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## Anexo 1

## Conjunto de Dados

| Concessionária | OPEX (1000 X R$) | CONSUMO (MWh) | NCONS | REDE (Km) |
|---|---|---|---|---|
| AES-SUL (1) | 71078 | 7210207 | 945758 | 30618 |
| BANDEIRANTES (2) | 224515 | 18190382 | 1256051 | 11442 |
| BOA VISTA (3) | 19245 | 272988 | 52147 | 700 |
| BRAGANTINA (4) | 15058 | 568207 | 89990 | 2638 |
| CAIUÁ (5) | 26004 | 693894 | 172411 | 4227 |
| CAT-LEO (6) | 32405 | 909697 | 283214 | 15577 |
| CEA (7) | 22414 | 450311 | 103728 | 1582 |
| CEAL (8) | 63825 | 1716664 | 589634 | 10701 |
| CEB (9) | 145797 | 3220449 | 594749 | 8071 |
| CEEE (10) | 314731 | 6083952 | 1239523 | 25300 |
| CELB (11) | 11440 | 455613 | 120787 | 1669 |
| CELESC (12) | 298866 | 12424970 | 1772221 | 57911 |
| CELG (13) | 259062 | 5957214 | 1650166 | 121725 |
| CELPA (14) | 191828 | 3660284 | 1048235 | 15407 |
| CELPE (15) | 146498 | 6768699 | 2244483 | 38984 |
| CELTINS (16) | 43563 | 665081 | 245377 | 11470 |
| CEMAR (17) | 105760 | 2294546 | 1089195 | 23978 |
| CEMAT (18) | 122108 | 3015825 | 597359 | 56137 |
| CEMIG (19) | 664659 | 34279987 | 5395922 | 294022 |
| CENF (20) | 9877 | 263154 | 75228 | 891 |
| CEPISA (21) | 59854 | 1244252 | 598927 | 14863 |
| CERJ (22) | 171248 | 6632670 | 1924552 | 21395 |
| CERON (23) | 51300 | 1098511 | 327205 | 14476 |
| CFLO (24) | 5099 | 194883 | 38067 | 423 |
| CHESP (25) | 2441 | 58741 | 23063 | 2030 |
| COCEL (26) | 3960 | 161612 | 28045 | 979 |
| COELBA (27) | 253846 | 8533268 | 2858271 | 32839 |
| COELCE (28) | 155384 | 5356489 | 1881919 | 45648 |
| COPEL (29) | 198014 | 8600422 | 2952251 | 150194 |
| COSERN (30) | 56943 | 2562271 | 710348 | 15796 |
| CPEE (31) | 5847 | 230183 | 42285 | 1708 |
| CPFL (32) | 262031 | 18386196 | 2936710 | 38597 |
| CSPE (33) | 6402 | 296201 | 56000 | 2228 |
| DEMEI (34) | 2421 | 81780 | 22585 | 110 |
| ELEKTRO (35) | 151626 | 9996081 | 1757598 | 70861 |
| ELETROACRE (36) | 14540 | 361584 | 127044 | 2071 |
| ELETROCAR (37) | 4112 | 129222 | 27568 | 1293 |
| ELETROPAULO (38) | 647659 | 32563414 | 5584566 | 17749 |
| ENERGIPE (39) | 39048 | 1661057 | 403232 | 7294 |
| ENERSUL (40) | 71250 | 2647522 | 572272 | 95652 |
| ESCELSA (41) | 97563 | 5790063 | 910676 | 32572 |
| JAGUARI (42) | 5636 | 339742 | 23691 | 505 |
| JOÃO CESA (43) | 393 | 19647 | 2025 | 14 |
| LIGHT (44) | 395162 | 20916104 | 3477668 | 17035 |
| MANAUS (45) | 68067 | 2622032 | 345955 | 1670 |
| MOCOCA (46) | 4569 | 156390 | 33229 | 747 |
| MUXFELDT (47) | 478 | 20271 | 5437 | 54 |
| NACIONAL (48) | 9185 | 344838 | 79251 | 609 |
| NOVA PALMA (49) | 1171 | 46654 | 12212 | 593 |
| PANAMBI (50) | 2076 | 55158 | 11218 | 164 |
| PIRATININGA (51) | 99920 | 9258348 | 1138768 | 8399 |
| POÇOS DE CALDAS (52) | 8257 | 253696 | 51356 | 6368 |
| RGE (53) | 72134 | 5766016 | 1001638 | 37323 |
| SAELPA (54) | 64546 | 1946799 | 869309 | 16909 |
| SANTA CRUZ (55) | 21123 | 674281 | 146410 | 5826 |
| SANTA MARIA (56) | 8171 | 241305 | 59014 | 4091 |
| SULGIPE (57) | 6322 | 157908 | 77067 | 3220 |
| URUSSANGA (58) | 1737 | 47182 | 3507 | 93 |
| V. PARANAPANEMA (59) | 22547 | 551396 | 131361 | 4027 |
| XANXERÊ (60) | 5135 | 131661 | 22286 | 887 |

