

# NMAnalysis

## Overview

The R package `NMAnalysis` provides the LDL-C network meta-data and the function for the Bayesian inference for the network meta-regression.

## Reference:

Li, H., Chen, M.-H., Ibrahim, J. G., Kim, S., Shah, A. K., Lin, J., Tershakovec, A. M. (2018). *Bayesian Inference for Network Meta-Regression Using Multivariate Random Effects with Applications to Cholesterol Lowering Drugs*.

## Install packages and check working environment

```
# install.packages("~/NMAnalysis_0.1.0.tar.gz", repos = NULL, type = "source")
## attach the package NMAnalysis
library(NMAnalysis)

## R session and environment information
sessionInfo()

## R version 3.3.0 (2016-05-03)
## Platform: x86_64-apple-darwin13.4.0 (64-bit)
## Running under: OS X 10.12.6 (unknown)
##
## locale:
##  [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
##  [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
##  [1] NMAnalysis_0.1.0
##
## loaded via a namespace (and not attached):
##  [1] backports_1.1.1 magrittr_1.5   rprojroot_1.2 tools_3.3.0
##  [5] htmltools_0.3.6 yaml_2.1.14   Rcpp_0.12.14  stringi_1.1.5
##  [9] rmarkdown_1.8   knitr_1.17    stringr_1.2.0 digest_0.6.12
## [13] evaluate_0.10.1
```

## The LDL-C network meta-data

### *NMAdata*

```
data("NMAdata")
head(NMAdata)
```

```
##   V1 V2 V3   V4   V5   V6 V7   V8   V9  V10  V11  V12  V13
## 1  1  0 92   2.7 13.30 174.00 50.0 162.00 56.62 0.806 0.409 28.11 0.00
## 2  1  1 345 -38.5 14.20 175.00 49.0 167.00 55.10 0.794 0.493 28.18 0.52
## 3  1  6 89 -19.8 10.50 176.00 51.0 163.00 56.90 0.772 0.380 28.51 0.00
## 4  1  7 353 -53.2 17.20 175.00 51.0 169.00 56.80 0.833 0.479 28.11 0.00
## 5  2  0 65  -0.6 12.09 177.88 50.2 159.42 53.40 0.800 0.477 28.29 0.00
## 6  2  5 205 -25.2 12.89 177.88 50.2 177.14 55.10 0.849 0.493 29.65 0.34
##   V14 V15
## 1 0.00 12
## 2 0.25 12
## 3 0.00 12
## 4 1.00 12
## 5 0.00 12
## 6 0.00 12
```

```
str(NMAdata)
```

```
## 'data.frame':   73 obs. of  15 variables:
## $ V1 : int  1 1 1 1 2 2 2 2 3 3 ...
## $ V2 : int  0 1 6 7 0 5 6 10 0 1 ...
## $ V3 : int  92 345 89 353 65 205 64 204 69 263 ...
## $ V4 : num  2.7 -38.5 -19.8 -53.2 -0.6 -25.2 -19.6 -38.6 -1.5 -36.5 ...
## $ V5 : num  13.3 14.2 10.5 17.2 12.1 ...
## $ V6 : num  174 175 176 175 178 ...
## $ V7 : num  50 49 51 51 50.2 50.2 50.2 50.2 52.3 51 ...
## $ V8 : num  162 167 163 169 159 ...
## $ V9 : num  56.6 55.1 56.9 56.8 53.4 ...
## $ V10: num  0.806 0.794 0.772 0.833 0.8 0.849 0.938 0.863 0.957 0.901 ...
## $ V11: num  0.409 0.493 0.38 0.479 0.477 0.493 0.359 0.407 0.443 0.418 ...
## $ V12: num  28.1 28.2 28.5 28.1 28.3 ...
## $ V13: num  0 0.52 0 0 0 0.34 0 1 0 0.48 ...
## $ V14: num  0 0.25 0 1 0 0 0 0 0 0.25 ...
## $ V15: int  12 12 12 12 12 12 12 12 12 12 ...
```

```
ID_study <- NMAdata[, 1]
ID_arm = NMAdata[, 2]
No_of_patients = NMAdata[, 3]
Mean_percent_change_from_baseline = NMAdata[, 4]
SD_percent_change_from_baseline = NMAdata[, 5]
Covariate_matrix = NMAdata[, 6:15]
```

