Chad

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

```
## # A tibble: 86 x 2
##      age  `2009`
##    <dbl>   <dbl>
##  1     0 202275.
##  2     1 203863.
##  3     2 220704.
##  4     3 221070.
##  5     4 223311.
##  6     5 220975.
##  7     6 210641.
##  8     7 198942.
##  9     8 184859.
## 10     9 170112.
## # ... with 76 more rows
```

```
## [1] "Census Females 5-year"
```

```
## # A tibble: 18 x 2
##      age  `1993`
##    <dbl>   <dbl>
##  1     0 562409.
##  2     5 500500.
##  3    10 401707.
##  4    15 317016.
##  5    20 269428.
##  6    25 239247.
##  7    30 199817.
##  8    35 162208.
##  9    40 132464.
## 10    45 104416.
## 11    50  82104.
## 12    55  63802.
## 13    60  52006.
## 14    65  39956.
## 15    70  38176.
## 16    75  37582.
## 17    80     NA
## 18    85     NA
```

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

```
## # A tibble: 86 x 2
##      age  `2009`
##    <dbl>   <dbl>
##  1     0 206187.
##  2     1 210077.
##  3     2 226819.
##  4     3 227081.
##  5     4 229282.
##  6     5 226472.
```

```
##  7     6 215783.
##  8     7 204745.
##  9     8 191454.
## 10     9 177825.
## # ... with 76 more rows
```

```
## [1] "Census Males 5-year"
```

```
## # A tibble: 18 x 2
##      age  `1993`
##    <dbl>   <dbl>
##  1     0 567470.
##  2     5 510473.
##  3    10 408514.
##  4    15 298617.
##  5    20 225577.
##  6    25 191518.
##  7    30 166186.
##  8    35 139564.
##  9    40 114484.
## 10    45  91839.
## 11    50  73183.
## 12    55  58250.
## 13    60  48631.
## 14    65  38604.
## 15    70  37058.
## 16    75  41378.
## 17    80     NA
## 18    85     NA
```

Thiele log-Normal Hump Spline

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

```
##           log_tau2_logpop_f           log_tau2_logpop_f           log_tau2_logpop_m           log_tau2_
##                   4.8016672                   2.9887900                   5.0520798                   3
##               log_tau2_gx_m         log_lambda_gx_age_f         log_lambda_gx_age_m        log_lambda_g
##                   3.5235742                   7.4356270                   7.4622366                   7
##     log_lambda_gx_agetime_m               log_lambda_tp log_lambda_tp_0_inflated_sd           log_dispe
##                   6.9077616                   2.1197742                  -3.5278117                   0
##     log_marginal_prec_psi_f       log_marginal_prec_A_f       log_marginal_prec_B_f     log_marginal_pre
##                   6.8049117                   6.7749257                   6.3509082                   6
##       log_marginal_prec_B_m            log_lambda_phi_f            log_lambda_psi_f         log_lambda_
##                   3.2330874                   4.3066574                   4.3066000                   4
##               log_lambda_A_f              log_lambda_B_f            log_lambda_phi_m           log_lambd
##                   4.3050569                   4.2853854                   4.3081280                   4
##        log_lambda_epsilon_m              log_lambda_A_m              log_lambda_B_m    logit_lambda_slop
##                   4.3506823                   4.3065724                   4.4790265                  -0
##    logit_lambda_slope_rho_m     logit_delta_slope_rho_m   logit_epsilon_slope_rho_m
##                  -2.6268570                   1.7548513                  -1.0799570
```

