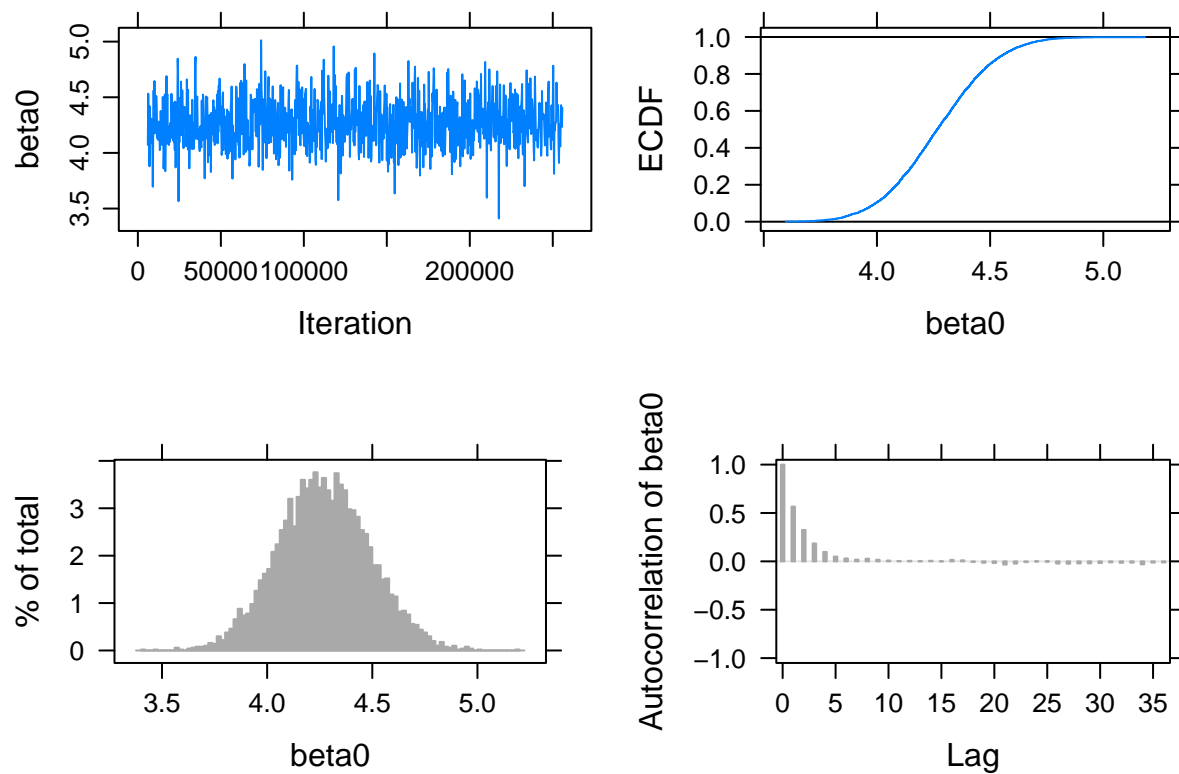
summary(posterior_MLR)
```

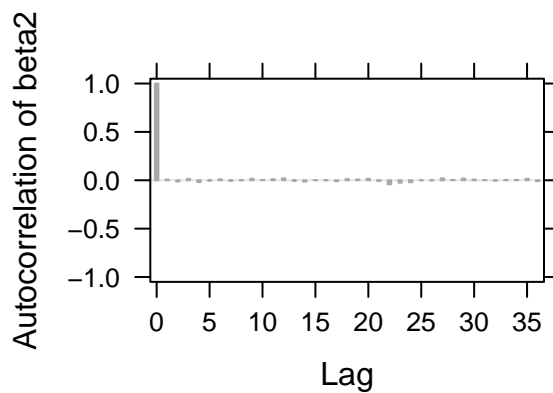
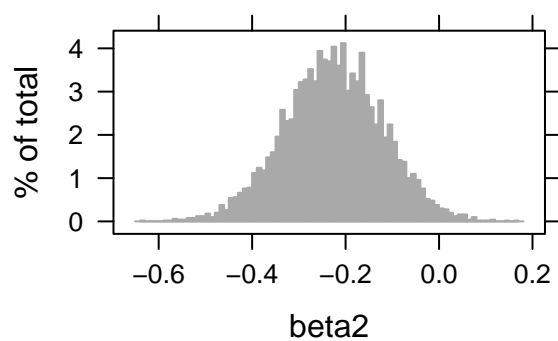
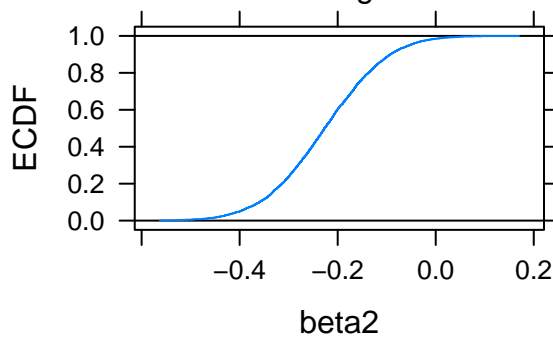
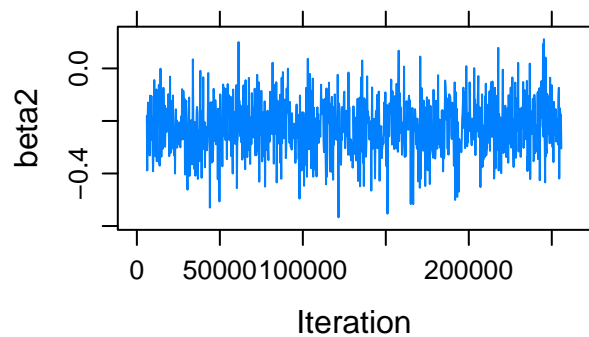
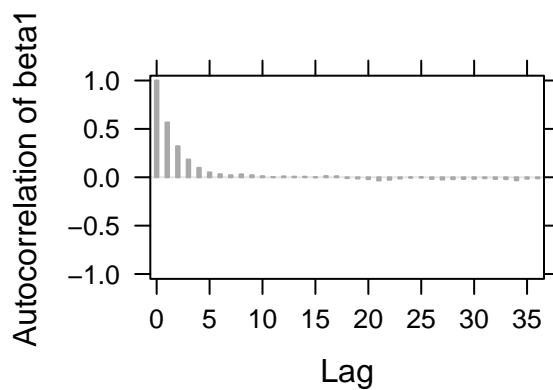
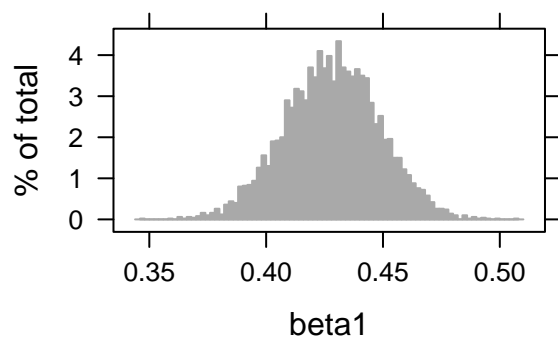
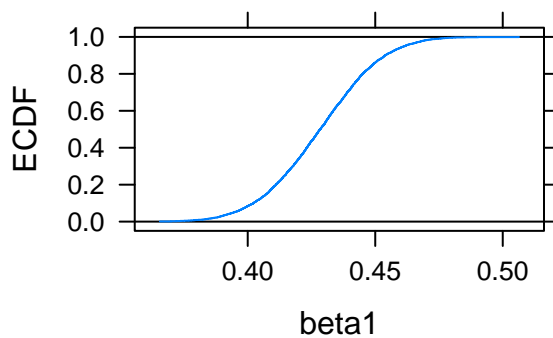
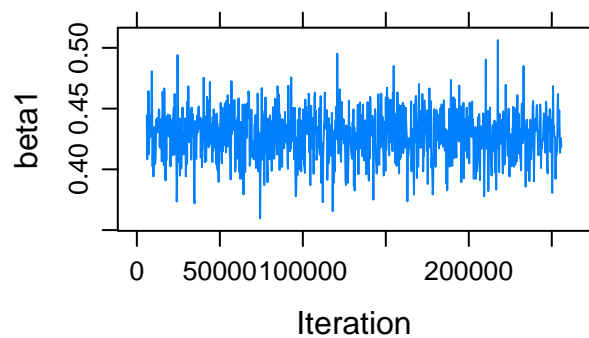
```
