Fit Test Try 2

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$$Y_i = \alpha_{j[i]} + \sum \beta_p X_{pi} + \epsilon_i, forhospitals(i = 1toN)$$

$$\alpha_j = a + \sum b_k W_{kj} + u_j, formarkets(j = 1toJ)$$

```
### load required packages
library(lme4)
```

```
## Loading required package: Matrix
```

```
library(tidyverse)
```

```
## Loading tidyverse: ggplot2
## Loading tidyverse: tibble
## Loading tidyverse: tidyr
## Loading tidyverse: readr
## Loading tidyverse: purrr
## Loading tidyverse: dplyr
```

```
## Conflicts with tidy packages ----------------------------------------------
```

```
## expand(): tidyr, Matrix
## filter(): dplyr, stats
## lag():    dplyr, stats
```

```
### rstan requires having rtools installed
library(rstan)
```

```
## Warning: package 'rstan' was built under R version 3.4.3
```

```
## Loading required package: StanHeaders
```

```
## Warning: package 'StanHeaders' was built under R version 3.4.3
```

```
## rstan (Version 2.16.2, packaged: 2017-07-03 09:24:58 UTC, GitRev: 2e1f913d3ca3)
```

```
## For execution on a local, multicore CPU with excess RAM we recommend calling
## rstan_options(auto_write = TRUE)
## options(mc.cores = parallel::detectCores())
```

```
##
## Attaching package: 'rstan'
```

```
## The following object is masked from 'package:tidyr':
##
##     extract
```

```
###read in data
k12ReducedRG = read_csv("k12ReducedRG.csv")
```

```
## Parsed with column specification:
## cols(
##   .default = col_double(),
##   episode = col_integer(),
##   Provider = col_character(),
##   hrr = col_character(),
##   avgagehrr = col_integer(),
##   `Rank for Variable dshpct` = col_integer(),
##   `Rank for Variable cmi` = col_integer(),
##   `Rank for Variable mdadjadmit` = col_integer(),
##   qstarrating = col_integer(),
##   urbanlocation = col_integer(),
##   joinnetwork = col_integer(),
##   jchaoaccredited = col_integer(),
##   qieffort = col_integer(),
##   reform = col_integer(),
##   mdaffiliation = col_integer(),
##   ownershipstatus = col_integer(),
##   hospitalbedsize = col_integer()
## )
```

```
## See spec(...) for full column specifications.
```

Remove missing data for Stan:

```
###remove missing data colums
k12ReducedRG = k12ReducedRG %>%
  select(-reform, -joinnetwork)

###change data to only complete cases
k12ReducedRG = k12ReducedRG[complete.cases(k12ReducedRG),]

dim(k12ReducedRG)
```

```
## [1] 2920   28
```

Get m1 data ready for stan:

```
model1data = list(episode = k12ReducedRG$episode,
                  hrr = as.integer(as.factor(k12ReducedRG$hrr)),
                  K = length(unique(k12ReducedRG$hrr)),
                  N = nrow(k12ReducedRG))
```

```
model1stan = stan("model1.stan", data = model1data,  chains = 4, iter = 2000)
```

```
## Warning: There were 13 transitions after warmup that exceeded the maximum treedepth. Increase max_tr
## http://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded
```

```
## Warning: There were 2 chains where the estimated Bayesian Fraction of Missing Information was low. S
## http://mc-stan.org/misc/warnings.html#bfmi-low
```

```
## Warning: Examine the pairs() plot to diagnose sampling problems
```

Compare max and min from stan simulations to observed data:

```
###Extract Maxes
model1maxes = extract(model1stan, pars = c("maximum"))

###Extract Mins
model1mins = extract(model1stan, pars = c("minimum"))

###Mean Max
mean(model1maxes$maximum)
```

```
## [1] 29936.65
```

```
summary(model1maxes$maximum)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   27605   29215   29817   29937   30510   35555
```

```
###Mean Min
mean(model1mins$minimum)
```

```
## [1] 8322.247
```

```
summary(model1mins$minimum)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1355    7763    8460    8322    9042   10711
```

```
###Compare observed
summary(k12ReducedRG$episode)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    7119   17126   19269   19076   21028   41469
```

