Burkina Faso

```
## [1] "Census Females"
```

```
## # A tibble: 18 x 5
##    aggr.age  `1975`  `1985`  `1996`   `2006`
##  *    <dbl>   <dbl>   <dbl>   <dbl>    <dbl>
##  1        0 479362. 730674. 878880  1213119.
##  2        5 417499. 655082. 829526  1088934.
##  3       10 327051. 501749. 692800.  904373.
##  4       15 262454. 384257. 548244   762122.
##  5       20 237211. 330693. 446104.  662654.
##  6       25 221469. 287343. 378176.  555137.
##  7       30 189966. 240637. 322164.  448084.
##  8       35 154009. 202338. 265959.  363978.
##  9       40 126640. 172337. 215769.  299080.
## 10       45 103550. 145369. 175666.  240632.
## 11       50  83233. 120961. 144223.  190845.
## 12       55  63930. 100543. 116654.  151585.
## 13       60  48696.  83755.  94266.  120665.
## 14       65  35645.  63754.  73728.   92136.
## 15       70  25876.  44256.  54514.   67405.
## 16       75  17660.  23964.  35828.   45489.
## 17       80  10821.  41087.  20043.   27411.
## 18       85  13098.     NA   47060.   30478.
```

```
## [1] "Census Males"
```

```
## # A tibble: 18 x 5
##    aggr.age  `1975`  `1985`  `1996`   `2006`
##  *    <dbl>   <dbl>   <dbl>   <dbl>    <dbl>
##  1        0 498118. 733218. 889544  1236779.
##  2        5 454940. 669057. 855549. 1126534.
##  3       10 367257. 523028. 715078.  926371.
##  4       15 275547. 382357. 528713.  716367.
##  5       20 209858. 280615. 374910.  557683.
##  6       25 175866. 213548. 290199.  449918.
##  7       30 155352. 179190. 247737   370217.
##  8       35 135026. 156844. 208632.  304022.
##  9       40 116652. 138100. 174343.  249630.
## 10       45 101729. 123349. 147644.  202625.
## 11       50  88268. 108827. 125516.  165785.
## 12       55  72765.  93619. 106586.  136170.
## 13       60  56927.  78774.  89198.  109332.
## 14       65  41731.  60247.  70396    84418.
## 15       70  30718.  40187.  51780.   61603.
## 16       75  20445.  21680.  33238.   40173.
## 17       80  10919.  27286.  17172.   22717.
## 18       85  16960.     NA   38154.   20701.
```

Thiele Normal Hump

```
##    user  system elapsed
##   48.81    0.67   49.67
```

```
## [1] "relative convergence (4)"
```

Thiele log-Normal Hump

```
##    user  system elapsed
##   48.11    0.47   48.80
```

```
## [1] "relative convergence (4)"
```