##           Lower95      Median    Upper95      Mean      SD Mode
## beta0  3.8401288  4.265856654  4.68625457  4.270064662  0.21777079  NA
```

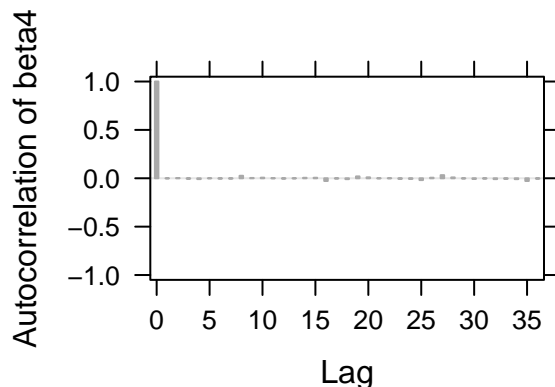
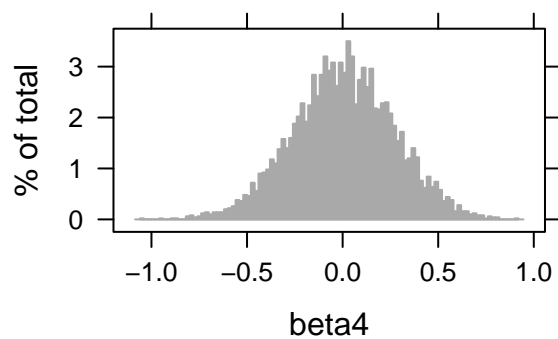
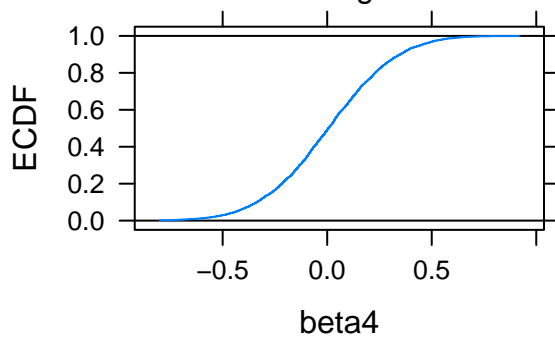
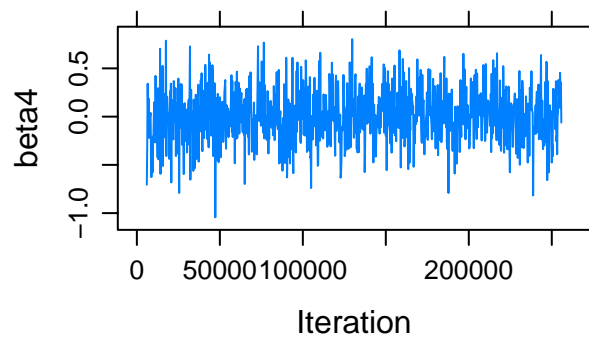
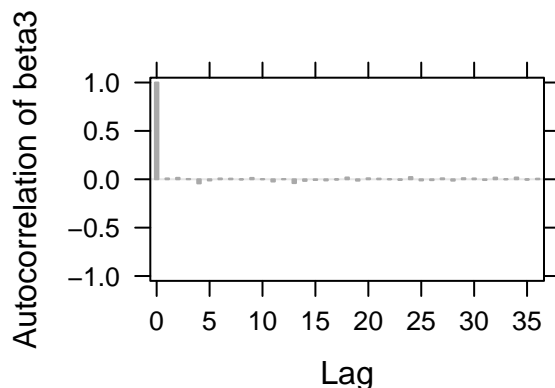
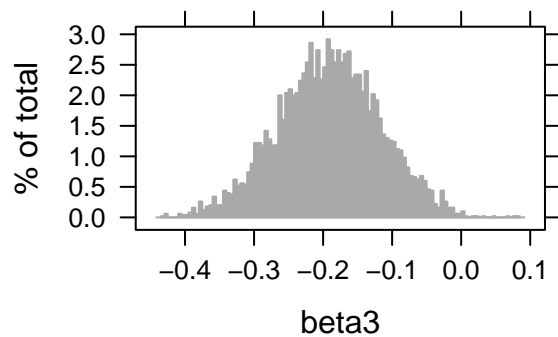
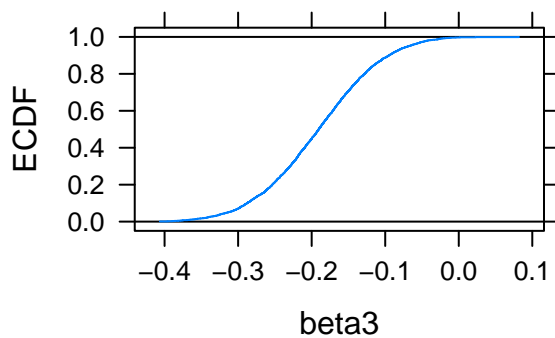
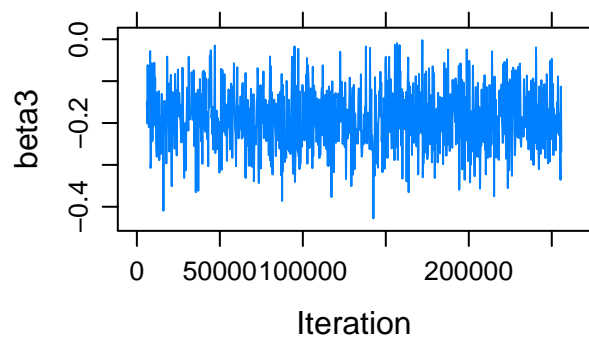
```
