setwd("C:/R files BHMRA")

library(jagsUI)

library(R2OpenBUGS)

library(MCMCvis)

library(rstan)

library(loo)

attach("DS\_7\_12.Rdata")

DS\_7\_12$T1=DS\_7\_12$T-1

#

# Fixed Coefficient Regression

#

cat("model { for (t in 1:T) {y[t] ~ dpois(mu[t])

LL[t] <- -mu[t]+y[t]\*log(mu[t])-logfact(y[t])

Dv[t] <- y[t]\*log(y[t]/mu[t])-(y[t]-mu[t])

G[t] <- 1/exp(LL[t])

log(mu[t]) <- alpha + beta[1]\*(x1[t]-mean(x1[]))/sd(x1[])+

beta[2]\*(x2[t]-mean(x2[]))/sd(x2[])+beta[3]\*(x3[t]-mean(x3[]))/sd(x3[])}

**# predictive checks (note: step is gt or equals)**

for (t in 1:T1) {ystar[t+1] ~ dpois(mu[t]);

predch[t] <- step(ystar[t+1]-y[t+1])-0.5\*equals(y[t+1],ystar[t+1])}

Fit[1] <- -2\*sum(LL[])

Fit[2] <- 2\*sum(Dv[])

alpha ~ dnorm(0,0.001)

for (j in 1:3) {beta[j] ~ dnorm(0,0.001)}}

", file="model1.jag")

**# Estimation**

params= c("Fit","beta","alpha","G","LL","predch")

init1 = list(alpha=0,beta=c(0,0,0)); init2 = list(alpha=2,beta=c(0,0,0))

inits = list(init1,init2)

R =autojags(DS\_7\_12, inits, params,model.file="model1.jag",2,iter.increment=2000, n.burnin=250,Rhat.limit=1.1, max.iter=20000, seed=1234, codaOnly= c('G', 'LL', 'predch'))

R$summary

**# Fit**

loo(as.matrix(R$sims.list$LL))

G.mn=apply(as.matrix(R$sims.list$G),2,mean)

CPO <- -log(G.mn)

**# LPML**

sum(CPO)

**# predictive checks**

predch.mn=apply(as.matrix(R$sims.list$predch),2,mean)

sum(predch.mn<0.05)

sum(predch.mn>0.95)

**#**

**# Random coefficients**

**#**

attach(DS\_7\_12)

D=list(n=T,y=y,x1=(x1-mean(x1))/sd(x1),x2=(x2-mean(x2))/sd(x2),x3=(x3-mean(x3))/sd(x3))

regtime.stan <- "

data { int<lower=1> n;

int y[n];

vector[n] x1;

vector[n] x2;

vector[n] x3;

}

parameters { vector[n] beta1;

vector[n] beta2;

vector[n] beta3;

vector[n] alpha;

real<lower=0> sigma[4];

}

transformed parameters { vector[n] mu;

for (t in 1:n) {mu[t] = exp(alpha[t]+beta1[t]\*x1[t]+beta2[t]\*x2[t]+beta3[t]\*x3[t]);}

}

model { beta1[1] ~ normal(0, 2);

beta2[1] ~ normal(0, 2);

beta3[1] ~ normal(0, 2);

alpha[1] ~ normal(0, 2);

sigma ~ uniform(0,5);

for (t in 2:n) {beta1[t] ~ normal(beta1[t-1], sigma[1]);

beta2[t] ~ normal(beta2[t-1], sigma[2]);

beta3[t] ~ normal(beta3[t-1], sigma[3]);

alpha[t] ~ normal(alpha[t-1], sigma[4]);}

for (t in 1:n) { y[t] ~ poisson(mu[t]); }

}

generated quantities {

vector[n] log\_lik;

vector[n] ystar;

for (t in 1:n ) { log\_lik[t] = poisson\_lpmf(y[t] |mu[t]);

ystar[t] = poisson\_rng(mu[t]); }

}

"

**# Initial Values and Estimation**

sm <- stan\_model(model\_code=regtime.stan)

fit <- sampling(sm,data =D, iter = 1500,warmup=250,chains = 2,seed= 12345)

summary(fit, pars = c("beta1","beta2","beta3","alpha"), probs = c(0.025,0.05, 0.95, 0.975))$summary

**# Fit, Predictive Checks**

pred.samps= as.matrix(fit,pars="ystar")

pred.samps=pred.samps[1:2500,1:1246]

y1=D$y[2:1247]

check=matrix(,2500,1246)

for (t in 1:2500) {check[t,]= ifelse(pred.samps[t,]>y1[],1,0)+ifelse(pred.samps[t,]==y1[],0.5,0)}

predexceed=apply(check,2,mean)

sum((predexceed>0.95)+(predexceed<0.05))

**# LOO-IC and LPML**

LL.samps= as.matrix(fit,pars="log\_lik")

loo(LL.samps)

L.samps=exp(LL.samps)

G.samps=1/L.samps

G.mn=apply(G.samps,2,mean)

CPO <- -log(G.mn)

# LPML

sum(CPO)

**# Coefficient Plots**

alpha.mn= apply(as.matrix(fit,pars="alpha"),2,mean)

plot(alpha.mn)

beta1.mn= apply(as.matrix(fit,pars="beta1"),2,mean)

plot(beta1.mn)

beta2.samps <- as.matrix(fit,pars="beta2")

A1=apply(beta2.samps,2,quantile,0.10)

A2=apply(beta2.samps,2,mean)

A3=apply(beta2.samps,2,quantile,0.90)

plot(A2, type="o", col="black", pch="o", lty=1, ylim=c(min(A1),max(A3)), main="Figure 7.3 Varying Beta Coefficients, beta2",

ylab=expression(paste("Posterior Mean and 80% CRI, ",beta[2])),xlab="Day")

points(A1, col="gray40", pch="\*")

lines(A1, col="gray40",lty=2)

points(A3, col="gray20",pch="+")

lines(A3, col="gray20", lty=3)

beta3.samps <- as.matrix(fit,pars="beta3")

A1=apply(beta3.samps,2,quantile,0.10)

A2=apply(beta3.samps,2,mean)

A3=apply(beta3.samps,2,quantile,0.90)

plot(A2, type="o", col="black", pch="o", lty=1, ylim=c(min(A1),max(A3)),

main="Figure 7.4 Varying Beta Coefficients, beta3",

ylab=expression(paste("Posterior Mean and 80% CRI, ",beta[3])),xlab="Day")

points(A1, col="gray40", pch="\*")

lines(A1, col="gray40",lty=2)

points(A3, col="gray20",pch="+")

lines(A3, col="gray20", lty=3)