Thiele log-Normal Hump RW

```
## Order of parameters:
##  [1] "log_tau2_logpop_f"          "log_tau2_logpop_m"          "log_tau2_fx"                "log_tau
##  [5] "log_tau2_gx_m"              "log_basepop_f"              "log_basepop_m"              "log_fx"
##  [9] "gx_f"                       "gx_m"                       "logit_rho_g_x_f"            "logit_r
## [13] "logit_rho_g_t_f"            "logit_rho_g_t_m"            "log_lambda_tp"              "log_lam
## [17] "tp_params"                  "log_dispersion_f"           "log_dispersion_m"           "log_phi
## [21] "log_phi_innov_m"            "log_psi_innov_f"            "log_psi_innov_m"            "log_lam
## [25] "log_lambda_innov_m"         "log_delta_innov_f"          "log_delta_innov_m"          "log_eps
## [29] "log_epsilon_innov_m"        "log_A_innov_f"              "log_A_innov_m"              "log_B_i
## [33] "log_B_innov_m"              "log_phi_f"                  "log_phi_m"                  "log_psi
## [37] "log_psi_m"                  "log_lambda_f"               "log_lambda_m"               "log_del
## [41] "log_delta_m"                "log_epsilon_f"              "log_epsilon_m"              "log_A_f
## [45] "log_A_m"                    "log_B_f"                    "log_B_m"                    "log_mar
## [49] "log_marginal_prec_phi_m"    "log_marginal_prec_psi_f"    "log_marginal_prec_psi_m"    "log_mar
## [53] "log_marginal_prec_lambda_m" "log_marginal_prec_delta_f"  "log_marginal_prec_delta_m"  "log_mar
## [57] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_f"     "log_marginal_prec_A_m"      "log_mar
## [61] "log_marginal_prec_B_m"      "logit_rho_phi_f"            "logit_rho_phi_m"            "logit_r
## [65] "logit_rho_psi_m"            "logit_rho_lambda_f"         "logit_rho_lambda_m"         "logit_r
## [69] "logit_rho_delta_m"          "logit_rho_epsilon_f"        "logit_rho_epsilon_m"        "logit_r
## [73] "logit_rho_A_m"              "logit_rho_B_f"              "logit_rho_B_m"
## Not matching template order:
##  [1] "log_tau2_logpop_f"          "log_tau2_logpop_m"          "log_tau2_fx"                "log_tau
##  [5] "log_tau2_gx_m"              "logit_rho_g_x_f"            "logit_rho_g_t_f"            "logit_r
##  [9] "logit_rho_g_t_m"            "log_basepop_f"              "log_basepop_m"              "log_fx"
## [13] "gx_f"                       "gx_m"                       "log_lambda_tp"              "log_lam
## [17] "log_dispersion_f"           "log_dispersion_m"           "tp_params"                  "log_phi
## [21] "log_psi_f"                  "log_lambda_f"               "log_delta_f"                "log_eps
## [25] "log_A_f"                    "log_B_f"                    "log_phi_m"                  "log_psi
## [29] "log_lambda_m"               "log_delta_m"                "log_epsilon_m"              "log_A_m
## [33] "log_B_m"                    "log_marginal_prec_phi_f"    "log_marginal_prec_psi_f"    "log_mar
## [37] "log_marginal_prec_delta_f"  "log_marginal_prec_epsilon_f" "log_marginal_prec_A_f"     "log_mar
## [41] "log_marginal_prec_phi_m"    "log_marginal_prec_psi_m"    "log_marginal_prec_lambda_m" "log_mar
## [45] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_m"     "log_marginal_prec_B_m"      "logit_r
## [49] "logit_rho_psi_f"            "logit_rho_A_f"              "logit_rho_B_f"              "logit_r
## [53] "logit_rho_psi_m"            "logit_rho_A_m"              "logit_rho_B_m"
## Your parameter list has been re-ordered.
## (Disable this warning with checkParameterOrder=FALSE)
## Constructing atomic D_lgamma
## Constructing atomic D_lgamma
## Constructing atomic D_lgamma
## Optimizing tape... Done
## iter: 1  value: 1964.974 mgc: 94.63484 ustep: 0.01776843
## iter: 2  value: 1660.7 mgc: 74.97415 ustep: 0.06907148
## iter: 3  value: 1416.987 mgc: 674.7952 ustep: 0.005141115
## iter: 4  value: 1226.311 mgc: 131.1399 ustep: 0.0717944
## iter: 5  value: 1185.701 mgc: 27.85888 ustep: 0.03823743
## iter: 6  value: 1149.18 mgc: 59.27228 ustep: 0.1956244
## iter: 7  value: 1139.833 mgc: 25.86073 ustep: 0.2532151
```

```
## iter: 8  value: 1136.411 mgc: 22.65407 ustep: 0.5032546
## iter: 9  value: 1135.256 mgc: 9.93001 ustep: 0.7094334
## iter: 10  value: 1134.858 mgc: 9.085429 ustep: 0.8422945
## iter: 11  value: 1134.77 mgc: 2.661335 ustep: 0.9177743
## iter: 12  value: 1134.756 mgc: 0.6186161 ustep: 0.9580096
## iter: 13  value: 1134.755 mgc: 0.2582058 ustep: 0.9787817
## iter: 14  value: 1134.755 mgc: 0.01926648 ustep: 0.9893351
## iter: 15  value: 1134.755 mgc: 0.0004292762 ustep: 0.9946538
## iter: 16  value: 1134.755 mgc: 7.963985e-07 ustep: 0.9973236
## iter: 17  mgc: 7.8009e-09
## iter: 1  mgc: 7.8009e-09
## Matching hessian patterns... Done
## outer mgc:  54.29985
##   0:     2079.5205:  2.00000  4.00000  2.00000  4.00000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 7.789275e-09
## iter: 1  mgc: 7.789275e-09
## outer mgc:  54.29985
##   1:     2079.5205:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 7.766023e-09
## iter: 1  mgc: 7.766023e-09
## outer mgc:  54.29985
##   2:     2079.5205:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 7.825005e-09
## iter: 1  mgc: 7.825005e-09
## outer mgc:  54.29985
##   3:     2079.5205:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  value: 1134.755 mgc: 1.080098e-08 ustep: 1
## iter: 2  mgc: 3.485701e-11
## iter: 1  mgc: 3.485701e-11
## outer mgc:  54.29985
##   4:     2079.5205:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  value: 1134.755 mgc: 1.058888e-08 ustep: 1
## mgc: 2.182787e-11
## iter: 1  mgc: 2.182787e-11
## outer mgc:  54.29985
##   5:     2079.5205:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  value: 1134.755 mgc: 2.117771e-08 ustep: 1
## mgc: 2.182787e-11
## iter: 1  value: 1134.755 mgc: 6.353317e-08 ustep: 1
## mgc: 4.365575e-11
## iter: 1  value: 1134.755 mgc: 2.541317e-07 ustep: 1
## iter: 2  mgc: 3.637979e-11
## iter: 1  value: 1134.755 mgc: 1.016526e-06 ustep: 1
## iter: 2  mgc: 2.182787e-11
## iter: 1  value: 1134.755 mgc: 4.066105e-06 ustep: 1
## iter: 2  mgc: 1.361355e-11
## iter: 1  value: 1134.755 mgc: 1.626443e-05 ustep: 1
## iter: 2  mgc: 1.455192e-11
## iter: 1  value: 1134.754 mgc: 6.505788e-05 ustep: 1
## iter: 2  mgc: 5.472767e-11
## iter: 1  value: 1134.749 mgc: 0.0002602342 ustep: 1
## iter: 2  mgc: 8.741489e-10
## iter: 1  value: 1134.73 mgc: 0.001040979 ustep: 1
## iter: 2  value: 1134.73 mgc: 1.398754e-08 ustep: 1
## mgc: 5.086276e-11
## iter: 1  value: 1134.655 mgc: 0.004164579 ustep: 1
```

```
## iter: 2  value: 1134.655 mgc: 2.238393e-07 ustep: 1
## iter: 3  mgc: 2.910383e-11
## iter: 1  value: 1134.355 mgc: 0.01666898 ustep: 1
## iter: 2  value: 1134.355 mgc: 3.58389e-06 ustep: 1
## iter: 3  mgc: 2.910383e-11
## iter: 1  value: 1133.159 mgc: 0.06684646 ustep: 1
## iter: 2  value: 1133.159 mgc: 5.749915e-05 ustep: 1
## iter: 3  mgc: 2.505267e-10
## iter: 1  value: 1128.414 mgc: 0.2701072 ustep: 1
## iter: 2  value: 1128.414 mgc: 0.00092985 ustep: 1
## iter: 3  value: 1128.414 mgc: 6.41247e-08 ustep: 1
## iter: 4  mgc: 3.6526e-11
## iter: 1  value: 1110.101 mgc: 1.123394 ustep: 1
## iter: 2  value: 1110.101 mgc: 0.01545994 ustep: 1
## iter: 3  value: 1110.101 mgc: 1.624275e-05 ustep: 1
## iter: 4  mgc: 6.505452e-11
## iter: 1  value: 1046.743 mgc: 5.234597 ustep: 1
## iter: 2  value: 1046.742 mgc: 0.2696944 ustep: 1
## iter: 3  value: 1046.742 mgc: 0.003458663 ustep: 1
## iter: 4  value: 1046.742 mgc: 1.38303e-06 ustep: 1
## iter: 5  mgc: 7.275958e-11
## iter: 1  value: 931.2999 mgc: 7.734845 ustep: 1
## iter: 2  value: 931.2981 mgc: 0.7460751 ustep: 1
## iter: 3  value: 931.2981 mgc: 0.005425558 ustep: 1
## iter: 4  value: 931.2981 mgc: 3.569638e-06 ustep: 1
## iter: 5  mgc: 7.399048e-11
## iter: 1  mgc: 7.399048e-11
## outer mgc:  19.32949
##   6:     1985.5241:  2.76025  3.89821  2.74967  3.89815  3.04535  2.27332  2.26243  3.12168  2.05489  3
## iter: 1  value: 684.0477 mgc: 6.76173 ustep: 1
## iter: 2  value: 684.0461 mgc: 0.1806861 ustep: 1
## iter: 3  value: 684.0461 mgc: 0.001093428 ustep: 1
## iter: 4  value: 684.0461 mgc: 9.752115e-08 ustep: 1
## mgc: 5.786305e-11
## iter: 1  value: 320.3587 mgc: 56.60255 ustep: 1
## iter: 2  value: 313.8834 mgc: 56.937 ustep: 1
## iter: 3  value: 313.3768 mgc: 9.380345 ustep: 1
## iter: 4  value: 313.3396 mgc: 7.326407 ustep: 1
## iter: 5  value: 313.3395 mgc: 0.02650733 ustep: 1
## iter: 6  value: 313.3395 mgc: 0.0006235018 ustep: 1
## iter: 7  mgc: 4.470058e-11
## iter: 1  mgc: 5.786305e-11
## outer mgc:  12.33389
##   7:     1933.2799:  3.98939  3.78037  3.96461  3.77950  3.14113  2.77805  2.74566  3.36253  2.16990  3
## iter: 1  value: 390.2967 mgc: 11.43629 ustep: 1
## iter: 2  value: 390.2864 mgc: 0.9247888 ustep: 1
## iter: 3  value: 390.2864 mgc: 0.01443646 ustep: 1
## iter: 4  value: 390.2864 mgc: 6.766572e-06 ustep: 1
## iter: 5  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  4.493035
##   8:     1906.2560:  5.12409  3.75196  5.10728  3.75680  3.32545  3.45585  3.38031  3.72536  2.35375  3
## iter: 1  value: 8.86109 mgc: 44.37421 ustep: 1
## iter: 2  value: 8.850125 mgc: 1.507855 ustep: 1
## iter: 3  value: 8.850124 mgc: 0.007401461 ustep: 1
## iter: 4  value: 8.850124 mgc: 3.543742e-06 ustep: 1
```

```
## iter: 5  mgc: 4.294454e-11
## iter: 1  mgc: 4.294454e-11
## outer mgc:  5.887911
##   9:     1900.8067:  4.65665  3.68359  4.76003  3.78220  3.82743  4.46994  4.21419  4.36508  2.64914  3
## iter: 1  value: -98.69616 mgc: 24.61206 ustep: 1
## iter: 2  value: -98.70259 mgc: 1.390612 ustep: 1
## iter: 3  value: -98.70259 mgc: 0.009061091 ustep: 1
## iter: 4  value: -98.70259 mgc: 1.019513e-05 ustep: 1
## iter: 5  mgc: 4.771694e-11
## iter: 1  mgc: 4.771694e-11
## outer mgc:  6.103282
##  10:     1895.8538:  5.07452  3.52109  4.68855  3.65432  4.81856  4.26553  3.88520  4.78165  2.80238  3
## iter: 1  value: -88.15712 mgc: 22.50465 ustep: 1
## iter: 2  value: -88.23704 mgc: 3.560446 ustep: 1
## iter: 3  value: -88.23939 mgc: 0.5696574 ustep: 1
## iter: 4  value: -88.2394 mgc: 0.04248037 ustep: 1
## iter: 5  value: -88.2394 mgc: 7.663597e-05 ustep: 1
## iter: 6  mgc: 9.360134e-10
## iter: 1  value: -85.49442 mgc: 4.004503 ustep: 1
## iter: 2  value: -85.4945 mgc: 0.07060907 ustep: 1
## iter: 3  value: -85.4945 mgc: 0.0004895798 ustep: 1
## iter: 4  value: -85.4945 mgc: 1.743673e-08 ustep: 1
## mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  1.089868
##  11:     1893.7120:  4.99544  3.55891  5.10864  3.68020  4.85341  4.12702  3.84486  4.76192  2.78656  3
## iter: 1  value: -73.14553 mgc: 2.539052 ustep: 1
## iter: 2  value: -73.1456 mgc: 0.09347382 ustep: 1
## iter: 3  value: -73.1456 mgc: 0.0003189956 ustep: 1
## iter: 4  value: -73.1456 mgc: 1.439949e-08 ustep: 1
## mgc: 3.310185e-11
## iter: 1  mgc: 3.310185e-11
## outer mgc:  2.04831
##  12:     1893.1249:  5.10237  3.63630  4.95526  3.72609  5.02287  3.92554  3.72742  4.79637  2.81340  3
## iter: 1  value: -98.17399 mgc: 2.583476 ustep: 1
## iter: 2  value: -98.17401 mgc: 0.07928747 ustep: 1
## iter: 3  value: -98.17401 mgc: 9.56275e-05 ustep: 1
## iter: 4  mgc: 2.562959e-10
## iter: 1  mgc: 2.562959e-10
## outer mgc:  2.254812
##  13:     1892.8180:  4.98293  3.64068  5.08132  3.73130  5.19797  3.83997  3.67296  4.89737  2.87336  3
## iter: 1  value: -144.4672 mgc: 3.215783 ustep: 1
## iter: 2  value: -144.4672 mgc: 0.03722179 ustep: 1
## iter: 3  value: -144.4672 mgc: 2.688067e-05 ustep: 1
## iter: 4  mgc: 1.730042e-10
## iter: 1  mgc: 1.730042e-10
## outer mgc:  2.123472
##  14:     1892.5359:  5.03370  3.61621  5.14535  3.69705  5.24817  3.85514  3.66143  5.03948  2.98007  3
## iter: 1  value: -150.1091 mgc: 6.186061 ustep: 1
## iter: 2  value: -150.1091 mgc: 0.07735814 ustep: 1
## iter: 3  value: -150.1091 mgc: 6.160998e-05 ustep: 1
## iter: 4  mgc: 8.66313e-10
## iter: 1  mgc: 8.66313e-10
## outer mgc:  1.020899
##  15:     1892.1371:  5.07436  3.66992  5.09714  3.67277  5.00674  3.79538  3.70611  5.09907  3.04910  3
## iter: 1  value: -161.6933 mgc: 5.858963 ustep: 1
```

```
## iter: 2  value: -161.6933 mgc: 0.03008918 ustep: 1
## iter: 3  value: -161.6933 mgc: 2.069528e-05 ustep: 1
## iter: 4  mgc: 7.141066e-11
## iter: 1  mgc: 7.141066e-11
## outer mgc:  0.5268165
##  16:     1891.8465:  5.05937  3.64849  5.04077  3.67064  5.01688  3.76041  3.61075  5.25639  3.11097  3
## iter: 1  value: -184.5391 mgc: 3.394897 ustep: 1
## iter: 2  value: -184.5391 mgc: 0.04301038 ustep: 1
## iter: 3  value: -184.5391 mgc: 8.880894e-06 ustep: 1
## iter: 4  mgc: 2.718747e-11
## iter: 1  mgc: 2.718747e-11
## outer mgc:  0.5452295
##  17:     1891.6180:  5.04503  3.72363  5.03641  3.73959  5.05278  3.68736  3.65068  5.39676  3.12280  3
## iter: 1  value: -199.8466 mgc: 2.960455 ustep: 1
## iter: 2  value: -199.8466 mgc: 0.04046365 ustep: 1
## iter: 3  value: -199.8466 mgc: 1.37544e-05 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  value: -229.489 mgc: 5.865641 ustep: 1
## iter: 2  value: -229.4891 mgc: 0.11017 ustep: 1
## iter: 3  value: -229.4891 mgc: 0.0001067442 ustep: 1
## iter: 4  mgc: 1.972873e-09
## iter: 1  mgc: 1.972873e-09
## outer mgc:  1.306901
##  18:     1891.2716:  4.99508  3.77532  5.07056  3.65739  5.10981  3.66625  3.60597  5.86072  3.11647  3
## iter: 1  value: -265.3775 mgc: 11.86259 ustep: 1
## iter: 2  value: -265.3777 mgc: 0.1364068 ustep: 1
## iter: 3  value: -265.3777 mgc: 0.0005279756 ustep: 1
## iter: 4  mgc: 6.947174e-09
## iter: 1  mgc: 6.947174e-09
## outer mgc:  0.8572782
##  19:     1891.1771:  5.04216  3.62319  5.05755  3.85460  5.05846  3.62169  3.67181  6.25832  2.96189  3
## iter: 1  value: -266.7723 mgc: 13.2026 ustep: 1
## iter: 2  value: -266.7723 mgc: 0.0571721 ustep: 1
## iter: 3  value: -266.7723 mgc: 0.0004841886 ustep: 1
## iter: 4  mgc: 6.666221e-09
## iter: 1  value: -262.6698 mgc: 1.511941 ustep: 1
## iter: 2  value: -262.6698 mgc: 0.004986773 ustep: 1
## iter: 3  value: -262.6698 mgc: 3.022916e-07 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  1.020606
##  20:     1891.0613:  5.04498  3.81226  5.07007  3.70768  5.06816  3.67650  3.63779  6.24803  2.94691  3
## iter: 1  value: -255.2393 mgc: 3.315515 ustep: 1
## iter: 2  value: -255.2393 mgc: 0.01425964 ustep: 1
## iter: 3  value: -255.2393 mgc: 4.610444e-06 ustep: 1
## iter: 4  mgc: 1.164153e-10
## iter: 1  mgc: 1.164153e-10
## outer mgc:  0.5600722
##  21:     1890.9926:  5.04143  3.76595  5.06868  3.69931  5.09945  3.70659  3.66091  6.12905  2.92488  3
## iter: 1  value: -236.8906 mgc: 2.373201 ustep: 1
## iter: 2  value: -236.8906 mgc: 0.005917989 ustep: 1
## iter: 3  value: -236.8906 mgc: 2.469052e-06 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.6836598
##  22:     1890.9774:  5.04425  3.78985  5.07144  3.80490  5.04751  3.80744  3.66749  5.98053  2.80373  3
```

```