## beta1 0.3882419 0.428382748 0.46702186 0.428186927 0.02024773 NA
## beta2 -0.4324816 -0.227295748 -0.02303789 -0.226517253 0.10523080 NA
## beta3 -0.3306556 -0.190482478 -0.04140575 -0.191212993 0.07415444 NA
## beta4 -0.5206527 0.004840372 0.51719407 0.004623109 0.26616225 NA
## beta5 -0.0510838 0.162814921 0.40645797 0.162083182 0.11830143 NA
## beta6 -0.4595443 0.083013003 0.68580148 0.082703016 0.28996472 NA
## beta7 -0.2892273 0.040916578 0.39024470 0.042723529 0.17484430 NA
## sigma 0.6904107 0.721247329 0.75457051 0.721355983 0.01634697 NA
##          MCerr MC%ofSD SSeff      AC.500 psrf
## beta0 0.0058531144      2.7 1384 8.671215e-03 NA
## beta1 0.0005445194      2.7 1383 1.118156e-02 NA
## beta2 0.0014881883      1.4 5000 3.940920e-03 NA
## beta3 0.0010321668      1.4 5161 1.701377e-03 NA
## beta4 0.0037641027      1.4 5000 6.253260e-03 NA
## beta5 0.0017356791      1.5 4646 3.048365e-02 NA
## beta6 0.0041007204      