## The function calling the FORTRAN code

### *NMAdmodel* usage and parameters

- Inputs:
  - ID\_model model ID, an interger input ranging from 1 to 8, which corresponds to the Models 1-8 listed in Table 1 of Li et al. (2018).
  - Nrep MCMC sample size. The default value is 100.
  - Nthinning thinning size. The default value is 1.
  - Nwarmup warm-up size. The default value is 10.
  - Iseed random seed for the FORTRAN random number generator. The default value is 1234567.
  - alpha desired HPD credible level. The default value is 0.05.

- `ID_study` a vector of length  $N$  for study IDs ( $N$  is the number of observations). The default value is `NMAdata[, 1]`.
- `ID_arm` a vector of length  $N$  for arm IDs. The default value is `NMAdata[, 2]`.
- `Npt` a vector of length  $N$  for the number of patients. The default value is `NMAdata[, 3]`.
- `Y` a vector of length  $N$  for the response variable (aggregate mean). The default value is `NMAdata[,4]`.
- `SD` a vector of length  $N$  for the standard deviation. The default value is `NMAdata[, 5]`.
- `X` design matrix,  $N$  by  $N_x$  ( $N_x$  is the number of covariates). The default value is `NMAdata[, 6:15]`.
- Outputs:
  - `DIC` a vector with values (“DIC”, “pD”, “barDIC”, “DICbar”, “LPML”)
  - `Beta_Posterior` a matrix of  $N_x$  by 4 giving the posterior estimates of beta
  - `Gamma_Posterior` a matrix of  $NT$  by 4 giving the posterior estimates of gamma ( $NT$  is the number of treatments)
  - `Tau2_Posterior` a matrix of  $NT$  by 4 giving the posterior estimates of tau2
  - `Rho_MEAN` a matrix of  $NT$  by  $NT$  giving the posterior mean of rho
  - `Rho_SD` a matrix of  $NT$  by  $NT$  giving the posterior standard deviation of rho
  - `Rho_HPD_Low` a matrix of  $NT$  by  $NT$  giving the lower bound of the HPD interval for rho
  - `Rho_HPD_Upp` a matrix of  $NT$  by  $NT$  giving the upper bound of the HPD interval for rho
- Note: The priors are specified in Section 4.1 of Li et al. (2018).