## iter: 1  value: -232.1193 mgc: 4.339197 ustep: 1
## iter: 2  value: -232.1193 mgc: 0.01756298 ustep: 1
## iter: 3  value: -232.1193 mgc: 1.395469e-05 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.7121755
##  23:     1890.9715:  5.03593  3.72495  5.05050  3.67247  5.07315  3.78696  3.74005  5.88831  2.69998  3
## iter: 1  value: -227.8668 mgc: 6.529034 ustep: 1
## iter: 2  value: -227.8668 mgc: 0.02990678 ustep: 1
## iter: 3  value: -227.8668 mgc: 0.0001097896 ustep: 1
## iter: 4  mgc: 6.351415e-10
## iter: 1  mgc: 6.351415e-10
## outer mgc:  0.3305345
##  24:     1890.9257:  5.03970  3.74105  5.05860  3.70767  5.10445  3.80105  3.68074  5.86357  2.72374  3
## iter: 1  value: -228.6454 mgc: 2.35864 ustep: 1
## iter: 2  value: -228.6454 mgc: 0.003757476 ustep: 1
## iter: 3  value: -228.6454 mgc: 4.379035e-07 ustep: 1
## iter: 4  mgc: 2.182787e-11
## iter: 1  mgc: 2.182787e-11
## outer mgc:  0.2460806
##  25:     1890.9181:  5.04683  3.76018  5.07178  3.73861  5.08836  3.85322  3.65478  5.86526  2.71231  3
## iter: 1  value: -226.2332 mgc: 2.778084 ustep: 1
## iter: 2  value: -226.2332 mgc: 0.003602873 ustep: 1
## iter: 3  value: -226.2332 mgc: 2.399897e-06 ustep: 1
## iter: 4  mgc: 2.401368e-11
## iter: 1  mgc: 2.401368e-11
## outer mgc:  0.2525589
##  26:     1890.9096:  5.04992  3.77473  5.07254  3.73902  5.07529  3.83613  3.68053  5.84345  2.67305  3
## iter: 1  value: -222.3444 mgc: 1.616237 ustep: 1
## iter: 2  value: -222.3444 mgc: 0.002293562 ustep: 1
## iter: 3  value: -222.3444 mgc: 2.390416e-07 ustep: 1
## iter: 4  mgc: 4.563427e-11
## iter: 1  mgc: 4.563427e-11
## outer mgc:  0.0560977
##  27:     1890.8983:  5.04397  3.75893  5.06245  3.72822  5.07751  3.83494  3.68152  5.81915  2.64777  3
## iter: 1  value: -222.9697 mgc: 0.8019277 ustep: 1
## iter: 2  value: -222.9697 mgc: 0.000526551 ustep: 1
## iter: 3  mgc: 2.442599e-09
## iter: 1  mgc: 2.442599e-09
## outer mgc:  0.03420605
##  28:     1890.8937:  5.04677  3.75781  5.06390  3.72421  5.08777  3.84437  3.67639  5.81294  2.63756  3
## iter: 1  value: -222.5905 mgc: 1.865197 ustep: 1
## iter: 2  value: -222.5905 mgc: 0.0005815425 ustep: 1
## iter: 3  mgc: 1.540841e-10
## iter: 1  mgc: 1.540841e-10
## outer mgc:  0.0709165
##  29:     1890.8872:  5.04649  3.75930  5.06759  3.72564  5.08537  3.85711  3.67049  5.80200  2.61534  3
## iter: 1  value: -224.4075 mgc: 1.741345 ustep: 1
## iter: 2  value: -224.4075 mgc: 0.001312006 ustep: 1
## iter: 3  mgc: 5.753542e-09
## iter: 1  mgc: 5.753542e-09
## outer mgc:  0.05106156
##  30:     1890.8825:  5.04959  3.76274  5.06537  3.72847  5.08835  3.85975  3.67055  5.80502  2.60661  3
## iter: 1  value: -227.329 mgc: 1.479388 ustep: 1
## iter: 2  value: -227.329 mgc: 0.0005127431 ustep: 1
## iter: 3  mgc: 2.955509e-09
```

```
## iter: 1  mgc: 2.955509e-09
## outer mgc:  0.04050355
##  31:     1890.8782:  5.04779  3.76209  5.06817  3.72787  5.08697  3.85371  3.67155  5.81740  2.62179  3
## iter: 1  value: -230.9712 mgc: 0.8354373 ustep: 1
## iter: 2  value: -230.9712 mgc: 0.0004919265 ustep: 1
## iter: 3  mgc: 2.965876e-10
## iter: 1  mgc: 2.965876e-10
## outer mgc:  0.02623156
##  32:     1890.8736:  5.04603  3.76219  5.06742  3.73000  5.08218  3.83894  3.67400  5.83972  2.66036  3
## iter: 1  value: -235.6869 mgc: 0.7781947 ustep: 1
## iter: 2  value: -235.6869 mgc: 0.001502786 ustep: 1
## iter: 3  value: -235.6869 mgc: 1.911529e-08 ustep: 1
## mgc: 5.820766e-11
## iter: 1  mgc: 5.820766e-11
## outer mgc:  0.03715693
##  33:     1890.8700:  5.04665  3.76166  5.06506  3.73089  5.09227  3.82119  3.67822  5.86942  2.70796  3
## iter: 1  value: -234.2378 mgc: 0.8775268 ustep: 1
## iter: 2  value: -234.2378 mgc: 0.00037223 ustep: 1
## iter: 3  mgc: 3.322961e-09
## iter: 1  mgc: 3.322961e-09
## outer mgc:  0.05072754
##  34:     1890.8683:  5.04273  3.75798  5.06676  3.72955  5.07921  3.81352  3.67784  5.87210  2.72546  3
## iter: 1  value: -232.8923 mgc: 0.5867933 ustep: 1
## iter: 2  value: -232.8923 mgc: 0.0001511205 ustep: 1
## iter: 3  mgc: 3.417591e-10
## iter: 1  mgc: 3.417591e-10
## outer mgc:  0.01255867
##  35:     1890.8669:  5.04503  3.75891  5.06557  3.72980  5.08541  3.81858  3.67804  5.86842  2.71117  3
## iter: 1  value: -229.0307 mgc: 0.7593625 ustep: 1
## iter: 2  value: -229.0307 mgc: 0.0003341674 ustep: 1
## iter: 3  mgc: 5.460663e-10
## iter: 1  mgc: 5.460663e-10
## outer mgc:  0.02133848
##  36:     1890.8650:  5.04753  3.75977  5.06524  3.72951  5.08950  3.83262  3.67649  5.85300  2.67337  3
## iter: 1  value: -226.5339 mgc: 0.3675921 ustep: 1
## iter: 2  value: -226.5339 mgc: 0.0001665256 ustep: 1
## iter: 3  mgc: 8.691003e-11
## iter: 1  mgc: 8.691003e-11
## outer mgc:  0.03462396
##  37:     1890.8635:  5.04882  3.76042  5.06532  3.72930  5.09013  3.84246  3.67565  5.84433  2.64619  3
## iter: 1  value: -221.2974 mgc: 0.6647241 ustep: 1
## iter: 2  value: -221.2974 mgc: 0.0009511138 ustep: 1
## iter: 3  mgc: 2.299892e-09
## iter: 1  mgc: 2.299892e-09
## outer mgc:  0.04276682
##  38:     1890.8601:  5.05064  3.76145  5.06560  3.72913  5.08950  3.86324  3.67431  5.82929  2.58557  3
## iter: 1  value: -219.2733 mgc: 0.3192307 ustep: 1
## iter: 2  value: -219.2733 mgc: 0.0003483486 ustep: 1
## iter: 3  mgc: 3.66542e-09
## iter: 1  mgc: 3.66542e-09
## outer mgc:  0.03708676
##  39:     1890.8573:  5.05095  3.76158  5.06598  3.72873  5.08630  3.87116  3.67434  5.82591  2.55928  3
## iter: 1  value: -219.6605 mgc: 0.455009 ustep: 1
## iter: 2  value: -219.6605 mgc: 0.001306838 ustep: 1
## iter: 3  value: -219.6605 mgc: 3.306723e-08 ustep: 1
## mgc: 8.731149e-11
```

```
## iter: 1  mgc: 8.731149e-11
## outer mgc:  0.02846663
##  40:     1890.8535:  5.04947  3.76126  5.06608  3.72893  5.08336  3.86910  3.67495  5.83031  2.56131  3
## iter: 1  value: -223.3143 mgc: 0.774509 ustep: 1
## iter: 2  value: -223.3143 mgc: 0.0008725393 ustep: 1
## iter: 3  value: -223.3143 mgc: 1.52743e-08 ustep: 1
## mgc: 4.763701e-11
## iter: 1  mgc: 4.763701e-11
## outer mgc:  0.01773169
##  41:     1890.8508:  5.04787  3.76048  5.06619  3.72854  5.08100  3.85445  3.67567  5.84215  2.60574  3
## iter: 1  value: -226.7239 mgc: 0.5660648 ustep: 1
## iter: 2  value: -226.7239 mgc: 0.0007245045 ustep: 1
## iter: 3  mgc: 1.363503e-09
## iter: 1  mgc: 1.363503e-09
## outer mgc:  0.01736981
##  42:     1890.8495:  5.04599  3.76022  5.06570  3.72916  5.08408  3.83793  3.67586  5.85219  2.65801  3
## iter: 1  value: -227.8896 mgc: 0.2235761 ustep: 1
## iter: 2  value: -227.8896 mgc: 0.0001346515 ustep: 1
## iter: 3  mgc: 4.122258e-11
## iter: 1  mgc: 4.122258e-11
## outer mgc:  0.007239683
##  43:     1890.8490:  5.04615  3.75995  5.06567  3.72862  5.08458  3.83070  3.67597  5.85528  2.67979  3
## iter: 1  value: -227.9159 mgc: 0.1556649 ustep: 1
## iter: 2  value: -227.9159 mgc: 4.037253e-05 ustep: 1
## iter: 3  mgc: 1.455192e-11
## iter: 1  mgc: 1.455192e-11
## outer mgc:  0.006825377
##  44:     1890.8487:  5.04595  3.76019  5.06536  3.72902  5.08745  3.82800  3.67582  5.85404  2.68786  3
## iter: 1  value: -227.5614 mgc: 0.3352167 ustep: 1
## iter: 2  value: -227.5614 mgc: 0.0001129862 ustep: 1
## iter: 3  mgc: 8.731149e-11
## iter: 1  mgc: 8.731149e-11
## outer mgc:  0.01251831
##  45:     1890.8481:  5.04655  3.76034  5.06541  3.72875  5.08837  3.82714  3.67573  5.85064  2.69087  3
## iter: 1  value: -227.0409 mgc: 0.2521798 ustep: 1
## iter: 2  value: -227.0409 mgc: 7.828515e-05 ustep: 1
## iter: 3  mgc: 2.263789e-11
## iter: 1  mgc: 2.263789e-11
## outer mgc:  0.01138148
##  46:     1890.8477:  5.04653  3.76054  5.06543  3.72900  5.08898  3.82842  3.67575  5.84803  2.68743  3
## iter: 1  value: -226.3223 mgc: 0.4308056 ustep: 1
## iter: 2  value: -226.3223 mgc: 8.666885e-05 ustep: 1
## iter: 3  mgc: 1.598508e-10
## iter: 1  mgc: 1.598508e-10
## outer mgc:  0.008430078
##  47:     1890.8472:  5.04651  3.76046  5.06576  3.72903  5.08700  3.83193  3.67621  5.84632  2.67708  3
## iter: 1  value: -226.1531 mgc: 0.1646536 ustep: 1
## iter: 2  value: -226.1531 mgc: 1.288138e-05 ustep: 1
## iter: 3  mgc: 1.455192e-11
## iter: 1  mgc: 1.455192e-11
## outer mgc:  0.004037265
##  48:     1890.8471:  5.04623  3.76031  5.06581  3.72915  5.08600  3.83340  3.67647  5.84731  2.67232  3
## iter: 1  value: -226.0609 mgc: 0.1993348 ustep: 1
## iter: 2  value: -226.0609 mgc: 4.201863e-05 ustep: 1
## iter: 3  mgc: 5.09317e-11
## iter: 1  mgc: 5.09317e-11
```

```
## outer mgc:  0.001576366
##  49:     1890.8471:  5.04616  3.76012  5.06585  3.72906  5.08507  3.83423  3.67660  5.84831  2.66950  3
## iter: 1  value: -225.9627 mgc: 0.09033515 ustep: 1
## iter: 2  value: -225.9627 mgc: 9.280626e-06 ustep: 1
## iter: 3  mgc: 2.596801e-11
## iter: 1  mgc: 2.596801e-11
## outer mgc:  0.001788553
##  50:     1890.8471:  5.04617  3.76011  5.06581  3.72905  5.08515  3.83450  3.67653  5.84812  2.66870  3
## iter: 1  value: -225.8354 mgc: 0.05766671 ustep: 1
## iter: 2  value: -225.8354 mgc: 3.672974e-06 ustep: 1
## iter: 3  mgc: 1.455192e-11
## iter: 1  mgc: 1.455192e-11
## outer mgc:  0.0006724443
##  51:     1890.8471:  5.04626  3.76012  5.06578  3.72901  5.08532  3.83474  3.67642  5.84749  2.66804  3
## iter: 1  value: -225.755 mgc: 0.02082357 ustep: 1
## iter: 2  value: -225.755 mgc: 1.961883e-07 ustep: 1
## mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  0.0006200179
##  52:     1890.8471:  5.04631  3.76015  5.06577  3.72900  5.08547  3.83489  3.67634  5.84697  2.66769  3
## iter: 1  value: -225.6758 mgc: 0.03759384 ustep: 1
## iter: 2  value: -225.6758 mgc: 5.348938e-07 ustep: 1
## mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  0.001293663
##  53:     1890.8470:  5.04637  3.76019  5.06577  3.72899  5.08561  3.83501  3.67626  5.84643  2.66742  3
## iter: 1  value: -225.6596 mgc: 0.0418058 ustep: 1
## iter: 2  value: -225.6596 mgc: 4.905735e-07 ustep: 1
## iter: 3  mgc: 3.486045e-11
## iter: 1  mgc: 3.486045e-11
## outer mgc:  0.001459642
##  54:     1890.8470:  5.04638  3.76020  5.06578  3.72899  5.08564  3.83498  3.67625  5.84633  2.66748  3
## iter: 1  value: -225.7165 mgc: 0.05830259 ustep: 1
## iter: 2  value: -225.7165 mgc: 1.044663e-06 ustep: 1
## iter: 3  mgc: 4.816347e-11
## iter: 1  mgc: 4.816347e-11
## outer mgc:  0.0008897072
##  55:     1890.8470:  5.04635  3.76018  5.06580  3.72900  5.08556  3.83477  3.67632  5.84678  2.66801  3
## iter: 1  value: -225.7765 mgc: 0.01230307 ustep: 1
## iter: 2  value: -225.7765 mgc: 8.094191e-08 ustep: 1
## mgc: 5.09317e-11
## iter: 1  mgc: 5.09317e-11
## outer mgc:  0.0002696848
##  56:     1890.8470:  5.04631  3.76015  5.06581  3.72901  5.08547  3.83461  3.67639  5.84724  2.66839  3
## iter: 1  value: -225.8086 mgc: 0.004535244 ustep: 1
## iter: 2  value: -225.8086 mgc: 2.379287e-08 ustep: 1
## mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.0001141497
##  57:     1890.8470:  5.04629  3.76014  5.06581  3.72901  5.08542  3.83453  3.67642  5.84750  2.66857  3
## iter: 1  mgc: 2.910383e-11

## converged: relative convergence (4)

## Order of parameters:
##  [1] "log_tau2_logpop_f"          "log_tau2_logpop_m"          "log_tau2_fx"                "log_tau
##  [5] "log_tau2_gx_m"              "log_basepop_f"              "log_basepop_m"              "log_fx"
```

```
##  [9] "gx_f"                          "gx_m"                          "logit_rho_g_x_f"               "logit_rl
## [13] "logit_rho_g_t_f"               "logit_rho_g_t_m"               "log_lambda_tp"                 "log_lam
## [17] "tp_params"                     "log_dispersion_f"              "log_dispersion_m"              "log_phi
## [21] "log_phi_innov_m"               "log_psi_innov_f"               "log_psi_innov_m"               "log_lam
## [25] "log_lambda_innov_m"            "log_delta_innov_f"             "log_delta_innov_m"             "log_eps
## [29] "log_epsilon_innov_m"           "log_A_innov_f"                 "log_A_innov_m"                 "log_B_i
## [33] "log_B_innov_m"                 "log_phi_f"                     "log_phi_m"                     "log_psi
## [37] "log_psi_m"                     "log_lambda_f"                  "log_lambda_m"                  "log_del
## [41] "log_delta_m"                   "log_epsilon_f"                 "log_epsilon_m"                 "log_A_f
## [45] "log_A_m"                       "log_B_f"                       "log_B_m"                       "log_marg
## [49] "log_marginal_prec_phi_m"       "log_marginal_prec_psi_f"       "log_marginal_prec_psi_m"       "log_marg
## [53] "log_marginal_prec_lambda_m"    "log_marginal_prec_delta_f"     "log_marginal_prec_delta_m"     "log_marg
## [57] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_f"         "log_marginal_prec_A_m"         "log_marg
## [61] "log_marginal_prec_B_m"         "logit_rho_phi_f"               "logit_rho_phi_m"               "logit_rl
## [65] "logit_rho_psi_m"               "logit_rho_lambda_f"            "logit_rho_lambda_m"            "logit_rl
## [69] "logit_rho_delta_m"             "logit_rho_epsilon_f"           "logit_rho_epsilon_m"           "logit_rl
## [73] "logit_rho_A_m"                 "logit_rho_B_f"                 "logit_rho_B_m"
## Not matching template order:
##  [1] "log_tau2_logpop_f"             "log_tau2_logpop_m"             "log_tau2_fx"                   "log_tau
##  [5] "log_tau2_gx_m"                 "logit_rho_g_x_f"               "logit_rho_g_t_f"               "logit_rl
##  [9] "logit_rho_g_t_m"               "log_basepop_f"                 "log_basepop_m"                 "log_fx"
## [13] "gx_f"                          "gx_m"                          "log_lambda_tp"                 "log_lam
## [17] "log_dispersion_f"              "log_dispersion_m"              "tp_params"                     "log_phi
## [21] "log_psi_f"                     "log_lambda_f"                  "log_delta_f"                   "log_eps
## [25] "log_A_f"                       "log_B_f"                       "log_phi_m"                     "log_psi
## [29] "log_lambda_m"                  "log_delta_m"                   "log_epsilon_m"                 "log_A_m
## [33] "log_B_m"                       "log_marginal_prec_phi_f"       "log_marginal_prec_psi_f"       "log_marg
## [37] "log_marginal_prec_delta_f"     "log_marginal_prec_epsilon_f" "log_marginal_prec_A_f"         "log_marg
## [41] "log_marginal_prec_phi_m"       "log_marginal_prec_psi_m"       "log_marginal_prec_lambda_m"  "log_marg
## [45] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_m"         "log_marginal_prec_B_m"         "logit_rl
## [49] "logit_rho_psi_f"               "logit_rho_A_f"                 "logit_rho_B_f"                 "logit_rl
## [53] "logit_rho_psi_m"               "logit_rho_A_m"                 "logit_rho_B_m"
## Your parameter list has been re-ordered.
## (Disable this warning with checkParameterOrder=FALSE)
```

```
##    user  system elapsed
##   20.07    0.28   20.42
```

```
## [1] "relative convergence (4)"
```