1.4 5000 9.247818e-03 NA
## beta7 0.0024726717      1.4 5000 1.516543e-02 NA
## sigma 0.0002311811      1.4 5000 -1.238722e-05 NA
```

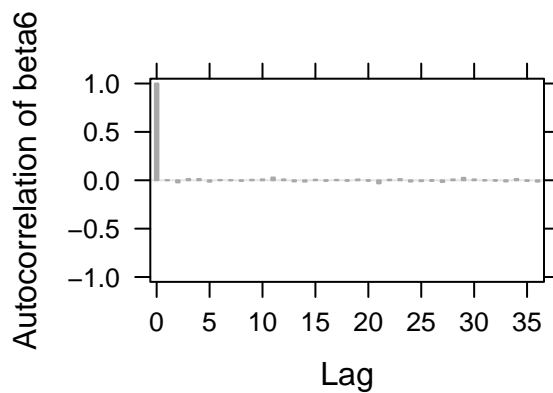
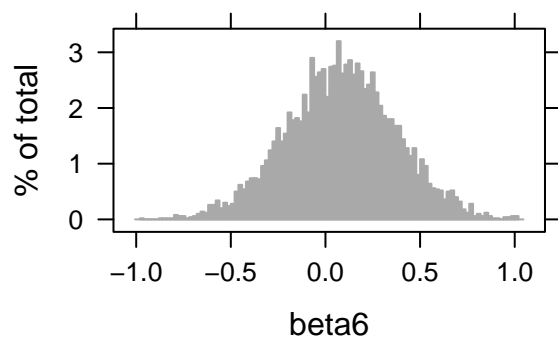
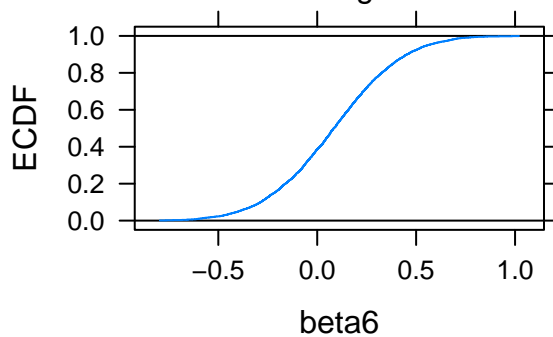
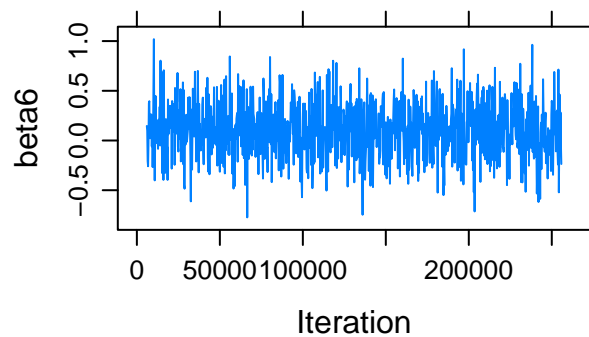
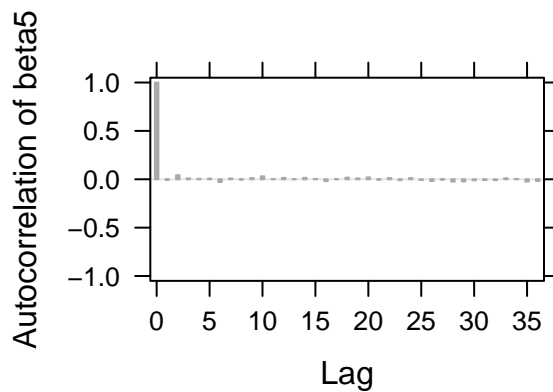
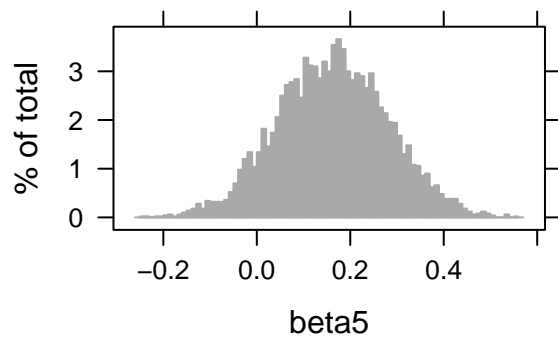
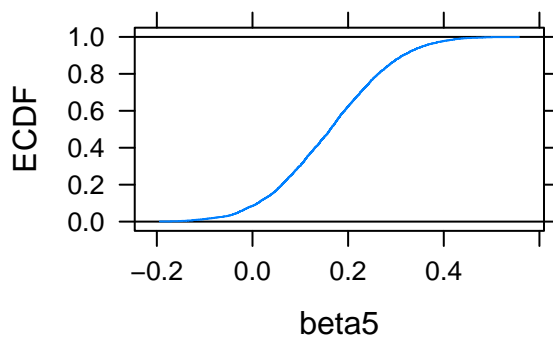
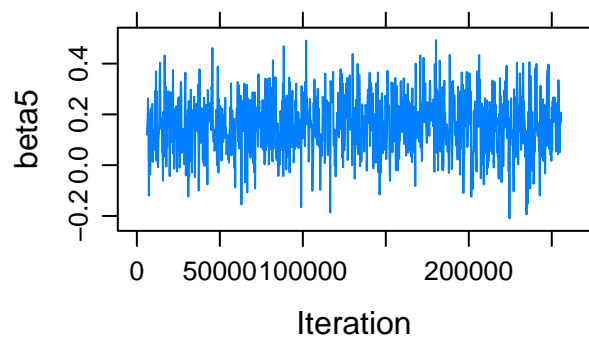