#### Example 1:

```
## Fit network meta-regression for Model 1, with default values for
## number of iterations, thinning sizes and warm-up sizes,
## and default initial seed
NMAModel(ID_model = 1L)

## $Size_of_Simulation
## [1] 100
##
## $Size_of_Thinning
## [1] 1
##
## $Size_of_Warmup
## [1] 10
##
## $ID_group
## [1] 1 1 1 1 1 1 1 1 1 1 1
##
## $DIC
## [1] 383.4532
##
## $pD
## [1] 19.71953
##
## $barDIC
## [1] 363.7336
##
## $DICbar
## [1] 344.0141
##
## $LPML
## [1] -163.6983
##
```

```

## $Beta_Posterior
##           MEAN           SD    HPD Lower    HPD Upper
## 1  -0.4354739  0.6313977  -1.5000305   0.81005612
## 2  -1.6662542  0.8540772  -3.0495861   0.03431984
## 3   0.5956887  0.8053813  -0.9072236   2.09423259
## 4  -0.6132343  0.6890904  -1.8259401   0.74585145
## 5  -1.1433188  0.5499485  -2.1005894  -0.08070893
## 6  -1.2550408  0.9338099  -2.9621119   0.29253488
## 7   0.2611053  0.7202621  -0.9276355   1.85258044
## 8   1.9799229  4.6276180  -8.0387573   9.34765888
## 9  -2.3769588  5.0047103 -11.1610735   8.10232693
## 10  0.7576191  0.7310144  -0.6464279   1.97978967
##
## $Gamma_Posterior
##           MEAN           SD    HPD Lower    HPD Upper
## 1  -0.01886022  8.317222 -14.24701   17.5562580
## 2  -39.43346611  1.841132 -42.20517  -35.3400147
## 3  -43.64123674  2.623668 -48.97036  -38.8305995
## 4  -28.70054814  5.443033 -38.61690  -17.7021200
## 5  -42.52493950  2.603627 -47.18329  -36.6620637
## 6  -28.27282721  5.575675 -38.43886  -18.5136760
## 7  -20.18531115  7.950291 -34.31781  -0.5530342
## 8  -47.83607418  2.756243 -53.56977  -42.9354127
## 9  -52.09346340  4.106668 -60.90566  -45.0394659
## 10 -45.54895731  4.351969 -56.19168  -37.9947914
## 11 -45.00434973  4.426966 -54.18307  -36.4943785
##
## $Tau2_Posterior
##           MEAN           SD    HPD Lower    HPD Upper
## 1   8.63213  1.93508   5.22041   12.23543
## 2   8.63213  1.93508   5.22041   12.23543
## 3   8.63213  1.93508   5.22041   12.23543
## 4   8.63213  1.93508   5.22041   12.23543
## 5   8.63213  1.93508   5.22041   12.23543
## 6   8.63213  1.93508   5.22041   12.23543
## 7   8.63213  1.93508   5.22041   12.23543
## 8   8.63213  1.93508   5.22041   12.23543
## 9   8.63213  1.93508   5.22041   12.23543
## 10  8.63213  1.93508   5.22041   12.23543
## 11  8.63213  1.93508   5.22041   12.23543
##
## $Rho_MEAN
##           [,1]           [,2]           [,3]           [,4]           [,5]
## [1,]  1.000000000  0.018190937 -0.0047884671 -0.04535317  0.023524163
## [2,]  0.018190937  1.000000000  0.0742543843  0.04940310  0.015305227
## [3,] -0.004788467  0.074254384  1.0000000000 -0.01146593  0.209362492
## [4,] -0.045353170  0.049403097 -0.0114659346  1.000000000 -0.013378444
## [5,]  0.023524163  0.015305227  0.2093624919 -0.01337844  1.000000000
## [6,]  0.005079557 -0.035302925  0.0698405596 -0.01678369  0.036670016
## [7,] -0.027830117  0.052492869 -0.0000092803 -0.04189076 -0.005676310
## [8,] -0.011600349 -0.041588105  0.3067811333 -0.05884149  0.148110805
## [9,]  0.009513435 -0.004922844  0.0415697029 -0.00784263  0.035005484
## [10,] 0.009658946 -0.009199462  0.0722711983 -0.01033378 -0.020554412
## [11,] 0.036657064 -0.056582042 -0.0786272700  0.05283110 -0.009394697