Thiele Normal Hump (Pop 5-9 to 70-74, DHS 15-19 to 45-49)

```
##    user  system elapsed
##    44.0     0.6    44.7
```

```
## [1] "relative convergence (4)"
```

Thiele log-Normal Hump (Pop 5-9 to 70-74, DHS 15-19 to 45-49)

```
##    user  system elapsed
##   46.47    0.45   47.08
```

```
## [1] "relative convergence (4)"
```

Thiele log-Normal Hump RW (Pop 5-9 to 70-74, DHS 15-19 to 45-49)

```
## Order of parameters:
##  [1] "log_tau2_logpop_f"             "log_tau2_logpop_m"             "log_tau2_fx"                   "log_tau
##  [5] "log_tau2_gx_m"                 "log_basepop_f"                 "log_basepop_m"                 "log_fx"
##  [9] "gx_f"                          "gx_m"                          "logit_rho_g_x_f"               "logit_rl
## [13] "logit_rho_g_t_f"               "logit_rho_g_t_m"               "log_lambda_tp"                 "log_lam
```

```
## [17] "tp_params"                   "log_dispersion_f"            "log_dispersion_m"            "log_phi
## [21] "log_phi_innov_m"             "log_psi_innov_f"             "log_psi_innov_m"             "log_lam
## [25] "log_lambda_innov_m"          "log_delta_innov_f"           "log_delta_innov_m"           "log_eps
## [29] "log_epsilon_innov_m"         "log_A_innov_f"               "log_A_innov_m"               "log_B_i
## [33] "log_B_innov_m"               "log_phi_f"                   "log_phi_m"                   "log_psi
## [37] "log_psi_m"                   "log_lambda_f"                "log_lambda_m"                "log_del
## [41] "log_delta_m"                 "log_epsilon_f"               "log_epsilon_m"               "log_A_f
## [45] "log_A_m"                     "log_B_f"                     "log_B_m"                     "log_mar
## [49] "log_marginal_prec_phi_m"     "log_marginal_prec_psi_f"     "log_marginal_prec_psi_m"     "log_mar
## [53] "log_marginal_prec_lambda_m"  "log_marginal_prec_delta_f"   "log_marginal_prec_delta_m"   "log_mar
## [57] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_f"       "log_marginal_prec_A_m"       "log_mar
## [61] "log_marginal_prec_B_m"       "logit_rho_phi_f"             "logit_rho_phi_m"             "logit_r
## [65] "logit_rho_psi_m"             "logit_rho_lambda_f"          "logit_rho_lambda_m"          "logit_r
## [69] "logit_rho_delta_m"           "logit_rho_epsilon_f"         "logit_rho_epsilon_m"         "logit_r
## [73] "logit_rho_A_m"               "logit_rho_B_f"               "logit_rho_B_m"
## Not matching template order:
##  [1] "log_tau2_logpop_f"           "log_tau2_logpop_m"           "log_tau2_fx"                 "log_tau
##  [5] "log_tau2_gx_m"               "logit_rho_g_x_f"             "logit_rho_g_t_f"             "logit_r
##  [9] "logit_rho_g_t_m"             "log_basepop_f"               "log_basepop_m"               "log_fx"
## [13] "gx_f"                        "gx_m"                        "log_lambda_tp"               "log_lam
## [17] "log_dispersion_f"            "log_dispersion_m"            "tp_params"                   "log_phi
## [21] "log_psi_f"                   "log_lambda_f"                "log_delta_f"                 "log_eps
## [25] "log_A_f"                     "log_B_f"                     "log_phi_m"                   "log_psi
## [29] "log_lambda_m"                "log_delta_m"                 "log_epsilon_m"               "log_A_m
## [33] "log_B_m"                     "log_marginal_prec_phi_f"     "log_marginal_prec_psi_f"     "log_mar
## [37] "log_marginal_prec_delta_f"   "log_marginal_prec_epsilon_f" "log_marginal_prec_A_f"       "log_mar
## [41] "log_marginal_prec_phi_m"     "log_marginal_prec_psi_m"     "log_marginal_prec_lambda_m"  "log_mar
## [45] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_m"       "log_marginal_prec_B_m"       "logit_r
## [49] "logit_rho_psi_f"             "logit_rho_A_f"               "logit_rho_B_f"               "logit_r
## [53] "logit_rho_psi_m"             "logit_rho_A_m"               "logit_rho_B_m"
## Your parameter list has been re-ordered.
## (Disable this warning with checkParameterOrder=FALSE)
## Optimizing tape... Done
## iter: 1  value: 1795.833 mgc: 78.61335 ustep: 0.01776843
## iter: 2  value: 1324.976 mgc: 55.79855 ustep: 0.06907148
## iter: 3  value: 1145.03 mgc: 247.6193 ustep: 0.03739777
## iter: 4  value: 1057.266 mgc: 56.03687 ustep: 0.1019173
## iter: 5  value: 1020.228 mgc: 33.03326 ustep: 0.3193129
## iter: 6  value: 1017.263 mgc: 26.94595 ustep: 0.09882027
## iter: 7  value: 1010.393 mgc: 69.36803 ustep: 0.3144255
## iter: 8  value: 1008.828 mgc: 2.917417 ustep: 0.5607805
## iter: 9  value: 1008.245 mgc: 5.700494 ustep: 0.7488779
## iter: 10  value: 1008.042 mgc: 0.9416999 ustep: 0.8653908
## iter: 11  value: 1007.993 mgc: 0.5666701 ustep: 0.9302708
## iter: 12  value: 1007.985 mgc: 0.7726287 ustep: 0.964509
## iter: 13  value: 1007.984 mgc: 0.1934007 ustep: 0.982096
## iter: 14  value: 1007.984 mgc: 0.0252813 ustep: 0.9910085
## iter: 15  value: 1007.984 mgc: 0.0004829745 ustep: 0.9954945
## iter: 16  value: 1007.984 mgc: 9.620696e-07 ustep: 0.9977449
## iter: 17  mgc: 5.971494e-09
## iter: 1  mgc: 5.971494e-09
## Matching hessian patterns... Done
## outer mgc:  50.40104
##   0:     1951.7017:  2.00000  4.00000  2.00000  4.00000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 5.97297e-09
## iter: 1  mgc: 5.97297e-09
```

```
## outer mgc:  50.40104
##   1:     1951.7017:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 5.975922e-09
## iter: 1  mgc: 5.975922e-09
## outer mgc:  50.40104
##   2:     1951.7017:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 5.981827e-09
## iter: 1  mgc: 5.981827e-09
## outer mgc:  50.40104
##   3:     1951.7017:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  mgc: 8.937628e-09
## iter: 1  mgc: 8.937628e-09
## outer mgc:  50.40104
##   4:     1951.7017:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  value: 1007.984 mgc: 1.778393e-08 ustep: 1
## iter: 2  mgc: 9.968038e-11
## iter: 1  mgc: 9.968038e-11
## outer mgc:  50.40104
##   5:     1951.7017:  2.00000   4.0000  2.00000   4.0000  3.00000  2.00000  2.00000  3.00000  2.00000  3
## iter: 1  value: 1007.984 mgc: 1.769267e-08 ustep: 1
## mgc: 2.905698e-11
## iter: 1  value: 1007.984 mgc: 5.307782e-08 ustep: 1
## mgc: 2.967093e-11
## iter: 1  value: 1007.984 mgc: 2.123113e-07 ustep: 1
## iter: 2  mgc: 2.480877e-11
## iter: 1  value: 1007.984 mgc: 8.492452e-07 ustep: 1
## iter: 2  mgc: 4.365575e-11
## iter: 1  value: 1007.984 mgc: 3.396981e-06 ustep: 1
## iter: 2  mgc: 2.182787e-11
## iter: 1  value: 1007.983 mgc: 1.358794e-05 ustep: 1
## iter: 2  mgc: 5.820766e-11
## iter: 1  value: 1007.982 mgc: 5.43519e-05 ustep: 1
## iter: 2  mgc: 5.555323e-11
## iter: 1  value: 1007.978 mgc: 0.0002174102 ustep: 1
## iter: 2  mgc: 8.909605e-10
## iter: 1  value: 1007.959 mgc: 0.0008696817 ustep: 1
## iter: 2  value: 1007.959 mgc: 1.42535e-08 ustep: 1
## mgc: 6.686929e-12
## iter: 1  value: 1007.886 mgc: 0.003479376 ustep: 1
## iter: 2  value: 1007.886 mgc: 2.280985e-07 ustep: 1
## iter: 3  mgc: 8.731149e-11
## iter: 1  value: 1007.591 mgc: 0.01392793 ustep: 1
## iter: 2  value: 1007.591 mgc: 3.652101e-06 ustep: 1
## iter: 3  mgc: 2.910383e-11
## iter: 1  value: 1006.417 mgc: 0.05587849 ustep: 1
## iter: 2  value: 1006.417 mgc: 5.859455e-05 ustep: 1
## iter: 3  mgc: 2.690506e-10
## iter: 1  value: 1001.756 mgc: 0.2261867 ustep: 1
## iter: 2  value: 1001.756 mgc: 0.0009476369 ustep: 1
## iter: 3  value: 1001.756 mgc: 6.851809e-08 ustep: 1
## iter: 4  mgc: 5.080736e-11
## iter: 1  value: 983.7196 mgc: 0.9476655 ustep: 1
## iter: 2  value: 983.7196 mgc: 0.01576219 ustep: 1
## iter: 3  value: 983.7196 mgc: 1.701863e-05 ustep: 1
## iter: 4  mgc: 5.579359e-11
## iter: 1  value: 920.6479 mgc: 4.457301 ustep: 1
```

```
## iter: 2  value: 920.6472 mgc: 0.2758428 ustep: 1
## iter: 3  value: 920.6472 mgc: 0.003353408 ustep: 1
## iter: 4  value: 920.6472 mgc: 1.447481e-06 ustep: 1
## iter: 5  mgc: 6.522194e-11
## iter: 1  value: 833.6346 mgc: 9.335905 ustep: 1
## iter: 2  value: 833.631 mgc: 1.734373 ustep: 1
## iter: 3  value: 833.631 mgc: 0.008899168 ustep: 1
## iter: 4  value: 833.631 mgc: 9.776024e-05 ustep: 1
## iter: 5  mgc: 1.134461e-09
## iter: 1  mgc: 1.134461e-09
## outer mgc:  19.85759
##   6:     1867.4849:  2.62939  3.91043  2.62065  3.91041  3.03560  2.21923  2.21028  3.09580  2.04274  3
## iter: 1  value: 578.0668 mgc: 6.970748 ustep: 1
## iter: 2  value: 578.0649 mgc: 0.2165465 ustep: 1
## iter: 3  value: 578.0649 mgc: 0.001212212 ustep: 1
## iter: 4  value: 578.0649 mgc: 1.929844e-07 ustep: 1
## mgc: 1.455192e-11
## iter: 1  value: 240.4821 mgc: 149.2714 ustep: 0.03522464
## iter: 2  value: 220.7021 mgc: 214.5647 ustep: 0.02565266
## iter: 3  value: 216.3815 mgc: 25.40919 ustep: 0.1602485
## iter: 4  value: 215.9178 mgc: 16.41073 ustep: 0.4003704
## iter: 5  value: 215.8745 mgc: 4.319613 ustep: 0.632785
## iter: 6  value: 215.8676 mgc: 0.6428618 ustep: 0.7954983
## iter: 7  value: 215.8659 mgc: 0.163564 ustep: 0.8919179
## iter: 8  value: 215.8658 mgc: 0.0752396 ustep: 0.9444196
## iter: 9  value: 215.8657 mgc: 0.01102117 ustep: 0.9718154
## iter: 10  value: 215.8657 mgc: 0.0004566694 ustep: 0.9858084
## iter: 11  value: 215.8657 mgc: 4.997795e-06 ustep: 0.9928795
## iter: 12  value: 215.8657 mgc: 5.820802e-08 ustep: 0.9964338
## iter: 13  mgc: 7.756531e-10
## iter: 1  mgc: 1.455192e-11
## outer mgc:  12.65181
##   7:     1812.1068:  3.94153  3.77469  3.91669  3.77406  3.13193  2.74368  2.71217  3.34261  2.15995  3
## iter: 1  value: 37.40562 mgc: 50.26488 ustep: 1
## iter: 2  value: 35.80399 mgc: 20.18898 ustep: 1
## iter: 3  value: 35.77844 mgc: 2.225335 ustep: 1
## iter: 4  value: 35.77839 mgc: 0.234426 ustep: 1
## iter: 5  value: 35.77839 mgc: 3.652265e-05 ustep: 1
## iter: 6  mgc: 6.482757e-10
## iter: 1  value: 308.9337 mgc: 9.660992 ustep: 1
## iter: 2  value: 308.9274 mgc: 0.670337 ustep: 1
## iter: 3  value: 308.9274 mgc: 0.008403439 ustep: 1
## iter: 4  value: 308.9274 mgc: 2.444001e-06 ustep: 1
## iter: 5  mgc: 1.533007e-11
## iter: 1  mgc: 1.533007e-11
## outer mgc:  4.975496
##   8:     1784.6758:  4.98403  3.74977  4.96565  3.75325  3.29543  3.35829  3.28693  3.67054  2.32663  3
## iter: 1  value: -73.56956 mgc: 33.05949 ustep: 1
## iter: 2  value: -73.58307 mgc: 2.134555 ustep: 1
## iter: 3  value: -73.58308 mgc: 0.02700238 ustep: 1
## iter: 4  value: -73.58308 mgc: 5.872964e-05 ustep: 1
## iter: 5  mgc: 1.16696e-10
## iter: 1  mgc: 1.16696e-10
## outer mgc:  2.991132
##   9:     1776.6944:  5.08501  3.70801  5.15890  3.78161  3.73713  4.34540  4.12454  4.27227  2.61858  3
## iter: 1  value: -160.9295 mgc: 23.28155 ustep: 1
```