```
plot(posterior_MLR)
```

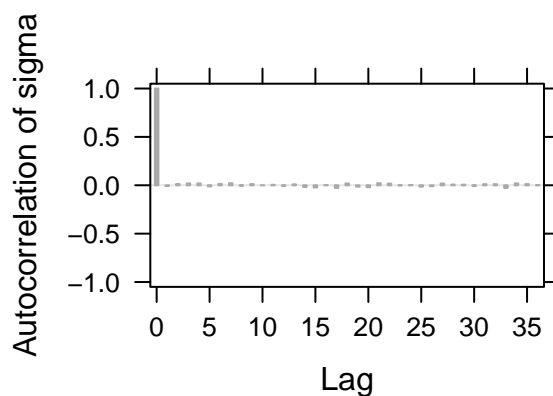
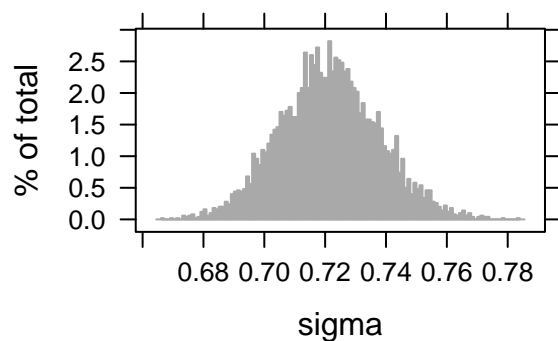
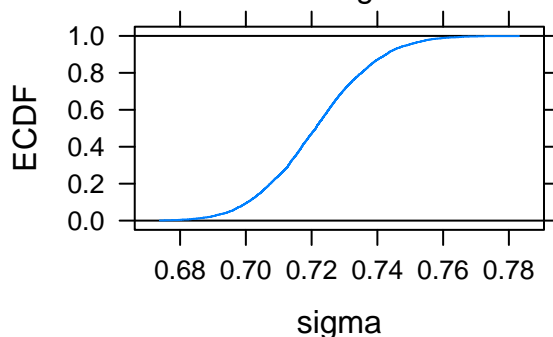
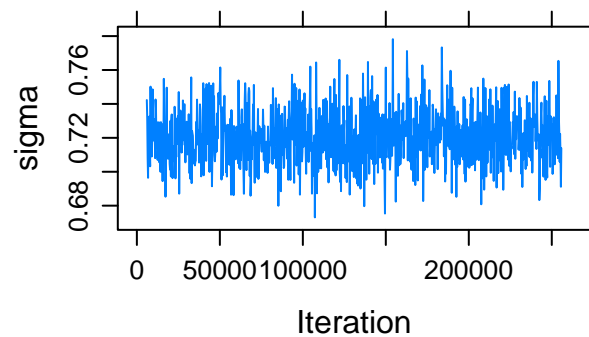
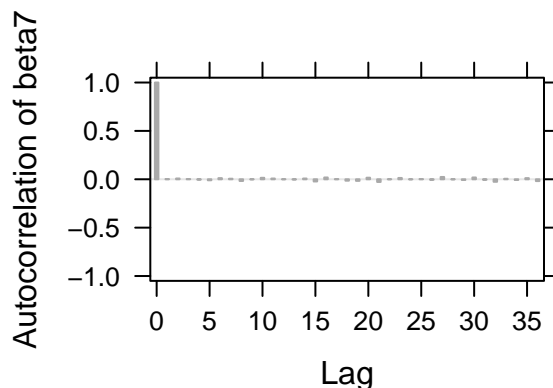
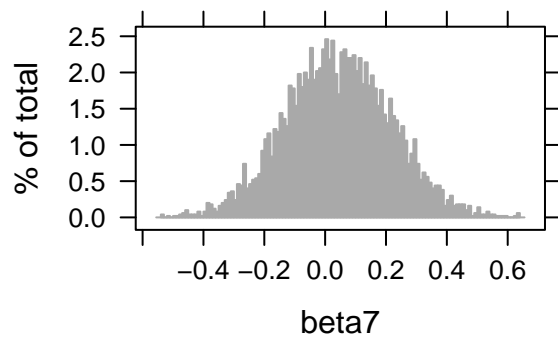
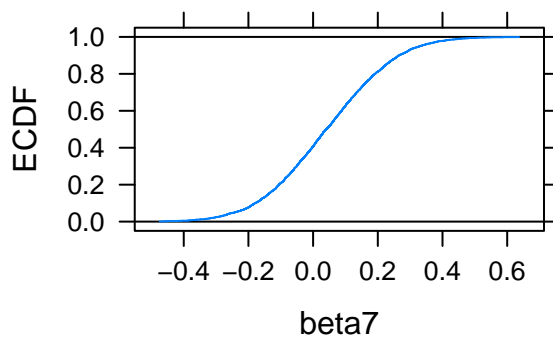
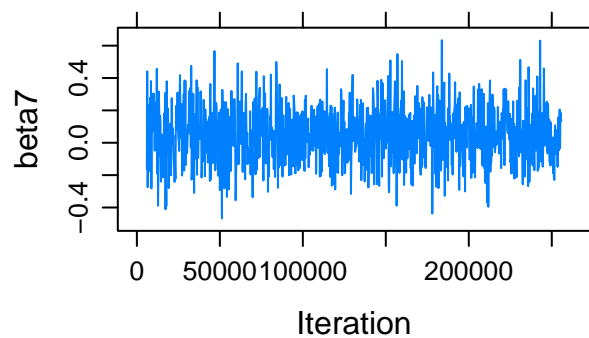
```
## Generating plots...
```

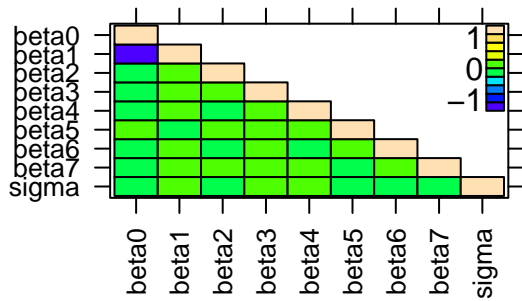