# Anexo 2

# Modelo Bayesiano

```
######################################################################
Analise Bayesiana de 60 empresas Distribuidoras de Energia  Eletrica.
#Termo de ineficiencia  distribuido como uma  Normal-Truncada:
# u ~ N+(neta,lambda)
# Forma Funcional:Translog
# Erro distribuido como uma Normal
# 2 Variaveis Dummies (Cluster A = 0 1 / Cluster B = 1 0 / Cluster C = 1 1 )
# Betas distribuidos como uma Normal Truncada
# Thin inicial de 20.000
# Simulacao de 400.000
# Thin final de 40 resultando em 10.000 amostras validas
# Arquivos para analisar no BOA: "nttlcomd095.ind" e "nttlcomd095.out"
# Resultados no arquivo:
# "resultados_eficiencias_normal_truncada_translog_COM_dummies_XX"
# XX -> 0.50; 0.55; 0.60; 0.65; 0.75; 0.80; 0.85; 0.90; 0.95

#################################################################

model
    {
       fi0 <- psi / sqrt(invlambda)

      for (i in 1:N){

      neta[i]  <-  fi0 +  fi[1] * dummy[i,1] +  fi[2]  *dummy[i,2]  + teta * VZp[i]

     u[i]  ~  djl.dnorm.trunc(neta[i],invlambda,0,1000)    #  normal-truncada

      eff[i] <- exp(-u[i])

      mu[i] <-  u[i] + alpha +  beta[1] * z[i,1] +  beta[2] * z[i,2] +  beta[3] * z[i,3] + beta[4]
* z[i,4]
         +  beta[5] * z[i,5]  +  beta[6] * z[i,6]  +  beta[7] * z[i,7]  +  beta[8] * z[i,8]  +  beta[9]
* z[i,9]

      Y[i]  ~ dnorm(mu[i],prec)
       }

      alpha <- alpha0 - beta[1]*(0.0059) - beta[2]*(0.1050) - beta[3]*20.4382
        - beta[4]*0.0774 - beta[5]*1.0057 - beta[6]*428.4159


  # Priors
         for (j in 1:p) {

         beta[j] ~ djl.dnorm.trunc(0,tau,0,1000)   # coeficientes independentes
                   }

         alpha0  ~ dnorm(0.0,0.000001)
         tau  ~  dgamma(0.01,0.01)
         prec ~ dgamma(0.01,0.01)
```

```
psi ~ dnorm(0,1)
c <- 5*log(rstar)*log(rstar)
  invlambda ~ dgamma(5,c)

for (i in 1:2) {
            # fi[i] ~ dgamma(1,1)
            fi[i] ~ dgamma(2,1)
                           }

teta <- psi / sqrt(invlambda)

lambda <- 1/(invlambda)   # variancia de "u"

}
```

**Data:**
list( Y= c(11.1715, 11.0639, 12.6595, 12.1644, 10.6820, 10.9997, 10.8454, 10.9498, 10.5725, 11.4883, 11.1282, 11.5121, 11.1863, 11.0751, 12.3217, 11.8900, 2.6078, 12.4648, 11.8948, 11.5689, 11.7127, 13.4070, 12.0509, 12.4445, 11.9537, 12.1961, 12.4762, 11.9292, 13.3811, 11.1740, 12.8871, 9.8650, 9.6197, 10.1660, 10.3861, 10.0174, 9.3449, 9.1980, 8.5368, 7.8002, 8.2840, 8.6737, 8.7644, 7.7919, 9.5847, 8.3217, 8.6369, 5.9738, 8.4270, 6.1696, 9.1253, 7.0656, 7.6382, 9.0188, 9.9581, 9.0083, 8.7518, 7.4599, 10.0234, 8.5438),

dummy= structure(.Data = c(1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    1,  0,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    0,  1,
    1,  1,
    1,  1,
    1,  1,
    1,  1,
    1,  1,
```

```
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1,
     1,   1), .Dim = c(60,2)),
```