```
## iter: 2  value: -160.9401 mgc: 1.96142 ustep: 1
## iter: 3  value: -160.9401 mgc: 0.02119274 ustep: 1
## iter: 4  value: -160.9401 mgc: 0.0001192305 ustep: 1
## iter: 5  mgc: 8.989289e-10
## iter: 1  mgc: 8.989289e-10
## outer mgc:  9.270653
##  10:     1774.2210:  5.41684  3.45098  4.86082  3.58924  4.61787  4.23496  3.84609  4.66647  2.70831  3
## iter: 1  value: -204.8058 mgc: 22.84727 ustep: 1
## iter: 2  value: -204.8217 mgc: 0.9575488 ustep: 1
## iter: 3  value: -204.8218 mgc: 0.01340249 ustep: 1
## iter: 4  value: -204.8218 mgc: 4.911301e-05 ustep: 1
## iter: 5  mgc: 4.724732e-11
## iter: 1  mgc: 4.724732e-11
## outer mgc:  6.829228
##  11:     1773.1074:  4.64051  3.34195  5.30744  3.52648  5.42441  3.88168  3.60644  4.93714  2.73100  3
## iter: 1  value: -264.2379 mgc: 23.28953 ustep: 1
## iter: 2  value: -264.2407 mgc: 0.5776935 ustep: 1
## iter: 3  value: -264.2407 mgc: 0.01071755 ustep: 1
## iter: 4  value: -264.2407 mgc: 4.173428e-05 ustep: 1
## iter: 5  mgc: 1.983489e-10
## iter: 1  value: -229.765 mgc: 10.22185 ustep: 1
## iter: 2  value: -229.7651 mgc: 0.1695635 ustep: 1
## iter: 3  value: -229.7651 mgc: 0.0001761337 ustep: 1
## iter: 4  mgc: 3.049598e-09
## iter: 1  mgc: 3.049598e-09
## outer mgc:  1.91786
##  12:     1770.3304:  5.00573  3.57890  4.99562  3.68176  5.36072  3.82176  3.71289  4.94379  2.78363  3
## iter: 1  value: -246.473 mgc: 11.6889 ustep: 1
## iter: 2  value: -246.4738 mgc: 0.2430458 ustep: 1
## iter: 3  value: -246.4738 mgc: 0.00299298 ustep: 1
## iter: 4  value: -246.4738 mgc: 4.663218e-06 ustep: 1
## iter: 5  mgc: 2.910383e-11
## iter: 1  value: -235.8334 mgc: 3.902604 ustep: 1
## iter: 2  value: -235.8335 mgc: 0.02454348 ustep: 1
## iter: 3  value: -235.8335 mgc: 3.458462e-05 ustep: 1
## iter: 4  mgc: 8.071959e-10
## iter: 1  mgc: 8.071959e-10
## outer mgc:  0.5683149
##  13:     1769.9740:  5.05493  3.60409  5.08777  3.69100  5.31142  3.83878  3.71081  4.95843  2.80926  3
## iter: 1  value: -239.169 mgc: 4.23341 ustep: 1
## iter: 2  value: -239.169 mgc: 0.01078718 ustep: 1
## iter: 3  value: -239.169 mgc: 1.388904e-05 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.8021511
##  14:     1769.7890:  5.00939  3.63725  5.02480  3.70091  5.22516  3.85465  3.69533  4.98343  2.85535  3
## iter: 1  value: -247.8376 mgc: 2.148862 ustep: 1
## iter: 2  value: -247.8376 mgc: 0.01868448 ustep: 1
## iter: 3  value: -247.8376 mgc: 5.311315e-06 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.6104701
##  15:     1769.6149:  5.05724  3.63536  5.09803  3.69835  5.16581  3.84796  3.68039  5.02016  2.90912  3
## iter: 1  value: -256.8127 mgc: 0.9666857 ustep: 1
## iter: 2  value: -256.8127 mgc: 0.005249698 ustep: 1
## iter: 3  value: -256.8127 mgc: 1.534155e-07 ustep: 1
```

```
## iter: 4  mgc: 3.818545e-11
## iter: 1  mgc: 3.818545e-11
## outer mgc:  0.395117
##  16:     1769.4739:  5.03133  3.64203  5.05265  3.70060  5.14507  3.81218  3.69196  5.05916  2.95177  3
## iter: 1  value: -265.428 mgc: 1.086131 ustep: 1
## iter: 2  value: -265.428 mgc: 0.01229326 ustep: 1
## iter: 3  value: -265.428 mgc: 1.4936e-06 ustep: 1
## iter: 4  mgc: 5.820766e-11
## iter: 1  mgc: 5.820766e-11
## outer mgc:  0.4922186
##  17:     1769.3572:  5.04428  3.66796  5.07465  3.70240  5.12895  3.80774  3.66122  5.11766  2.99614  3
## iter: 1  value: -274.031 mgc: 1.212235 ustep: 1
## iter: 2  value: -274.031 mgc: 0.01419918 ustep: 1
## iter: 3  value: -274.031 mgc: 2.542028e-06 ustep: 1
## iter: 4  mgc: 8.196022e-11
## iter: 1  value: -301.4166 mgc: 2.796621 ustep: 1
## iter: 2  value: -301.4167 mgc: 0.08316087 ustep: 1
## iter: 3  value: -301.4167 mgc: 0.0001377673 ustep: 1
## iter: 4  mgc: 1.789655e-09
## iter: 1  mgc: 1.789655e-09
## outer mgc:  0.4636272
##  18:     1768.9807:  5.05770  3.69838  5.06045  3.70522  5.11353  3.76066  3.60155  5.37666  3.11339  3
## iter: 1  value: -377.7333 mgc: 9.98825 ustep: 1
## iter: 2  value: -377.7352 mgc: 0.4738822 ustep: 1
## iter: 3  value: -377.7352 mgc: 0.00356646 ustep: 1
## iter: 4  value: -377.7352 mgc: 7.582858e-07 ustep: 1
## iter: 5  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  1.607388
##  19:     1768.8102:  5.02880  3.79092  5.13464  3.74436  4.95865  3.51698  3.74870  5.96760  3.13508  3
## iter: 1  value: -390.1996 mgc: 8.383747 ustep: 1
## iter: 2  value: -390.1997 mgc: 0.1245126 ustep: 1
## iter: 3  value: -390.1997 mgc: 0.0004279837 ustep: 1
## iter: 4  value: -390.1997 mgc: 1.534995e-08 ustep: 1
## mgc: 5.820766e-11
## iter: 1  mgc: 5.820766e-11
## outer mgc:  0.6095903
##  20:     1768.5841:  5.02050  3.79367  5.03704  3.65496  4.97912  3.72449  3.54404  6.35543  3.04666  3
## iter: 1  value: -372.9981 mgc: 4.446055 ustep: 1
## iter: 2  value: -372.9982 mgc: 0.1069295 ustep: 1
## iter: 3  value: -372.9982 mgc: 0.0001209763 ustep: 1
## iter: 4  mgc: 1.695721e-09
## iter: 1  mgc: 1.695721e-09
## outer mgc:  0.7057678
##  21:     1768.4891:  5.05943  3.65393  5.04419  3.84650  5.16985  3.72149  3.60349  6.06282  2.97758  3
## iter: 1  value: -349.88 mgc: 4.300457 ustep: 1
## iter: 2  value: -349.88 mgc: 0.07567678 ustep: 1
## iter: 3  value: -349.88 mgc: 0.0001162785 ustep: 1
## iter: 4  mgc: 7.401026e-10
## iter: 1  value: -365.1025 mgc: 1.347428 ustep: 1
## iter: 2  value: -365.1025 mgc: 0.01134792 ustep: 1
## iter: 3  value: -365.1025 mgc: 2.287924e-06 ustep: 1
## iter: 4  mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  0.4831323
##  22:     1768.4030:  5.02674  3.77146  5.08941  3.70170  5.15596  3.70409  3.65412  5.96912  2.94636  3
```

```
## iter: 1  value: -361.8281 mgc: 1.707842 ustep: 1
## iter: 2  value: -361.8281 mgc: 0.004627384 ustep: 1
## iter: 3  value: -361.8281 mgc: 5.071461e-07 ustep: 1
## iter: 4  mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.3195569
##  23:     1768.3658:  5.03141  3.74053  5.08087  3.69807  5.07221  3.71535  3.65847  5.98347  2.92210  3
## iter: 1  value: -359.9735 mgc: 1.983497 ustep: 1
## iter: 2  value: -359.9735 mgc: 0.003617123 ustep: 1
## iter: 3  value: -359.9735 mgc: 9.370865e-08 ustep: 1
## mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  0.118909
##  24:     1768.3454:  5.03808  3.77654  5.06708  3.73418  5.06324  3.74359  3.64309  5.99048  2.88499  3
## iter: 1  value: -357.2771 mgc: 1.60737 ustep: 1
## iter: 2  value: -357.2771 mgc: 0.001151635 ustep: 1
## iter: 3  value: -357.2771 mgc: 5.184539e-08 ustep: 1
## mgc: 2.910383e-11
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.2339724
##  25:     1768.3298:  5.05425  3.75569  5.05312  3.71383  5.09706  3.77446  3.65620  5.94867  2.81843  3
## iter: 1  value: -346.2302 mgc: 1.609538 ustep: 1
## iter: 2  value: -346.2302 mgc: 0.002417464 ustep: 1
## iter: 3  value: -346.2302 mgc: 8.203716e-08 ustep: 1
## mgc: 1.868283e-12
## iter: 1  mgc: 1.868283e-12
## outer mgc:  0.186563
##  26:     1768.3131:  5.05026  3.74983  5.05577  3.72575  5.08124  3.82561  3.66187  5.86261  2.73406  3
## iter: 1  value: -338.0084 mgc: 2.231084 ustep: 1
## iter: 2  value: -338.0084 mgc: 0.005518356 ustep: 1
## iter: 3  value: -338.0084 mgc: 3.252797e-07 ustep: 1
## iter: 4  mgc: 7.275958e-11
## iter: 1  mgc: 7.275958e-11
## outer mgc:  0.08454919
##  27:     1768.3019:  5.04584  3.74909  5.06113  3.72491  5.07337  3.85094  3.66374  5.79584  2.65781  3
## iter: 1  value: -334.2806 mgc: 2.019666 ustep: 1
## iter: 2  value: -334.2806 mgc: 0.002006959 ustep: 1
## iter: 3  value: -334.2806 mgc: 3.202188e-08 ustep: 1
## mgc: 3.036893e-11
## iter: 1  mgc: 3.036893e-11
## outer mgc:  0.06881075
##  28:     1768.2968:  5.04951  3.76191  5.06769  3.72806  5.08777  3.85324  3.66545  5.76025  2.59783  3
## iter: 1  value: -336.2885 mgc: 1.385684 ustep: 1
## iter: 2  value: -336.2885 mgc: 0.001005275 ustep: 1
## iter: 3  value: -336.2885 mgc: 3.616217e-08 ustep: 1
## mgc: 5.820766e-11
## iter: 1  value: -335.1468 mgc: 0.5514397 ustep: 1
## iter: 2  value: -335.1468 mgc: 0.0001552292 ustep: 1
## iter: 3  mgc: 9.959313e-10
## iter: 1  mgc: 9.959313e-10
## outer mgc:  0.05982494
##  29:     1768.2946:  5.04894  3.75684  5.06865  3.72038  5.09127  3.86320  3.65855  5.76259  2.59052  3
## iter: 1  value: -337.8171 mgc: 0.5158871 ustep: 1
## iter: 2  value: -337.8171 mgc: 0.002764741 ustep: 1
## iter: 3  value: -337.8171 mgc: 3.829572e-08 ustep: 1
## mgc: 2.910383e-11
```

```
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.05380861
##  30:     1768.2909:  5.04583  3.75638  5.06806  3.72064  5.08861  3.85978  3.65444  5.77984  2.60248  3
## iter: 1  value: -341.0589 mgc: 0.4044877 ustep: 1
## iter: 2  value: -341.0589 mgc: 0.0001909932 ustep: 1
## iter: 3  mgc: 2.361382e-10
## iter: 1  value: -345.087 mgc: 0.5006897 ustep: 1
## iter: 2  value: -345.087 mgc: 0.0002842636 ustep: 1
## iter: 3  mgc: 5.555698e-10
## iter: 1  mgc: 5.555698e-10
## outer mgc:  0.04250828
##  31:     1768.2848:  5.04501  3.75618  5.06463  3.72216  5.08048  3.84114  3.65258  5.82057  2.65442  3
## iter: 1  value: -351.3581 mgc: 0.7932917 ustep: 1
## iter: 2  value: -351.3581 mgc: 0.0007223786 ustep: 1
## iter: 3  mgc: 2.81194e-10
## iter: 1  mgc: 2.81194e-10
## outer mgc:  0.03551143
##  32:     1768.2803:  5.04490  3.75639  5.06514  3.72422  5.08219  3.82339  3.65307  5.85213  2.70751  3
## iter: 1  value: -356.1532 mgc: 0.7221141 ustep: 1
## iter: 2  value: -356.1532 mgc: 0.001337652 ustep: 1
## iter: 3  value: -356.1532 mgc: 1.698476e-08 ustep: 1
## mgc: 5.398537e-11
## iter: 1  mgc: 5.398537e-11
## outer mgc:  0.04606424
##  33:     1768.2759:  5.04370  3.75689  5.06344  3.72644  5.08554  3.80190  3.65697  5.87348  2.76634  3
## iter: 1  value: -355.5782 mgc: 0.8273494 ustep: 1
## iter: 2  value: -355.5782 mgc: 0.000345348 ustep: 1
## iter: 3  value: -355.5782 mgc: 1.296817e-08 ustep: 1
## mgc: 7.914391e-11
## iter: 1  mgc: 7.914391e-11
## outer mgc:  0.08910713
##  34:     1768.2736:  5.04877  3.75616  5.06694  3.72560  5.08392  3.79806  3.66019  5.86779  2.77787  3
## iter: 1  value: -352.5679 mgc: 0.4515347 ustep: 1
## iter: 2  value: -352.5679 mgc: 0.0008255241 ustep: 1
## iter: 3  mgc: 2.922227e-09
## iter: 1  mgc: 2.922227e-09
## outer mgc:  0.02970753
##  35:     1768.2714:  5.04460  3.75564  5.06757  3.72691  5.09329  3.80435  3.66154  5.85258  2.76058  3
## iter: 1  value: -348.1579 mgc: 0.7075073 ustep: 1
## iter: 2  value: -348.1579 mgc: 0.0002675245 ustep: 1
## iter: 3  mgc: 1.416449e-09
## iter: 1  mgc: 1.416449e-09
## outer mgc:  0.02054012
##  36:     1768.2697:  5.04586  3.75561  5.06487  3.72455  5.08954  3.81553  3.66127  5.83375  2.72581  3
## iter: 1  value: -344.9054 mgc: 0.6634934 ustep: 1
## iter: 2  value: -344.9054 mgc: 0.0004391282 ustep: 1
## iter: 3  mgc: 6.956462e-10
## iter: 1  mgc: 6.956462e-10
## outer mgc:  0.02362788
##  37:     1768.2682:  5.04743  3.75504  5.06706  3.72420  5.08767  3.83158  3.65857  5.82672  2.68793  3
## iter: 1  value: -343.8805 mgc: 0.6022937 ustep: 1
## iter: 2  value: -343.8805 mgc: 0.0003978887 ustep: 1
## iter: 3  mgc: 1.430956e-09
## iter: 1  mgc: 1.430956e-09
## outer mgc:  0.01267964
##  38:     1768.2670:  5.04698  3.75563  5.06541  3.72329  5.08639  3.83849  3.65757  5.83305  2.66165  3
```