```

```

##           [,6]           [,7]           [,8]           [,9]           [,10]
## [1,]  0.005079557 -0.0278301174 -0.011600349  0.009513435  0.009658946
## [2,] -0.035302925  0.0524928693 -0.041588105 -0.004922844 -0.009199462
## [3,]  0.069840560 -0.0000092803  0.306781133  0.041569703  0.072271198
## [4,] -0.016783691 -0.0418907600 -0.058841487 -0.007842630 -0.010333776
## [5,]  0.036670016 -0.0056763096  0.148110805  0.035005484 -0.020554412
## [6,]  1.000000000 -0.0386350544  0.029556575  0.064619301  0.041500400
## [7,] -0.038635054  1.0000000000  0.038434773  0.026316550 -0.023214475
## [8,]  0.029556575  0.0384347731  1.000000000 -0.009235956  0.013407822
## [9,]  0.064619301  0.0263165501 -0.009235956  1.000000000  0.025371101
## [10,] 0.041500400 -0.0232144746  0.013407822  0.025371101  1.000000000
## [11,] 0.043950653  0.0044300031 -0.020418110  0.050610196  0.028396708
##           [,11]
## [1,]  0.036657064
## [2,] -0.056582042
## [3,] -0.078627270
## [4,]  0.052831103
## [5,] -0.009394697
## [6,]  0.043950653
## [7,]  0.004430003
## [8,] -0.020418110
## [9,]  0.050610196
## [10,] 0.028396708
## [11,] 1.000000000
##
## $Rho_SD
##           [,1]           [,2]           [,3]           [,4]           [,5]           [,6]
## [1,]  0.0000000  0.3115072  0.3089941  0.2845551  0.3378842  0.3039492
## [2,]  0.3115072  0.0000000  0.2490177  0.3025878  0.2952181  0.2675500
## [3,]  0.3089941  0.2490177  0.0000000  0.2876466  0.2346558  0.2883998
## [4,]  0.2845551  0.3025878  0.2876466  0.0000000  0.3120952  0.2772470
## [5,]  0.3378842  0.2952181  0.2346558  0.3120952  0.0000000  0.2773110
## [6,]  0.3039492  0.2675500  0.2883998  0.2772470  0.2773110  0.0000000
## [7,]  0.2805648  0.2900306  0.3209575  0.2901806  0.3006610  0.2850849
## [8,]  0.3051430  0.2789881  0.2412673  0.3089748  0.2521936  0.2947734
## [9,]  0.3066170  0.2793752  0.3094885  0.3004417  0.2940252  0.2883340
## [10,] 0.2918393  0.3229605  0.2803835  0.2691000  0.2902011  0.2960548
## [11,] 0.2796669  0.2316870  0.2708938  0.3114871  0.2828316  0.2670826
##           [,7]           [,8]           [,9]           [,10]           [,11]
## [1,]  0.2805648  0.3051430  0.3066170  0.2918393  0.2796669
## [2,]  0.2900306  0.2789881  0.2793752  0.3229605  0.2316870
## [3,]  0.3209575  0.2412673  0.3094885  0.2803835  0.2708938
## [4,]  0.2901806  0.3089748  0.3004417  0.2691000  0.3114871
## [5,]  0.3006610  0.2521936  0.2940252  0.2902011  0.2828316
## [6,]  0.2850849  0.2947734  0.2883340  0.2960548  0.2670826
## [7,]  0.0000000  0.2892563  0.2867072  0.3001283  0.2743534
## [8,]  0.2892563  0.0000000  0.3116946  0.2697711  0.2744041
## [9,]  0.2867072  0.3116946  0.0000000  0.2898931  0.2890740
## [10,] 0.3001283  0.2697711  0.2898931  0.0000000  0.2775672
## [11,] 0.2743534  0.2744041  0.2890740  0.2775672  0.0000000
##
## $Rho_HPDLow
##           [,1]           [,2]           [,3]           [,4]           [,5]           [,6]
## [1,]  1.0000000 -0.5798235 -0.57831974 -0.6234730 -0.5982333 -0.5217805