```
post <- as.mcmc(posterior_MLR)

synthesize <- function(X, index, n){
  mean_Y <- post[index, "beta0"] + X$x_income * post[index, "beta1"] + X$x_rural * post[index, "beta2"]
  synthetic_Y <- rnorm(n, mean_Y, post[index, "sigma"])
  data.frame(X$x_income, synthetic_Y)
}
```

Generating $m = 20$ synthetic values

```
n <- dim(data)[1]
m <- 20
synthetic_m <- vector("list", m)
params <- data.frame(x_income, x_rural, x_race_B, x_race_N, x_race_A, x_race_P, x_race_M)
for (l in 1:m){
  synthetic_one <- synthesize(params, 4980+l, n)
  names(synthetic_one) <- c("OriginalIncome", "logIncome_syn")
  synthetic_m[[l]] <- synthetic_one
}
```

Analysis-specific utility measures

```
orig_mean <- mean(synthetic_m[[1]]$OriginalIncome)
orig_median <- median(synthetic_m[[1]]$OriginalIncome)
orig_variance <- var(synthetic_m[[1]]$OriginalIncome)
print(lm(data$log_TotalExpSTD ~ synthetic_m[[1]]$OriginalIncome))

##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$OriginalIncome)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$OriginalIncome
##                4.3219                0.4211