```
## iter: 1  value: -343.4494 mgc: 0.2836101 ustep: 1
## iter: 2  value: -343.4494 mgc: 0.000171666 ustep: 1
## iter: 3  mgc: 1.64464e-10
## iter: 1  mgc: 1.64464e-10
## outer mgc:  0.01611561
##  39:     1768.2659:  5.04736  3.75607  5.06496  3.72342  5.08581  3.84192  3.65713  5.83938  2.64841  3
## iter: 1  value: -343.5357 mgc: 0.7351367 ustep: 1
## iter: 2  value: -343.5357 mgc: 0.001158492 ustep: 1
## iter: 3  mgc: 9.691437e-09
## iter: 1  mgc: 9.691437e-09
## outer mgc:  0.02527523
##  40:     1768.2624:  5.04781  3.75717  5.06381  3.72379  5.08502  3.84753  3.65744  5.86189  2.62309  3
## iter: 1  value: -343.9067 mgc: 0.4691516 ustep: 1
## iter: 2  value: -343.9067 mgc: 0.00047108 ustep: 1
## iter: 3  mgc: 7.571098e-09
## iter: 1  mgc: 7.571098e-09
## outer mgc:  0.03245324
##  41:     1768.2593:  5.04807  3.75760  5.06328  3.72448  5.08554  3.84632  3.65805  5.87232  2.62226  3
## iter: 1  value: -345.5612 mgc: 0.5485929 ustep: 1
## iter: 2  value: -345.5612 mgc: 0.001429766 ustep: 1
## iter: 3  value: -345.5612 mgc: 4.882649e-08 ustep: 1
## mgc: 5.820766e-11
## iter: 1  mgc: 5.820766e-11
## outer mgc:  0.02340845
##  42:     1768.2552:  5.04765  3.75734  5.06376  3.72483  5.08655  3.83769  3.65916  5.87376  2.65017  3
## iter: 1  value: -346.1178 mgc: 0.46131 ustep: 1
## iter: 2  value: -346.1178 mgc: 0.0008255131 ustep: 1
## iter: 3  mgc: 4.734471e-09
## iter: 1  mgc: 4.734471e-09
## outer mgc:  0.01063368
##  43:     1768.2534:  5.04711  3.75672  5.06470  3.72486  5.08773  3.82830  3.65889  5.85977  2.68469  3
## iter: 1  value: -345.7386 mgc: 0.3686365 ustep: 1
## iter: 2  value: -345.7386 mgc: 0.0005779719 ustep: 1
## iter: 3  mgc: 2.111078e-09
## iter: 1  mgc: 2.111078e-09
## outer mgc:  0.007842697
##  44:     1768.2527:  5.04662  3.75608  5.06553  3.72430  5.08771  3.82340  3.65831  5.84540  2.70522  3
## iter: 1  value: -345.1415 mgc: 0.1906994 ustep: 1
## iter: 2  value: -345.1415 mgc: 8.301175e-05 ustep: 1
## iter: 3  mgc: 5.121958e-11
## iter: 1  mgc: 5.121958e-11
## outer mgc:  0.006974123
##  45:     1768.2524:  5.04652  3.75582  5.06570  3.72409  5.08774  3.82277  3.65786  5.83863  2.70881  3
## iter: 1  value: -344.1991 mgc: 0.4297124 ustep: 1
## iter: 2  value: -344.1991 mgc: 0.0001667074 ustep: 1
## iter: 3  mgc: 1.62685e-10
## iter: 1  mgc: 1.62685e-10
## outer mgc:  0.008033744
##  46:     1768.2519:  5.04631  3.75543  5.06597  3.72365  5.08726  3.82268  3.65731  5.82943  2.71168  3
## iter: 1  value: -343.7103 mgc: 0.3684158 ustep: 1
## iter: 2  value: -343.7103 mgc: 5.077629e-05 ustep: 1
## iter: 3  mgc: 8.731149e-11
## iter: 1  mgc: 8.731149e-11
## outer mgc:  0.008786986
##  47:     1768.2514:  5.04623  3.75537  5.06598  3.72361  5.08704  3.82300  3.65720  5.82672  2.71108  3
## iter: 1  value: -343.6779 mgc: 0.582445 ustep: 1
```

```
## iter: 2  value: -343.6779 mgc: 7.025838e-05 ustep: 1
## iter: 3  mgc: 1.223395e-10
## iter: 1  mgc: 1.223395e-10
## outer mgc:  0.005792639
##  48:     1768.2508:  5.04619  3.75564  5.06581  3.72385  5.08661  3.82408  3.65788  5.83107  2.70617  3
## iter: 1  value: -344.0483 mgc: 0.1320151 ustep: 1
## iter: 2  value: -344.0483 mgc: 3.097352e-05 ustep: 1
## iter: 3  mgc: 4.365575e-11
## iter: 1  mgc: 4.365575e-11
## outer mgc:  0.00378048
##  49:     1768.2507:  5.04628  3.75593  5.06562  3.72420  5.08681  3.82461  3.65849  5.83694  2.70254  3
## iter: 1  value: -344.319 mgc: 0.1647815 ustep: 1
## iter: 2  value: -344.319 mgc: 3.345706e-05 ustep: 1
## iter: 3  mgc: 4.922052e-11
## iter: 1  mgc: 4.922052e-11
## outer mgc:  0.001391016
##  50:     1768.2507:  5.04633  3.75607  5.06553  3.72436  5.08695  3.82494  3.65888  5.84066  2.70049  3
## iter: 1  value: -344.2833 mgc: 0.06679447 ustep: 1
## iter: 2  value: -344.2833 mgc: 5.921457e-06 ustep: 1
## iter: 3  mgc: 1.455192e-11
## iter: 1  mgc: 1.455192e-11
## outer mgc:  0.000657277
##  51:     1768.2507:  5.04635  3.75607  5.06553  3.72438  5.08705  3.82503  3.65887  5.84074  2.70008  3
## iter: 1  value: -344.1948 mgc: 0.04920719 ustep: 1
## iter: 2  value: -344.1948 mgc: 3.25724e-06 ustep: 1
## iter: 3  mgc: 5.820766e-11
## iter: 1  mgc: 5.820766e-11
## outer mgc:  0.0006084951
##  52:     1768.2507:  5.04635  3.75604  5.06556  3.72434  5.08706  3.82516  3.65880  5.84016  2.69982  3
## iter: 1  value: -344.1227 mgc: 0.01426764 ustep: 1
## iter: 2  value: -344.1227 mgc: 2.536977e-07 ustep: 1
## mgc: 1.928158e-11
## iter: 1  mgc: 1.928158e-11
## outer mgc:  0.0005404195
##  53:     1768.2507:  5.04636  3.75602  5.06557  3.72431  5.08706  3.82523  3.65872  5.83963  2.69972  3
## iter: 1  value: -344.0494 mgc: 0.02159117 ustep: 1
## iter: 2  value: -344.0494 mgc: 4.460711e-07 ustep: 1
## mgc: 3.062306e-11
## iter: 1  mgc: 3.062306e-11
## outer mgc:  0.0005354388
##  54:     1768.2506:  5.04636  3.75599  5.06558  3.72427  5.08703  3.82529  3.65864  5.83907  2.69967  3
## iter: 1  value: -343.9997 mgc: 0.04422731 ustep: 1
## iter: 2  value: -343.9997 mgc: 8.833589e-07 ustep: 1
## mgc: 5.03364e-11
## iter: 1  mgc: 5.03364e-11
## outer mgc:  0.0006682567
##  55:     1768.2506:  5.04636  3.75598  5.06559  3.72424  5.08701  3.82530  3.65857  5.83877  2.69971  3
## iter: 1  value: -344.0225 mgc: 0.0532442 ustep: 1
## iter: 2  value: -344.0225 mgc: 7.054684e-07 ustep: 1
## iter: 3  mgc: 5.593093e-11
## iter: 1  mgc: 5.593093e-11
## outer mgc:  0.0005701811
##  56:     1768.2506:  5.04637  3.75598  5.06559  3.72424  5.08701  3.82522  3.65860  5.83907  2.69986  3
## iter: 1  value: -344.0916 mgc: 0.03797588 ustep: 1
## iter: 2  value: -344.0916 mgc: 6.539013e-07 ustep: 1
## iter: 3  mgc: 2.910383e-11
```

```
## iter: 1  mgc: 2.910383e-11
## outer mgc:  0.0002241918
##  57:     1768.2506:  5.04637  3.75600  5.06558  3.72427  5.08705  3.82510  3.65869  5.83974  2.70004  3
## iter: 1  value: -344.1298 mgc: 0.006522523 ustep: 1
## iter: 2  value: -344.1298 mgc: 8.384405e-08 ustep: 1
## mgc: 2.568068e-11
## iter: 1  mgc: 2.568068e-11
## outer mgc:  0.0001686945
##  58:     1768.2506:  5.04637  3.75601  5.06558  3.72428  5.08707  3.82505  3.65875  5.84008  2.70010  3
## iter: 1  mgc: 2.568068e-11
```

```
## converged: relative convergence (4)
```

```
## Order of parameters:
##  [1] "log_tau2_logpop_f"           "log_tau2_logpop_m"           "log_tau2_fx"                 "log_tau
##  [5] "log_tau2_gx_m"               "log_basepop_f"               "log_basepop_m"               "log_fx"
##  [9] "gx_f"                        "gx_m"                        "logit_rho_g_x_f"             "logit_r
## [13] "logit_rho_g_t_f"             "logit_rho_g_t_m"             "log_lambda_tp"               "log_lam
## [17] "tp_params"                   "log_dispersion_f"            "log_dispersion_m"            "log_phi
## [21] "log_phi_innov_m"             "log_psi_innov_f"             "log_psi_innov_m"             "log_lam
## [25] "log_lambda_innov_m"          "log_delta_innov_f"           "log_delta_innov_m"           "log_eps
## [29] "log_epsilon_innov_m"         "log_A_innov_f"               "log_A_innov_m"               "log_B_i
## [33] "log_B_innov_m"               "log_phi_f"                   "log_phi_m"                   "log_psi
## [37] "log_psi_m"                   "log_lambda_f"                "log_lambda_m"                "log_del
## [41] "log_delta_m"                 "log_epsilon_f"               "log_epsilon_m"               "log_A_f
## [45] "log_A_m"                     "log_B_f"                     "log_B_m"                     "log_marg
## [49] "log_marginal_prec_phi_m"     "log_marginal_prec_psi_f"     "log_marginal_prec_psi_m"     "log_marg
## [53] "log_marginal_prec_lambda_m"  "log_marginal_prec_delta_f"   "log_marginal_prec_delta_m"   "log_marg
## [57] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_f"       "log_marginal_prec_A_m"       "log_marg
## [61] "log_marginal_prec_B_m"       "logit_rho_phi_f"             "logit_rho_phi_m"             "logit_r
## [65] "logit_rho_psi_m"             "logit_rho_lambda_f"          "logit_rho_lambda_m"          "logit_r
## [69] "logit_rho_delta_m"           "logit_rho_epsilon_f"         "logit_rho_epsilon_m"         "logit_r
## [73] "logit_rho_A_m"               "logit_rho_B_f"               "logit_rho_B_m"
## Not matching template order:
##  [1] "log_tau2_logpop_f"           "log_tau2_logpop_m"           "log_tau2_fx"                 "log_tau
##  [5] "log_tau2_gx_m"               "logit_rho_g_x_f"             "logit_rho_g_t_f"             "logit_r
##  [9] "logit_rho_g_t_m"             "log_basepop_f"               "log_basepop_m"               "log_fx"
## [13] "gx_f"                        "gx_m"                        "log_lambda_tp"               "log_lam
## [17] "log_dispersion_f"            "log_dispersion_m"            "tp_params"                   "log_phi
## [21] "log_psi_f"                   "log_lambda_f"                "log_delta_f"                 "log_eps
## [25] "log_A_f"                     "log_B_f"                     "log_phi_m"                   "log_psi
## [29] "log_lambda_m"                "log_delta_m"                 "log_epsilon_m"               "log_A_m
## [33] "log_B_m"                     "log_marginal_prec_phi_f"     "log_marginal_prec_psi_f"     "log_marg
## [37] "log_marginal_prec_delta_f"   "log_marginal_prec_epsilon_f" "log_marginal_prec_A_f"       "log_marg
## [41] "log_marginal_prec_phi_m"     "log_marginal_prec_psi_m"     "log_marginal_prec_lambda_m"  "log_marg
## [45] "log_marginal_prec_epsilon_m" "log_marginal_prec_A_m"       "log_marginal_prec_B_m"       "logit_r
## [49] "logit_rho_psi_f"             "logit_rho_A_f"               "logit_rho_B_f"               "logit_r
## [53] "logit_rho_psi_m"             "logit_rho_A_m"               "logit_rho_B_m"
## Your parameter list has been re-ordered.
## (Disable this warning with checkParameterOrder=FALSE)
```

```
##    user  system elapsed
##   20.78    0.28   21.15
```

```
## [1] "relative convergence (4)"
```