```

```

## [2,] -0.5798235  1.0000000 -0.35995483 -0.4286826 -0.5006528 -0.5628219
## [3,] -0.5783197 -0.3599548  1.00000000 -0.5490885 -0.2109224 -0.4976746
## [4,] -0.6234730 -0.4286826 -0.54908854  1.0000000 -0.6300015 -0.5817047
## [5,] -0.5982333 -0.5006528 -0.21092245 -0.6300015  1.0000000 -0.5958759
## [6,] -0.5217805 -0.5628219 -0.49767459 -0.5817047 -0.5958759  1.0000000
## [7,] -0.6131093 -0.5703363 -0.64314072 -0.5462292 -0.4981066 -0.5368735
## [8,] -0.4986951 -0.6680505 -0.07946109 -0.6077521 -0.3567769 -0.5279124
## [9,] -0.5725763 -0.5808832 -0.68224123 -0.6204344 -0.6043757 -0.4335728
## [10,] -0.5271062 -0.5719136 -0.47548052 -0.5263160 -0.5843389 -0.6528543
## [11,] -0.5521279 -0.4849414 -0.51710831 -0.5485668 -0.5960303 -0.4901636
##      [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] -0.6131093 -0.49869507 -0.5725763 -0.5271062 -0.5521279
## [2,] -0.5703363 -0.66805048 -0.5808832 -0.5719136 -0.4849414
## [3,] -0.6431407 -0.07946109 -0.6822412 -0.4754805 -0.5171083
## [4,] -0.5462292 -0.60775212 -0.6204344 -0.5263160 -0.5485668
## [5,] -0.4981066 -0.35677692 -0.6043757 -0.5843389 -0.5960303
## [6,] -0.5368735 -0.52791235 -0.4335728 -0.6528543 -0.4901636
## [7,]  1.0000000 -0.43768981 -0.4346719 -0.5009666 -0.4850300
## [8,] -0.4376898  1.00000000 -0.6247193 -0.5263467 -0.4763492
## [9,] -0.4346719 -0.62471932  1.0000000 -0.4385324 -0.5542001
## [10,] -0.5009666 -0.52634674 -0.4385324  1.0000000 -0.5312468
## [11,] -0.4850300 -0.47634922 -0.5542001 -0.5312468  1.0000000
##
## $Rho_HPD_Upp
##      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,] 1.0000000 0.5729403 0.5493276 0.4075127 0.6625819 0.7063866
## [2,] 0.5729403 1.0000000 0.5722995 0.6662463 0.5361043 0.4527126
## [3,] 0.5493276 0.5722995 1.0000000 0.4726270 0.6051076 0.5544928
## [4,] 0.4075127 0.6662463 0.4726270 1.0000000 0.5182417 0.4376663
## [5,] 0.6625819 0.5361043 0.6051076 0.5182417 1.0000000 0.4764342
## [6,] 0.7063866 0.4527126 0.5544928 0.4376663 0.4764342 1.0000000
## [7,] 0.3981447 0.5568730 0.5097274 0.5007295 0.5259321 0.4896465
## [8,] 0.5168736 0.4352302 0.7831712 0.4726806 0.5778019 0.5541099
## [9,] 0.4463901 0.4980119 0.5052050 0.5191325 0.5006004 0.5610238
## [10,] 0.5604058 0.6025931 0.6328918 0.5568360 0.5025252 0.5016679
## [11,] 0.5180678 0.3790144 0.4876131 0.5351372 0.4162969 0.4768008
##      [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] 0.3981447 0.5168736 0.4463901 0.5604058 0.5180678
## [2,] 0.5568730 0.4352302 0.4980119 0.6025931 0.3790144
## [3,] 0.5097274 0.7831712 0.5052050 0.6328918 0.4876131
## [4,] 0.5007295 0.4726806 0.5191325 0.5568360 0.5351372
## [5,] 0.5259321 0.5778019 0.5006004 0.5025252 0.4162969
## [6,] 0.4896465 0.5541099 0.5610238 0.5016679 0.4768008
## [7,] 1.0000000 0.5772291 0.5599557 0.6103009 0.4851076
## [8,] 0.5772291 1.0000000 0.5214767 0.4806017 0.5378610
## [9,] 0.5599557 0.5214767 1.0000000 0.6427853 0.5527155
## [10,] 0.6103009 0.4806017 0.6427853 1.0000000 0.5846117
## [11,] 0.4851076 0.5378610 0.5527155 0.5846117 1.0000000

```

## Example 2:

```

## Fit network meta-regression for Model 8
NMAModel(ID_model = 8L, Nrep = 500L, Nthinning = 2L, Nwarmup = 100L, Iseed = 12091990L)