```
VZp= c( -2.4806,  0.6128,  1.3825,  1.4127,  1.9324,  1.2131,  1.1440,  -0.5864,
-0.4555, -1.2314, -0.2243, -2.2696, -1.9254,  0.3458, -1.9568,  1.0717,
-0.4020,   0.9779 , -0.6480,  1.1135,  0.8115, -0.9043, -0.2370,  0.0931,  0.0345,
-0.5040, -1.6217, -1.4764, -0.8450, -0.1403, -0.9648,  2.1037,
-0.1762,  0.6312,  0.5130,  1.2926, -0.3019,  0.6348, -0.2060,  0.8720,
-0.3589, -0.2749, -0.6512,  0.0818,  0.7955,  0.2501, -1.2678, -0.8317,  0.0510,
-0.4483, -0.1644, -0.3028,  0.6413,  0.3027,  0.2136,  0.3949,  0.7853,  0.5898,  0.8345,
0.7243),
```

```
z=structure(.Data = c(0.3502,  -0.5090,  2.9090,  0.0494,  -0.8425,  116.6758,
-0.1439,  8.3137,  -9.4326,  -0.3191,  -0.2868,  1.2088,  0.0207,  -0.9727,  40.1787,
0.0570,  -6.7813,  -3.9359,  -0.0001,  -0.3879,  2.8765,  -0.0774,  -0.9257,  115.1627,  -
0.0016,  0.1350,  -6.5974,  -0.2616,  -0.2000,  2.2219,  -0.0120,  -0.9967,  85.0654,
0.0243,  -5.7946,  -2.1530,  -0.1626,  -0.8772,  0.0689,  -0.0528,  -0.4094,  -7.8741,
0.1210,  -3.2144,  -15.8369,  -0.4523,  -0.7219,  1.1402,  0.1219,  -0.6251,  37.2129,
0.2754,  -9.6338,  -13.3124,  -0.0524,  -0.8223,  0.6801,  -0.0752,  -0.4912,  17.5696,
0.0334 ,  -0.9820,  -15.1485,  -0.1561,  -0.4276,  1.7568,  -0.0548,  -0.9017,  64.2052,
0.0485,  -3.3336,  -7.1608,  -0.1148,  -0.0053,  0.7948,  -0.0655,  -0.9958,  22.4247,
-0.0109,  -2.3138,  2.1157,  0.2653,  -0.6678,  2.7642,  -0.0039,  -0.6890,  109.9391,  -
0.1526,  6.2913,  -13.0583,  -0.0243,  1.4878,  0.3855,  -0.0770,  1.5312,  5.2103,
-0.0293,  -0.3835,  33.1676,  0.0896,  0.7679,  2.6413,  -0.0683,  -0.2438,  104.2505,
0.0833,  2.2029,  20.1463,  0.2149,  -0.7794,  2.8766,  -0.0286,  -0.5509,  115.1662,
-0.1489,  5.1479,  -15.7239,  -0.4612,  -0.5906,  1.7220,  0.1299,  -0.7699,  62.6604,
0.2211,  -10.0903,  -10.7611,  0.4656,  0.8135,  3.2877,  0.1449,  -0.1622,  134.5056,
0.4330,  11.1867,  21.7912,  -0.0176,  0.2500,  1.5193,  -0.0772,  -0.8797,  53.7185,  -
0.0042,  -0.2586,  7.7941,  0.2974,  -0.7544,  3.9257,  0.0146,  -0.5840,  165.1846,
-0.1969,  7.3875,  -15.8218,  0.0762,  -1.7534,  3.7012,  -0.0707,  1.7115 ,  154.2954,  -
0.1353,  1.9811,  -39.7913,  -0.3206,  -0.6555,  3.4901,  0.0217,  -0.7027,  144.1513,
0.1733,   -7.5316,  -13.1728,  -0.4741,  -0.7992,  2.1172,  0.1418,  -0.5238,  80.3309,
0.3251,  -10.5608,  -15.6591,  0.3291,  -1.4925,  2.3001,  0.0348,  0.9194,  88.6183,
-0.4648,  7.6165,  -31.5493,  0.3317,  -1.6037,  5.9719,  0.0365,  1.2403,  269.0784,
-0.5058,  8.9139,  -39.5807,  -0.3310,  -0.1518,  3.1292,  0.0284,  -1.0036,  127.0081,
0.0152,  -7.6637,  -1.1042,  -0.4116,  -0.3717,  3.7197,  0.0872,  -0.9346,  155.1902,
0.1082,  -9.8009,  -6.4424,  -0.2856,  -0.9210,  3.2927,  0.0008,  -0.3399,  134.7427,
0.2282,  -6.6373,  -19.3650,  -0.1282,  -1.7073,  4.3893,  -0.0624,  1.5616,  187.9887,
```

0.1961, -3.0380, -39.7809, 0.0445, -0.1615, 4.3230, -0.0749, -1.0025, 184.7033, -