Figure 1: Estimated parameters

```
## Using Sex as id variables
## Using Sex as id variables
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_point).
```

Figure 2: Estimated parameters

Figure 3: Estimated ${}_{45}q_{15}$

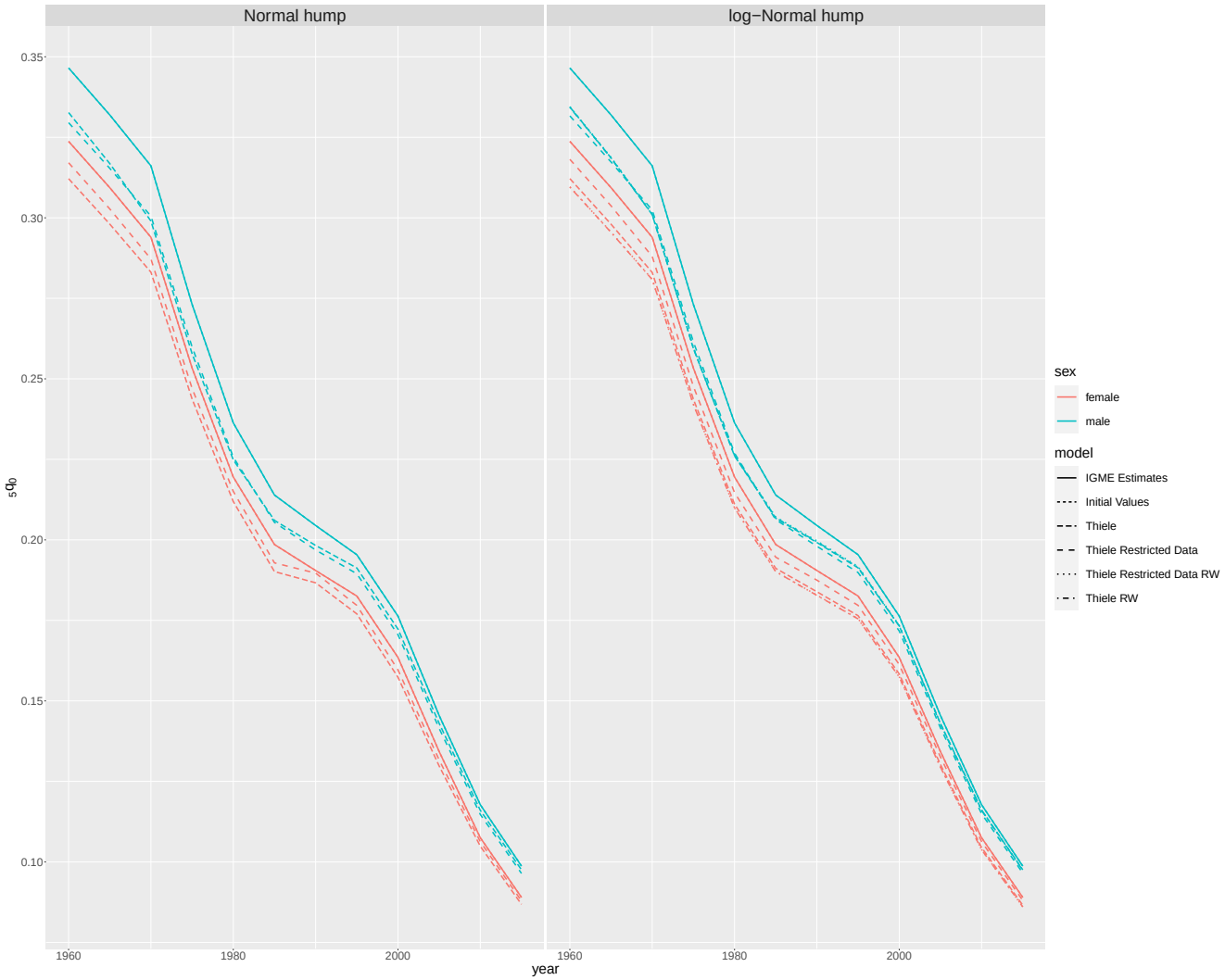

Figure 4: Estimated ${}_5q_0$

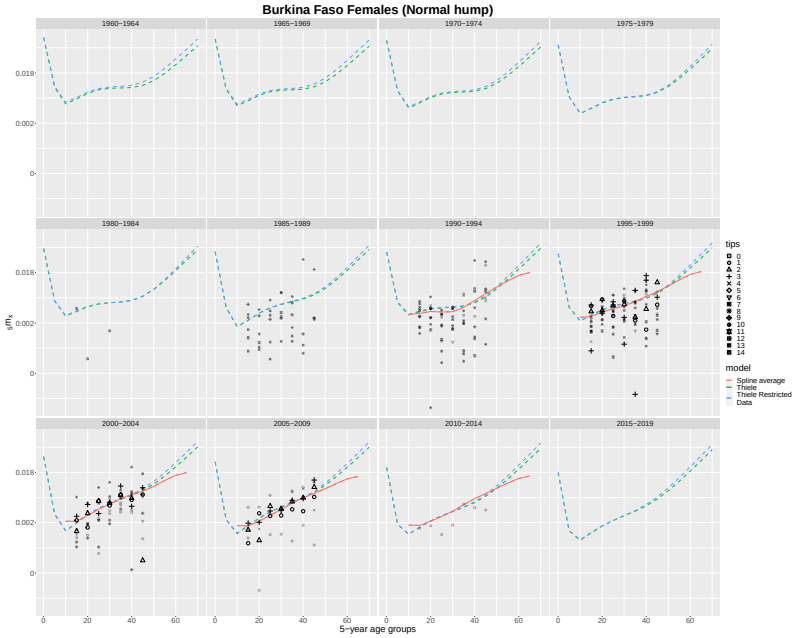

Figure 5: Mortality Schedules

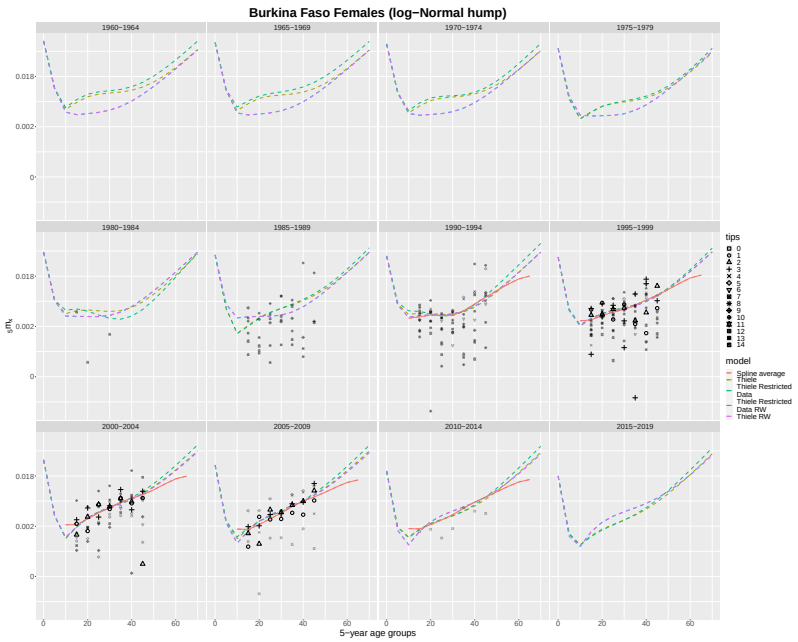

Figure 6: Mortality Schedules

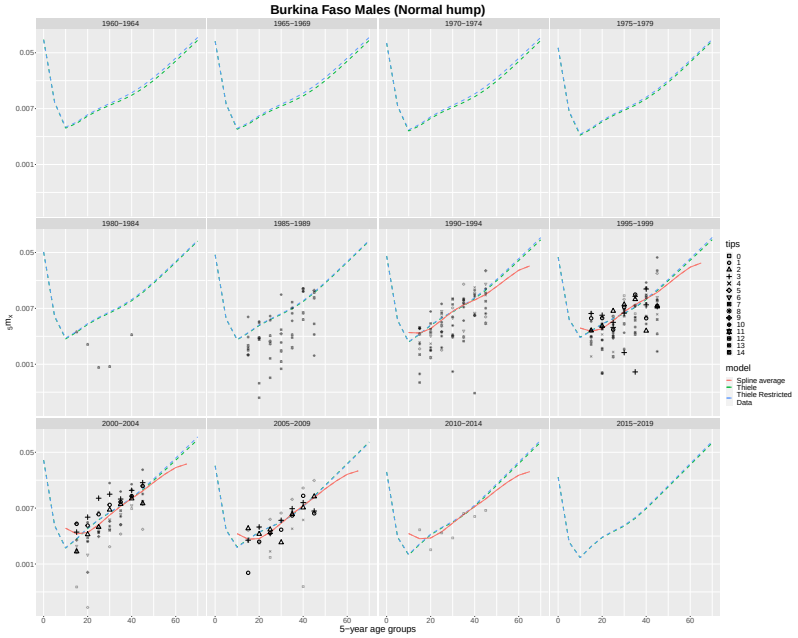

Figure 7: Mortality Schedules

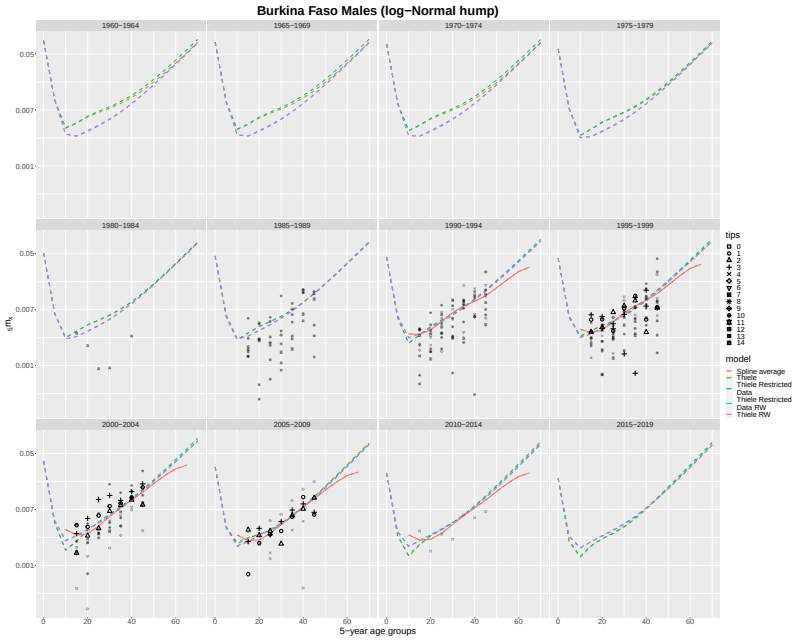

Figure 8: Mortality Schedules

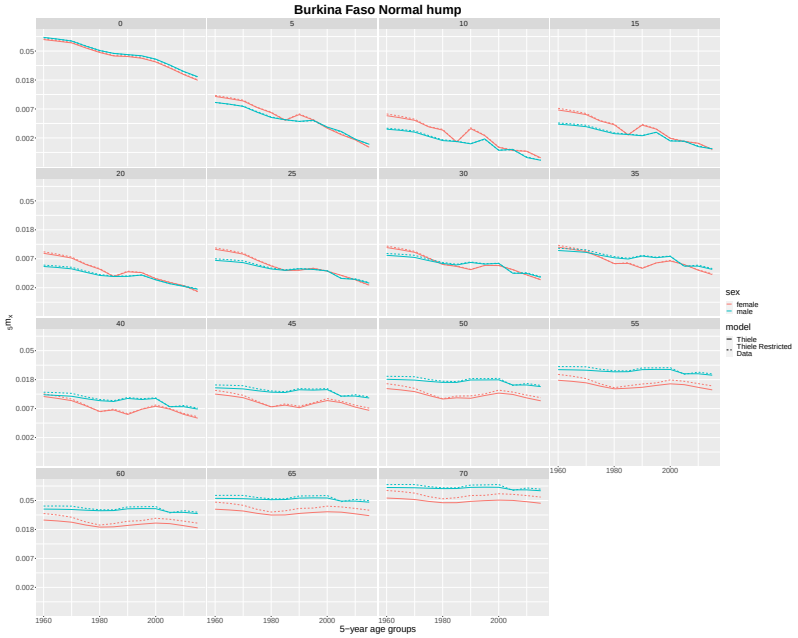

Figure 9: Mortality Schedules

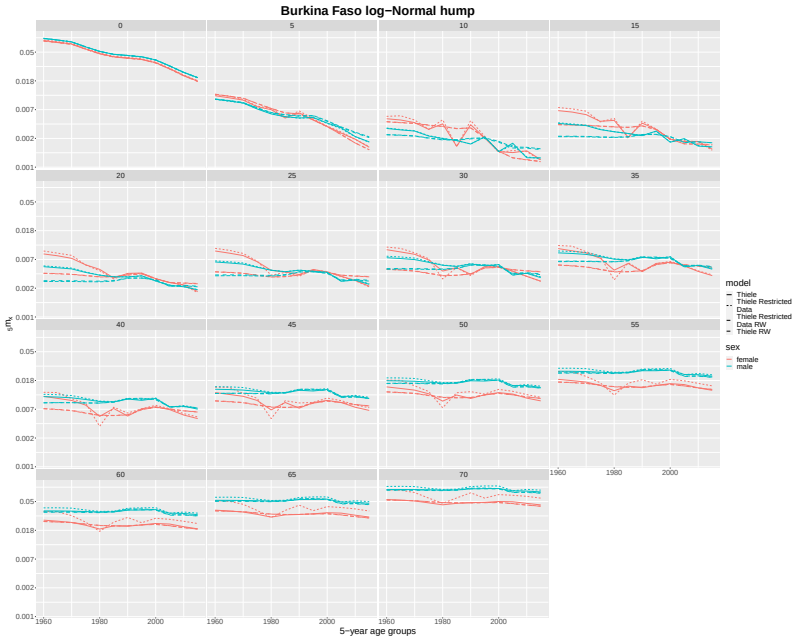

Figure 10: Mortality Schedules

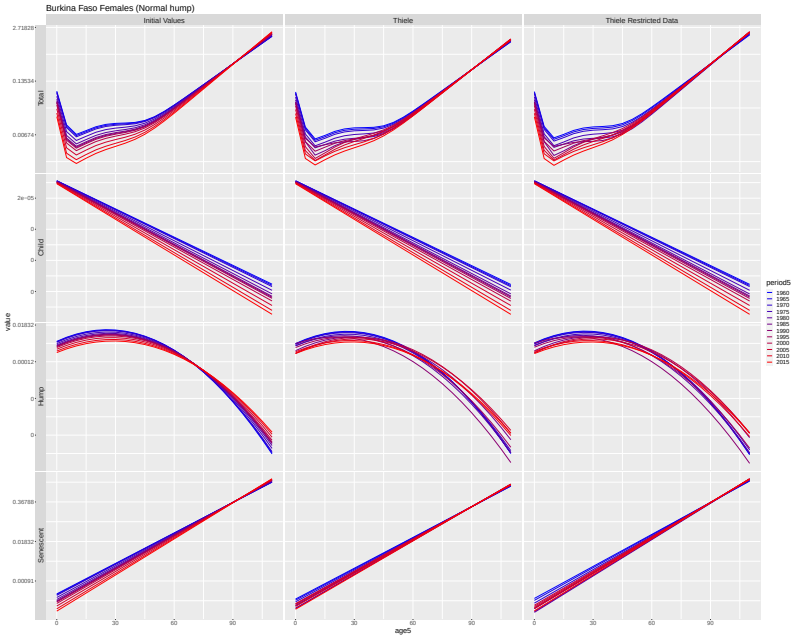

Figure 11: Thiele Decomposed

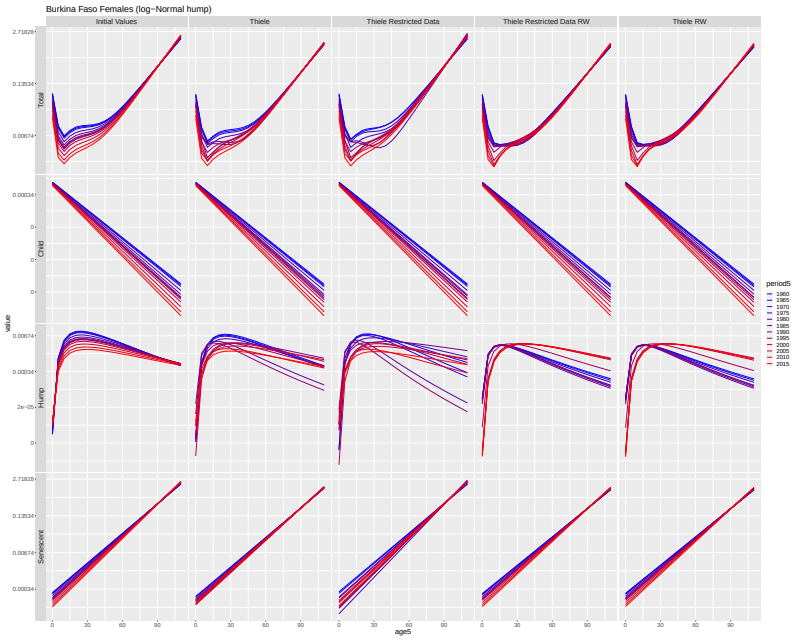