```

```

## $Size_of_Simulation
## [1] 500
##
## $Size_of_Thinning
## [1] 2
##
## $Size_of_Warmup
## [1] 100
##
## $ID_group
## [1] 1 4 2 4 3 4 5 6 6 6 6
##
## $DIC
## [1] 368.3462
##
## $pD
## [1] 19.71511
##
## $barDIC
## [1] 348.631
##
## $DICbar
## [1] 328.9159
##
## $LPML
## [1] -160.954
##
## $Beta_Posterior
##      MEAN      SD  HPD Lower  HPD Upper
## 1  -0.09348772 0.6400611 -1.2068781  1.1988179
## 2  -1.45909907 0.7022565 -2.6006714  0.1093702
## 3   0.55255886 0.5810123 -0.5454087  1.7107003
## 4  -0.68946316 0.5353105 -1.7403865  0.3206709
## 5  -0.84704781 0.5701610 -1.9934154  0.2621270
## 6  -1.21989714 0.7001616 -2.4916446  0.1854466
## 7   0.37872852 0.6065095 -0.7504327  1.6283931
## 8   3.18505312 2.9435161 -2.8414909  8.3712827
## 9  -1.84628468 3.2949714 -8.3437531  4.1866854
## 10  1.05865445 0.6474581 -0.2288193  2.2506828
##
## $Gamma_Posterior
##      MEAN      SD  HPD Lower  HPD Upper
## 1   0.9202635 5.310728 -8.570129  12.376994
## 2 -40.2742033 1.119873 -42.205986 -38.038720
## 3 -44.4666439 1.582078 -47.211370 -40.941470
## 4 -27.9032958 3.332310 -33.768168 -21.176619
## 5 -42.1853166 2.083472 -45.786383 -37.673019
## 6 -27.8997022 3.538394 -35.915700 -21.097543
## 7 -19.3274198 5.178496 -29.046828 -8.716895
## 8 -47.4799512 2.087536 -51.820617 -43.907814
## 9 -52.1372281 4.375809 -62.392613 -44.606330
## 10 -47.8352887 4.595761 -56.472630 -38.305439
## 11 -46.5680522 4.505708 -54.511827 -37.319452
##

```

```

## $Tau2_Posterior
##      MEAN      SD HPD Lower HPD Upper
## 1  2.111665 2.392003 0.1076517 6.582854
## 2  2.756719 3.762036 0.1358838 8.277035
## 3  4.967991 2.527019 1.3609899 10.107807
## 4  2.756719 3.762036 0.1358838 8.277035
## 5  14.445795 6.922249 4.4622381 28.290591
## 6  2.756719 3.762036 0.1358838 8.277035
## 7  2.219783 2.813296 0.0885115 8.185263
## 8  14.339344 7.695409 2.7638977 29.718275
## 9  14.339344 7.695409 2.7638977 29.718275
## 10 14.339344 7.695409 2.7638977 29.718275
## 11 14.339344 7.695409 2.7638977 29.718275
##
## $Rho_MEAN
##      [,1]      [,2]      [,3]      [,4]      [,5]
## [1,] 1.000000000 -5.036448e-02 0.016691996 0.013471036 0.057743419
## [2,] -0.050364476 1.000000e+00 0.031959146 0.010032022 0.014947977
## [3,] 0.016691996 3.195915e-02 1.000000000 0.005796002 0.142534707
## [4,] 0.013471036 1.003202e-02 0.005796002 1.000000000 -0.001584872
## [5,] 0.057743419 1.494798e-02 0.142534707 -0.001584872 1.000000000
## [6,] 0.014662794 3.499156e-03 0.009675082 -0.024953717 0.023216969
## [7,] -0.026203401 -4.053509e-06 -0.012134653 -0.004453927 -0.009142454
## [8,] 0.012820714 -4.645664e-02 0.283536939 -0.009741490 0.079620766
## [9,] 0.014171317 -5.177877e-03 0.006581231 -0.009903181 -0.003325724
## [10,] -0.030959714 -4.934166e-03 -0.017727291 -0.025156513 -0.018257859
## [11,] 0.008103704 -4.297360e-03 0.003436485 -0.003956466 0.007896801
##      [,6]      [,7]      [,8]      [,9]     [,10]
## [1,] 0.0146627938 -2.620340e-02 0.012820714 0.014171317 -0.030959714
## [2,] 0.0034991563 -4.053509e-06 -0.046456639 -0.005177877 -0.004934166
## [3,] 0.0096750822 -1.213465e-02 0.283536939 0.006581231 -0.017727291
## [4,] -0.0249537167 -4.453927e-03 -0.009741490 -0.009903181 -0.025156513
## [5,] 0.0232169693 -9.142454e-03 0.079620766 -0.003325724 -0.018257859
## [6,] 1.0000000000 5.424751e-04 0.010573564 0.004172696 -0.020831601
## [7,] 0.0005424751 1.000000e+00 0.026209127 0.004925787 -0.014702167
## [8,] 0.0105735638 2.620913e-02 1.000000000 -0.021166598 -0.005624125
## [9,] 0.0041726958 4.925787e-03 -0.021166598 1.000000000 -0.015959140
## [10,] -0.0208316010 -1.470217e-02 -0.005624125 -0.015959140 1.000000000
## [11,] 0.0011620277 -2.091421e-03 -0.009698689 -0.014543178 0.005839145
##      [,11]
## [1,] 0.008103704
## [2,] -0.004297360
## [3,] 0.003436485
## [4,] -0.003956466
## [5,] 0.007896801
## [6,] 0.001162028
## [7,] -0.002091421
## [8,] -0.009698689
## [9,] -0.014543178
## [10,] 0.005839145
## [11,] 1.000000000
##
## $Rho_SD
##      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]