mean <- c()
median <- c()
variance <- c()

print("=====")
```



```

## [1] "=====
for (l in 1:m) {
  mean[l] = mean(synthetic_m[[l]]$logIncome_syn)
  variance[l] = var(synthetic_m[[l]]$logIncome_syn)
  median[l] = median(synthetic_m[[l]]$logIncome_syn)
  print(lm(data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn))
}

##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[l]]$logIncome_syn
##                6.1045                0.3053
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[l]]$logIncome_syn
##                5.9850                0.3196
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[l]]$logIncome_syn
##                6.0556                0.3136
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[l]]$logIncome_syn
##                6.1434                0.2999
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[l]]$logIncome_syn
##                5.8778                0.3303
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[l]]$logIncome_syn)
##
## Coefficients:

```

```

##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               5.344                0.391
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               5.7524                0.3485
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               6.0107                0.3117
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               5.8549                0.3336
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               5.6238                0.3599
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               5.7581                0.3456
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##               (Intercept)  synthetic_m[[1]]$logIncome_syn
##               6.2073                0.2938
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)

```

```

##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   5.9798                      0.3191
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   5.6713                      0.3555
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   6.1038                      0.3045
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   5.7190                      0.3476
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   6.1490                      0.3007
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   5.7653                      0.3449
##
##
## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                   6.1325                      0.3032
##
##

```

```

## Call:
## lm(formula = data$log_TotalExpSTD ~ synthetic_m[[1]]$logIncome_syn)
##
## Coefficients:
##              (Intercept)  synthetic_m[[1]]$logIncome_syn
##                6.1097                0.3025

q_m <- sum(mean) / m
b_m <- sum((mean - q_m)^2 / (m-1))
u_m <- sum(variance) / m

L_s = q_m - (u_m^2) * 3
U_s = q_m + (u_m^2) * 3

L_o = orig_mean - (orig_variance^2) * 3
U_o = orig_mean + (orig_variance^2) * 3

L_i = max(L_s, L_o)
U_i = min(U_s, U_o)

I = ((U_i - L_i) / (2*(U_o - L_o))) + ((U_i - L_i) / (2*(U_s - L_s)))
print(I)

## [1] 0.6816442

```