Figure 12: Thiele Decomposed

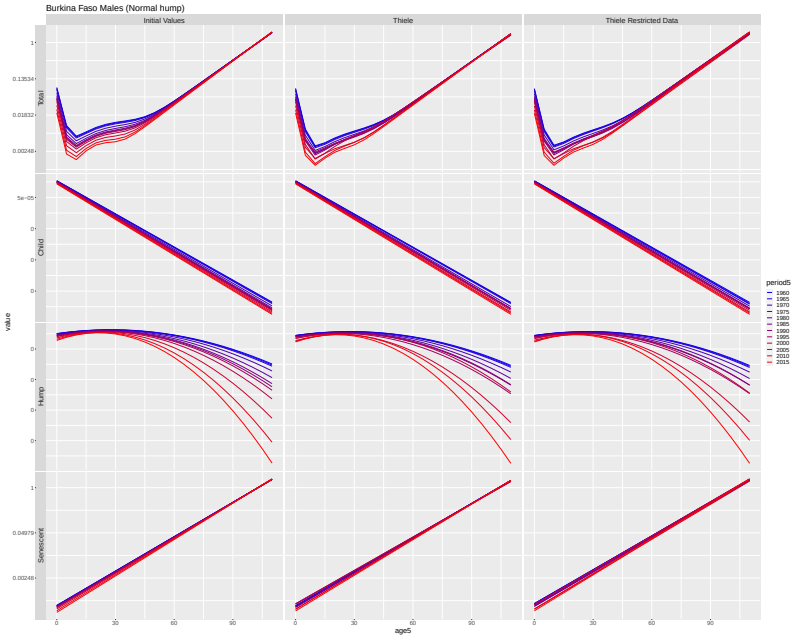

Figure 13: Thiele Decomposed

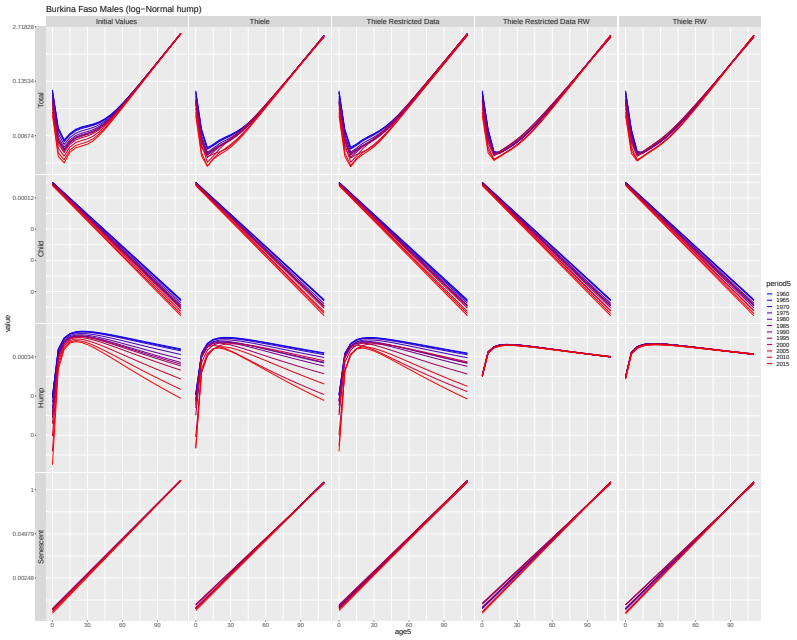

Figure 14: Thiele Decomposed

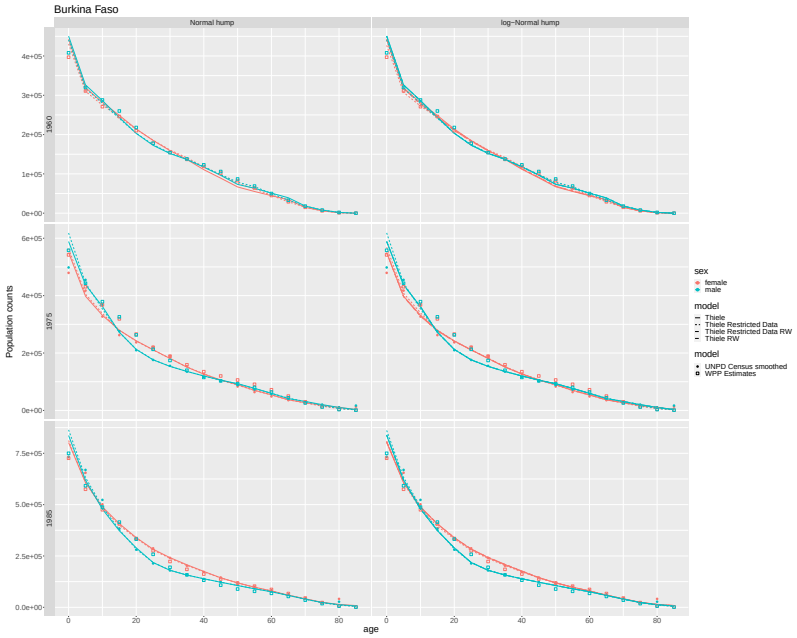

Figure 15: Population

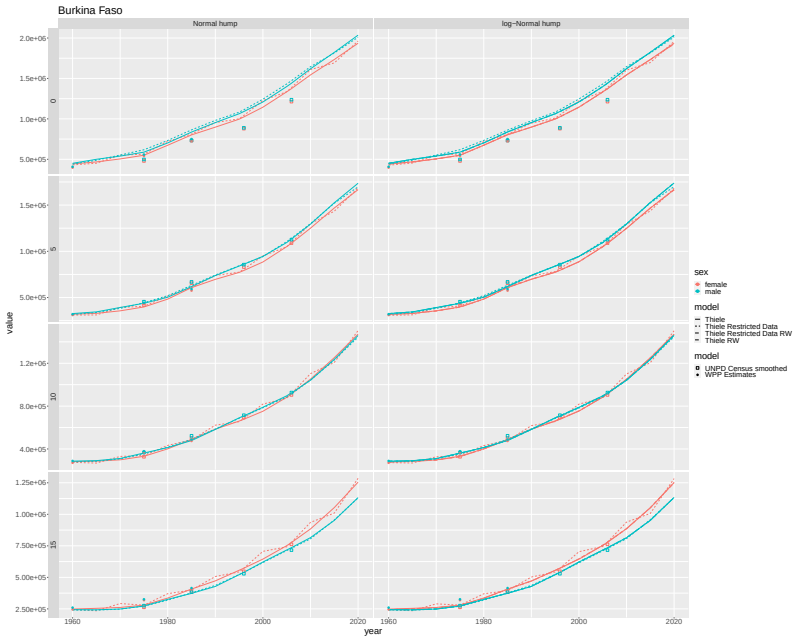

Figure 16: Population

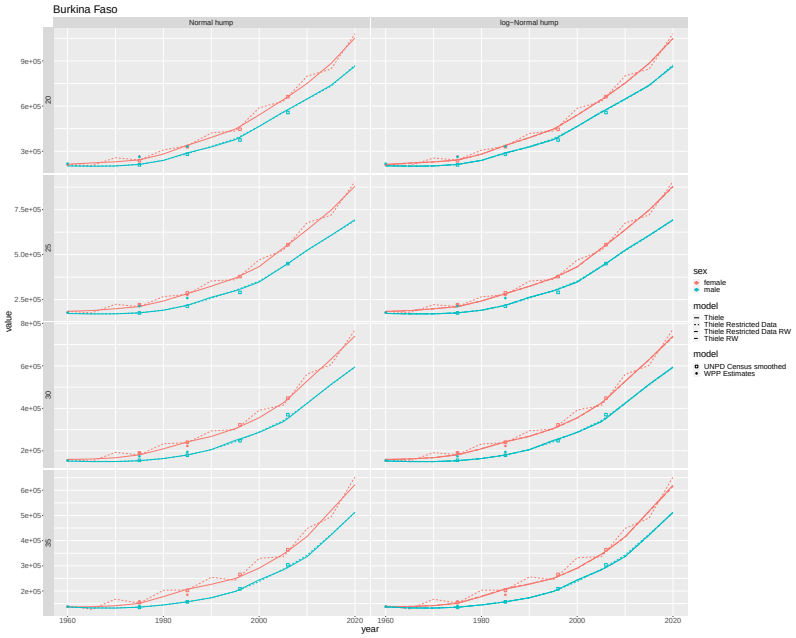

Figure 17: Population

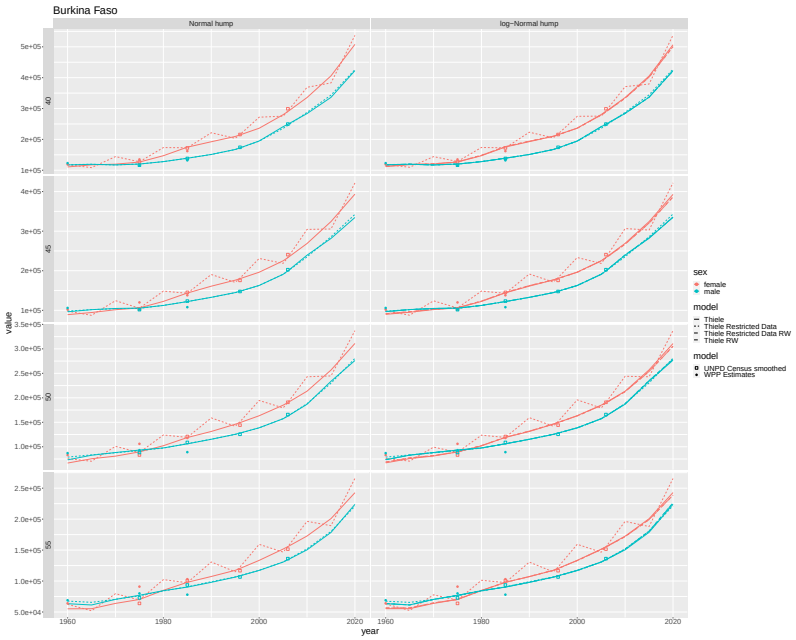

Figure 18: Population

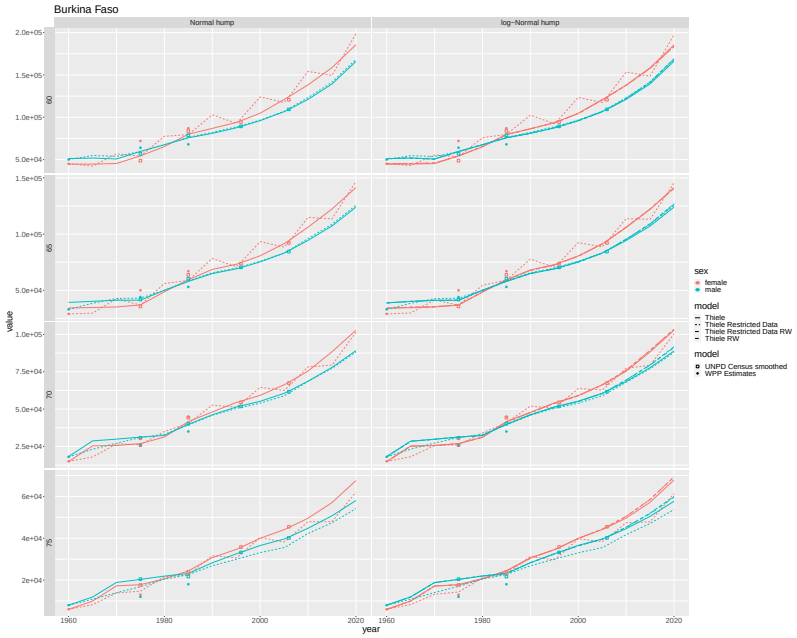

Figure 19: Population

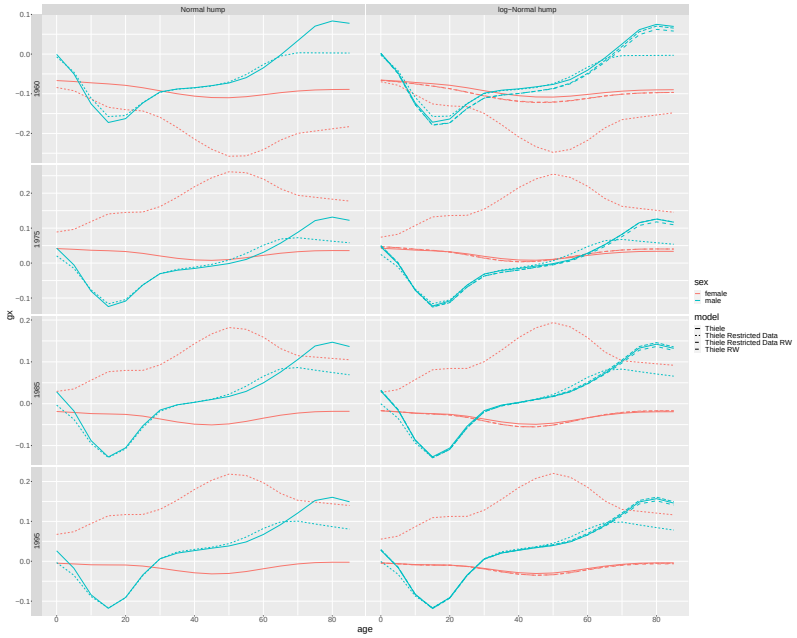

Figure 20: Migration

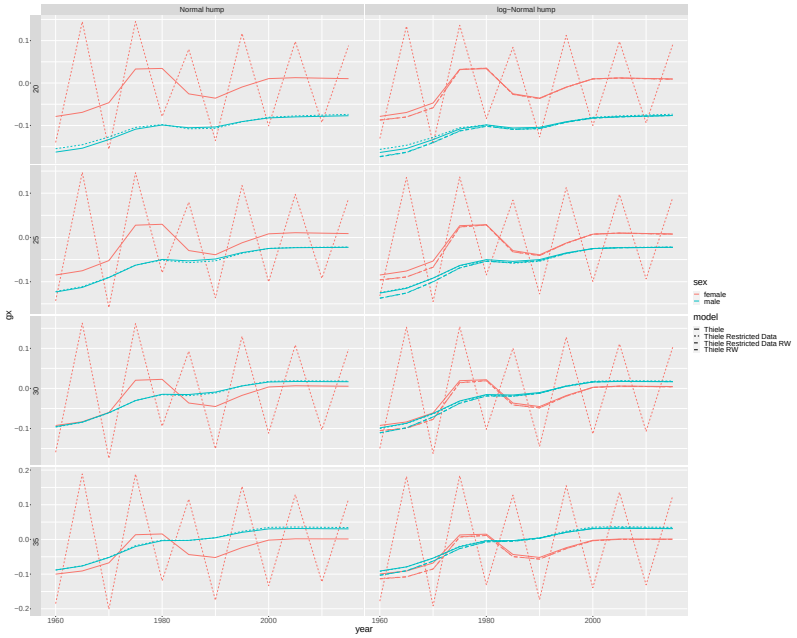

Figure 21: Migration

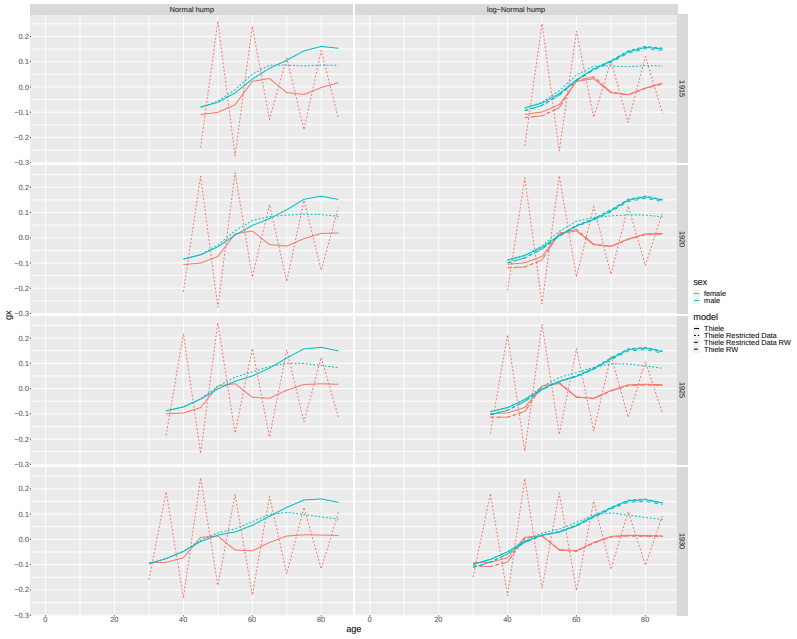

Figure 22: Migration

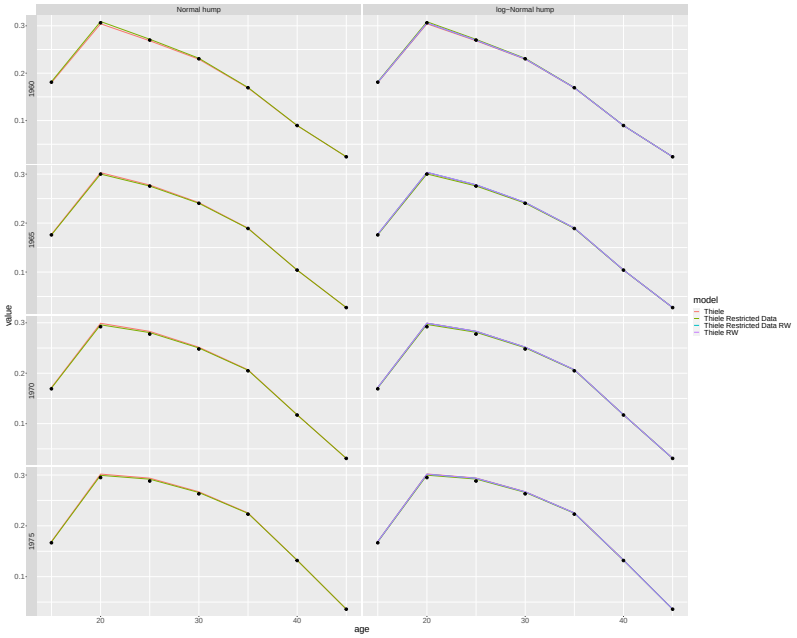

Figure 23: Fertility

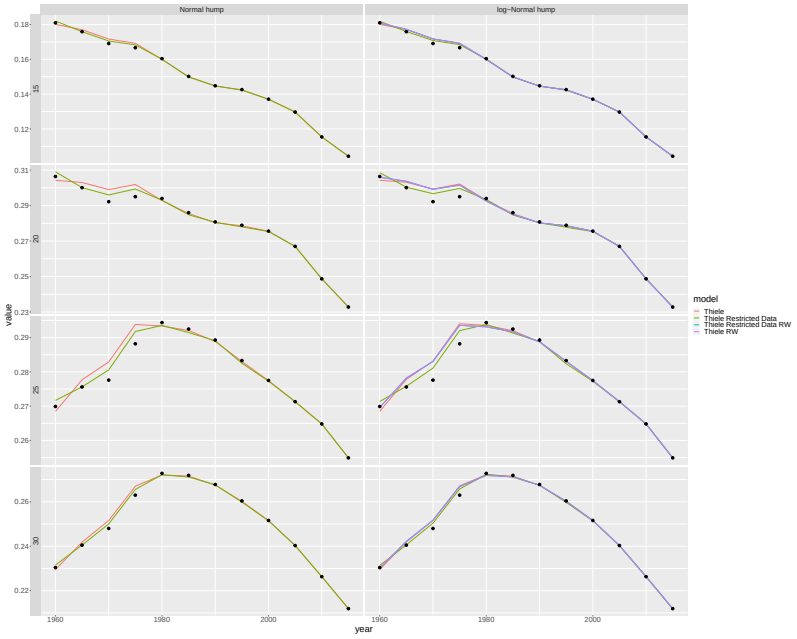

Figure 24: Fertility