```



```

## [1,] 0.0000000 0.2869136 0.2847820 0.2694887 0.2993530 0.2905937
## [2,] 0.2869136 0.0000000 0.2778349 0.2903572 0.2795544 0.2713373
## [3,] 0.2847820 0.2778349 0.0000000 0.2737260 0.2586455 0.2839900
## [4,] 0.2694887 0.2903572 0.2737260 0.0000000 0.2855993 0.2913437
## [5,] 0.2993530 0.2795544 0.2586455 0.2855993 0.0000000 0.2883202
## [6,] 0.2905937 0.2713373 0.2839900 0.2913437 0.2883202 0.0000000
## [7,] 0.2844671 0.2756896 0.2939770 0.2898667 0.2912368 0.2993318
## [8,] 0.2950269 0.2681829 0.2514478 0.2731005 0.2774507 0.2864966
## [9,] 0.2692160 0.2797890 0.2760247 0.2754775 0.2953651 0.2982078
## [10,] 0.2756208 0.2914645 0.2870746 0.2796456 0.2837114 0.2990540
## [11,] 0.2926712 0.2780347 0.2904520 0.2631909 0.2673361 0.2767029
##      [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] 0.2844671 0.2950269 0.2692160 0.2756208 0.2926712
## [2,] 0.2756896 0.2681829 0.2797890 0.2914645 0.2780347
## [3,] 0.2939770 0.2514478 0.2760247 0.2870746 0.2904520
## [4,] 0.2898667 0.2731005 0.2754775 0.2796456 0.2631909
## [5,] 0.2912368 0.2774507 0.2953651 0.2837114 0.2673361
## [6,] 0.2993318 0.2864966 0.2982078 0.2990540 0.2767029
## [7,] 0.0000000 0.2943618 0.2973955 0.2937521 0.2935622
## [8,] 0.2943618 0.0000000 0.2925462 0.2890589 0.2988790
## [9,] 0.2973955 0.2925462 0.0000000 0.2891069 0.2757610
## [10,] 0.2937521 0.2890589 0.2891069 0.0000000 0.2981940
## [11,] 0.2935622 0.2988790 0.2757610 0.2981940 0.0000000
##
## $Rho_HPD_Low
##      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,] 1.0000000 -0.6254224 -0.5012122 -0.5080487 -0.5168069 -0.5952161
## [2,] -0.6254224 1.0000000 -0.4456183 -0.5056958 -0.4915250 -0.5224390
## [3,] -0.5012122 -0.4456183 1.0000000 -0.4801268 -0.3542993 -0.5177235
## [4,] -0.5080487 -0.5056958 -0.4801268 1.0000000 -0.4878101 -0.5744337
## [5,] -0.5168069 -0.4915250 -0.3542993 -0.4878101 1.0000000 -0.5800005
## [6,] -0.5952161 -0.5224390 -0.5177235 -0.5744337 -0.5800005 1.0000000
## [7,] -0.5705183 -0.4979109 -0.5504390 -0.4895568 -0.5906192 -0.5484362
## [8,] -0.5467819 -0.5489507 -0.2535189 -0.5569691 -0.4264945 -0.4983186
## [9,] -0.4843420 -0.5199809 -0.5078936 -0.5681568 -0.5245618 -0.5593801
## [10,] -0.5133834 -0.5257363 -0.5316388 -0.5514735 -0.5604878 -0.6167027
## [11,] -0.5594839 -0.5266842 -0.4860538 -0.5473862 -0.4516101 -0.5382366
##      [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] -0.5705183 -0.5467819 -0.4843420 -0.5133834 -0.5594839
## [2,] -0.4979109 -0.5489507 -0.5199809 -0.5257363 -0.5266842
## [3,] -0.5504390 -0.2535189 -0.5078936 -0.5316388 -0.4860538
## [4,] -0.4895568 -0.5569691 -0.5681568 -0.5514735 -0.5473862
## [5,] -0.5906192 -0.4264945 -0.5245618 -0.5604878 -0.4516101
## [6,] -0.5484362 -0.4983186 -0.5593801 -0.6167027 -0.5382366
## [7,] 1.0000000 -0.4939419 -0.4635034 -0.5808011 -0.5718414
## [8,] -0.4939419 1.0000000 -0.5833940 -0.5485489 -0.5444515
## [9,] -0.4635034 -0.5833940 1.0000000 -0.5759575 -0.6176616
## [10,] -0.5808011 -0.5485489 -0.5759575 1.0000000 -0.5389175
## [11,] -0.5718414 -0.5444515 -0.6176616 -0.5389175 1.0000000
##
## $Rho_HPD_Upp
##      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,] 1.0000000 0.4995098 0.5635084 0.4738493 0.5888678 0.5554273
## [2,] 0.4995098 1.0000000 0.5863715 0.5911273 0.5427718 0.4751820