Get m2 data ready for stan:

```
###rename columns
k12ReducedRG = k12ReducedRG %>%
  rename(cmirank = "Rank for Variable cmi",
         dshpctrank = "Rank for Variable dshpct",
         mdadjadmitrank = "Rank for Variable mdadjadmit")
```

```
### prepare data for STAN
model2data = list(episode = k12ReducedRG$episode,
                  hrr = as.integer(as.factor(k12ReducedRG$hrr)),
                  qstar = k12ReducedRG$qstarrating,
                  qieffort = k12ReducedRG$qieffort,
                  accredited = k12ReducedRG$jchaoaccredited,
                  urban = k12ReducedRG$urbanlocation,
                  mdaffiliation = k12ReducedRG$mdaffiliation,
                  ownership = k12ReducedRG$ownershipstatus,
                  bedsize = k12ReducedRG$hospitalbedsize,
                  cmi = k12ReducedRG$cmirank,
                  dsh = k12ReducedRG$dshpctrank,
                  mdadjadmitrank = k12ReducedRG$mdadjadmitrank,
                  K = length(unique(k12ReducedRG$hrr)),
                  id = as.integer(as.factor(k12ReducedRG$Provider)),
                  N = nrow(k12ReducedRG))
```

```
###run stan simulation

model2stan = stan("model2.stan", data = model2data, chains = 2, iter=600)
```

```
## In file included from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/config.hpp:39:0,
##                  from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/math/tools/config.
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/c
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/c
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/c
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/m
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math.hpp:4
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/src/stan/model/
##                  from file308042cb8c5.cpp:8:
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/config/compiler/gcc.hpp:186:0: warning:
##  #  define BOOST_NO_CXX11_RVALUE_REFERENCES
##  ^
## <command-line>:0:0: note: this is the location of the previous definition
## In file included from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/base.h
##                  from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array.hpp:21
##                  from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/numeric/odeint/uti
##                  from C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/numeric/odeint.hpp
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/prim/
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/prim/
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/prim/
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/m
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math.hpp:4
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/src/stan/model/
##                  from file308042cb8c5.cpp:8:
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp: In stati
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp:42:43: wa
##        typedef typename Array::index_range index_range;
##                                            ^
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp:43:37: wa
##        typedef typename Array::index index;
##                                      ^
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp: In stati
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp:53:43: wa
##        typedef typename Array::index_range index_range;
##                                            ^
## C:/Users/blain/Documents/R/win-library/3.4/BH/include/boost/multi_array/concept_checks.hpp:54:37: wa
##        typedef typename Array::index index;
##                                      ^
## In file included from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/c
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/m
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math.hpp:4
##                  from C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/src/stan/model/
##                  from file308042cb8c5.cpp:8:
## C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/core/set_zero_all_adjoi
## C:/Users/blain/Documents/R/win-library/3.4/StanHeaders/include/stan/math/rev/core/set_zero_all_adjoi
##      static void set_zero_all_adjoints() {
```

```
##                   ^
##
## SAMPLING FOR MODEL 'model2' NOW (CHAIN 1).
##
## Gradient evaluation took 0.002 seconds
## 1000 transitions using 10 leapfrog steps per transition would take 20 seconds.
## Adjust your expectations accordingly!
##
##
## Iteration:   1 / 600 [  0%]  (Warmup)
## Iteration:  60 / 600 [ 10%]  (Warmup)
## Iteration: 120 / 600 [ 20%]  (Warmup)
## Iteration: 180 / 600 [ 30%]  (Warmup)
## Iteration: 240 / 600 [ 40%]  (Warmup)
## Iteration: 300 / 600 [ 50%]  (Warmup)
## Iteration: 301 / 600 [ 50%]  (Sampling)
## Iteration: 360 / 600 [ 60%]  (Sampling)
## Iteration: 420 / 600 [ 70%]  (Sampling)
## Iteration: 480 / 600 [ 80%]  (Sampling)
## Iteration: 540 / 600 [ 90%]  (Sampling)
## Iteration: 600 / 600 [100%]  (Sampling)
##
##  Elapsed Time: 160.592 seconds (Warm-up)
##                275.245 seconds (Sampling)
##                435.837 seconds (Total)
##
##
## SAMPLING FOR MODEL 'model2' NOW (CHAIN 2).
##
## Gradient evaluation took 0 seconds
## 1000 transitions using 10 leapfrog steps per transition would take 0 seconds.
## Adjust your expectations accordingly!
##
##
## Iteration:   1 / 600 [  0%]  (Warmup)
## Iteration:  60 / 600 [ 10%]  (Warmup)
## Iteration: 120 / 600 [ 20%]  (Warmup)
## Iteration: 180 / 600 [ 30%]  (Warmup)
## Iteration: 240 / 600 [ 40%]  (Warmup)
## Iteration: 300 / 600 [ 50%]  (Warmup)
## Iteration: 301 / 600 [ 50%]  (Sampling)
## Iteration: 360 / 600 [ 60%]  (Sampling)
## Iteration: 420 / 600 [ 70%]  (Sampling)
## Iteration: 480 / 600 [ 80%]  (Sampling)
## Iteration: 540 / 600 [ 90%]  (Sampling)
## Iteration: 600 / 600 [100%]  (Sampling)
##
##  Elapsed Time: 164.989 seconds (Warm-up)
##                272.795 seconds (Sampling)
##                437.784 seconds (Total)
```

```
## Warning: There were 600 transitions after warmup that exceeded the maximum treedepth. Increase max_t
## http://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded
```

```
## Warning: Examine the pairs() plot to diagnose sampling problems
```

Compare simulation max and mean to observed

```
###Extract maxes
model2maxes = extract(model2stan, pars = c("maximum"))

###Extract mins
model2mins = extract(model2stan, pars = c("minimum"))

###Mean max
mean(model2maxes$maximum)
```

```
## [1] 17549.68
```

```
summary(model2maxes$maximum)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   11120   14255   16725   17550   21065   26605
```

```
###Mean min
mean(model2mins$minimum)
```

```
## [1] -4097.518
```

```
summary(model2mins$minimum)
```

```
##     Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## -11744.9   -7222.8   -5036.7   -4097.5    -772.8    4218.3
```

```
###Compare observed
summary(k12ReducedRG$episode)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    7119   17126   19269   19076   21028   41469
```