0.0028, 1.2461, -1.4004, 0.2182, -1.0327, 3.8594, -0.0272, -0.1452, 161.9573,
-0.2078, 5.4438, -22.5404, -0.2872, 0.8562, 4.7674, 0.0018, -0.0819, 206.9066, -
0.2705, -7.0926, 24.2273, 0.3941, -2.0273, 2.4123, 0.0826, 2.6894, 93.7311,
-0.7689, 9.1404, -43.9252, -0.1780, 0.6383, 4.1652, -0.0477, -0.4533, 176.9142, -
0.1280, -4.2364, 18.2877,
-0.0155, 1.0154, -2.6528, -0.0773, 0.2495, -112.0955, -0.0108, -0.1720, 19.9261,
0.2441, 0.2381, -1.2659, -0.0149, -0.8881, -60.8379, 0.0858, 4.7931, 6.5771, -
0.0591, -0.0153, -0.5387, -0.0745, -0.9977, -32.4258, -0.0048, -1.0598, 1.7843, -
0.0330, -0.9890, 0.4967, -0.0766, -0.2243, 9.8570, 0.0240, -0.5682,
-18.5061, -0.1053, 0.5994, -1.5541, -0.0675, -0.5095, -71.8056, -0.0700,
-1.8770, 13.3024, -0.2080, 0.5744, -1.4316, -0.0365, -0.5443, -67.1652, -0.1373, -
3.8420, 12.9116, -0.2779, 0.8261, -2.3542, -0.0034, -0.1388, -101.3840,
-0.2533, -4.9201, 16.8383, -0.0632, 1.2719, -3.2840, -0.0741, 0.8899,
-134.1466, -0.0790, -0.9839, 23.6185, -0.0488, -0.7154, -3.7311, -0.0755,
-0.6331, -149.2883, 0.0262, -0.7173, -10.1982, 0.2375, 0.4116, -3.2389, -0.0181, -
0.7389, -132.5971, 0.1257, 4.1864, 8.8841, 0.2297, 0.1266, -2.5162, -0.0219 ,
-0.9521, -107.2173, 0.0546, 4.2219, 4.1509, 0.2073, 0.0379, -2.0637, -0.0320,
-0.9853, -90.7928, 0.0304, 3.9159, 2.6252, -0.4240, 2.0079, -4.7566, 0.0975,
3.4587, -182.5027, -0.8835, -6.5571, 33.1341, -0.3387, 0.2840, -1.4658, 0.0334, -
0.8544, -68.4613, -0.1295, -6.3150, 7.3797, 0.1771, 0.0620, -3.2823, -0.0439,
-0.9779, -134.0894, 0.0306, 3.1388, 2.8652, 0.6691, 1.3161, -3.1196 , 0.3781,
1.0138, -128.4794, 0.9591, 11.6887, 24.6119, 0.2412, 2.9118, -8.0491, -0.0163,
8.0953, -274.9240, 0.7454, 3.0612, 37.3756, 0.0304, 0.6543, -3.2734, -0.0761, -
0.4293, -133.7845 , 0.0275, 0.6224, 13.0320, -0.2505, 1.8431, -6.8596, -0.0176,
2.7892, -244.0360, -0.4765, -3.3212, 26.4522, -0.2385, 1.2912, -2.3016,
-0.0233, 0.9435, -99.4774, -0.3248, -4.2195, 25.3217, 0.0734, 0.1961, -4.7922, -
0.0711, -0.9151, -183.6173 , 0.0239 , 1.2408, 4.7113, -0.0197, 1.3983, -5.2754, -
0.0772, 1.2540, -198.5047, -0.0208, -0.2102, 22.7936, 0.3960, -0.9698,
-1.7752, 0.0841, -0.2578, -80.1068, -0.3476, 7.5007, -16.1406, 0.1176, -0.3298 , -
0.5207, -0.0621, -0.9552, -31.7061, -0.0278, 2.4588, -4.4787, 0.1687, -0.5864, -
1.9128, -0.0469, -0.7739, -85.2247, -0.0840, 3.2330, -8.9192, -0.3359, -0.5387, -
2.1397, 0.0316, -0.8176 , -93.5803, 0.1432, -6.0397, -7.9363, 0.6945, 1.6994,
-6.3230, 0.4131, 2.2501, -229.1755, 1.2637, 9.8856, 25.4696, 0.0127, -0.1073,
-0.8786, -0.0770, -1.0057, -45.8366, -0.0000, 0.3625, -0.0464, 0.2805, 0.3799,
-3.5578, 0.0046, -0.7707, -143.4672, 0.1388, 4.8336, 8.1845), .
Dim = c(60,9)), p = 9, N =60,rstar=0.95)

**Initial:**
list(u=c( 1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1,
    1,1,1),
    fi=c(1,1), alpha0=0, psi=1,  beta=c(0,0,0,0,0,0,0,0,0), tau=1, invlambda=1,prec=1)