```

```

## [3,] 0.5635084 0.5863715 1.0000000 0.5199820 0.6150973 0.5142497
## [4,] 0.4738493 0.5911273 0.5199820 1.0000000 0.5712975 0.5332185
## [5,] 0.5888678 0.5427718 0.6150973 0.5712975 1.0000000 0.5394905
## [6,] 0.5554273 0.4751820 0.5142497 0.5332185 0.5394905 1.0000000
## [7,] 0.5057288 0.5498213 0.5815074 0.5657557 0.4640865 0.5582723
## [8,] 0.5730495 0.4720060 0.7015762 0.5232735 0.6531203 0.6482845
## [9,] 0.5315572 0.5286037 0.5233545 0.4863597 0.5656186 0.5474694
## [10,] 0.4936889 0.5893038 0.5463241 0.5082082 0.4658694 0.4971867
## [11,] 0.5237075 0.4978603 0.5542182 0.4612371 0.5442468 0.5234430
##      [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] 0.5057288 0.5730495 0.5315572 0.4936889 0.5237075
## [2,] 0.5498213 0.4720060 0.5286037 0.5893038 0.4978603
## [3,] 0.5815074 0.7015762 0.5233545 0.5463241 0.5542182
## [4,] 0.5657557 0.5232735 0.4863597 0.5082082 0.4612371
## [5,] 0.4640865 0.6531203 0.5656186 0.4658694 0.5442468
## [6,] 0.5582723 0.6482845 0.5474694 0.4971867 0.5234430
## [7,] 1.0000000 0.6267329 0.6484442 0.5094457 0.5341393
## [8,] 0.6267329 1.0000000 0.4898264 0.5344091 0.5774533
## [9,] 0.6484442 0.4898264 1.0000000 0.5318717 0.4377319
## [10,] 0.5094457 0.5344091 0.5318717 1.0000000 0.5823237
## [11,] 0.5341393 0.5774533 0.4377319 0.5823237 1.0000000

```