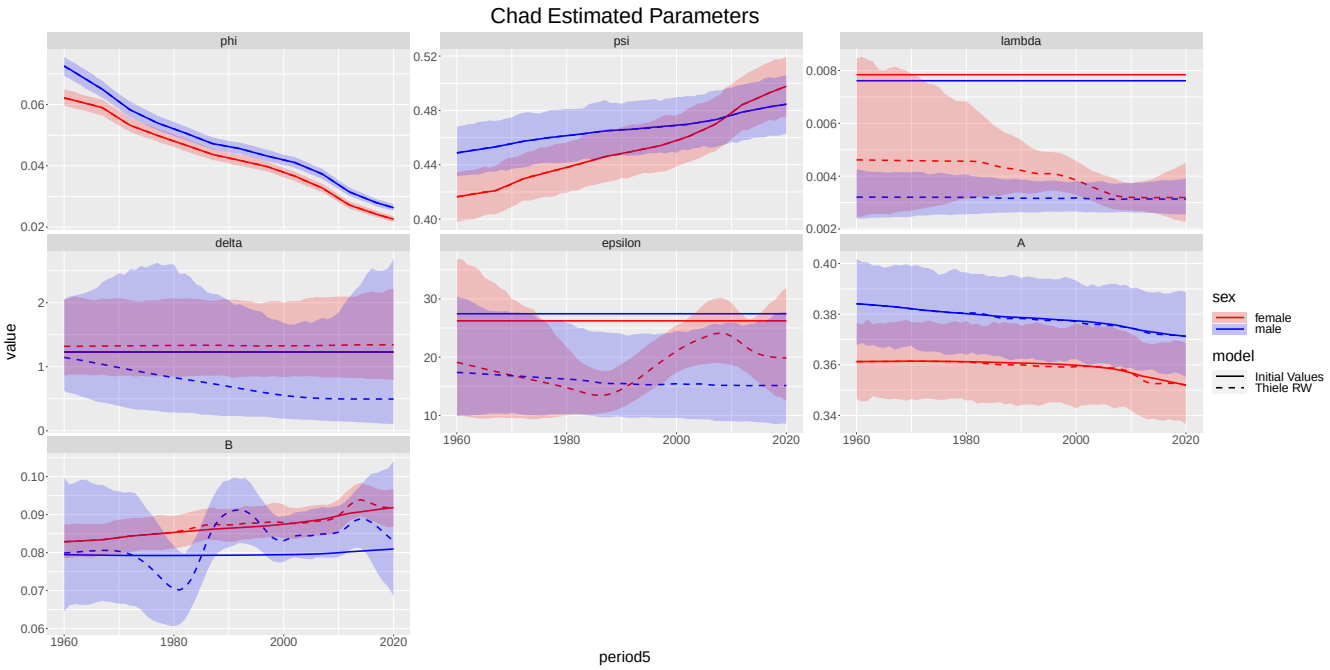

Figure 1: Estimated parameters

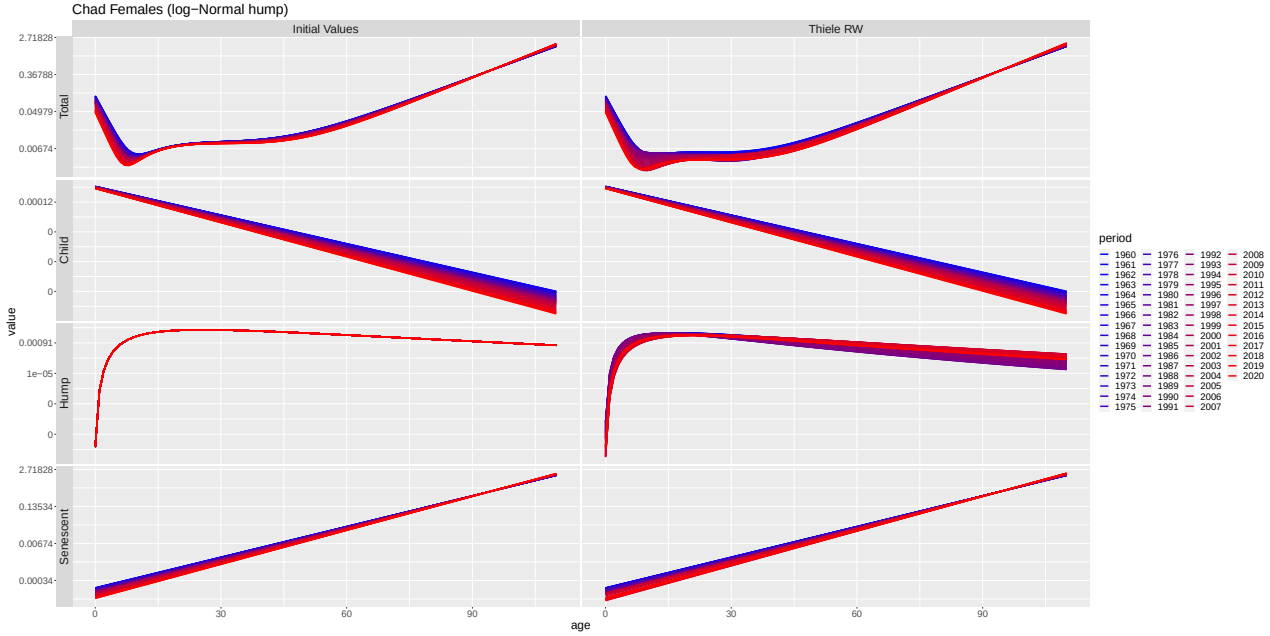

Figure 2: Thiele Decomposed

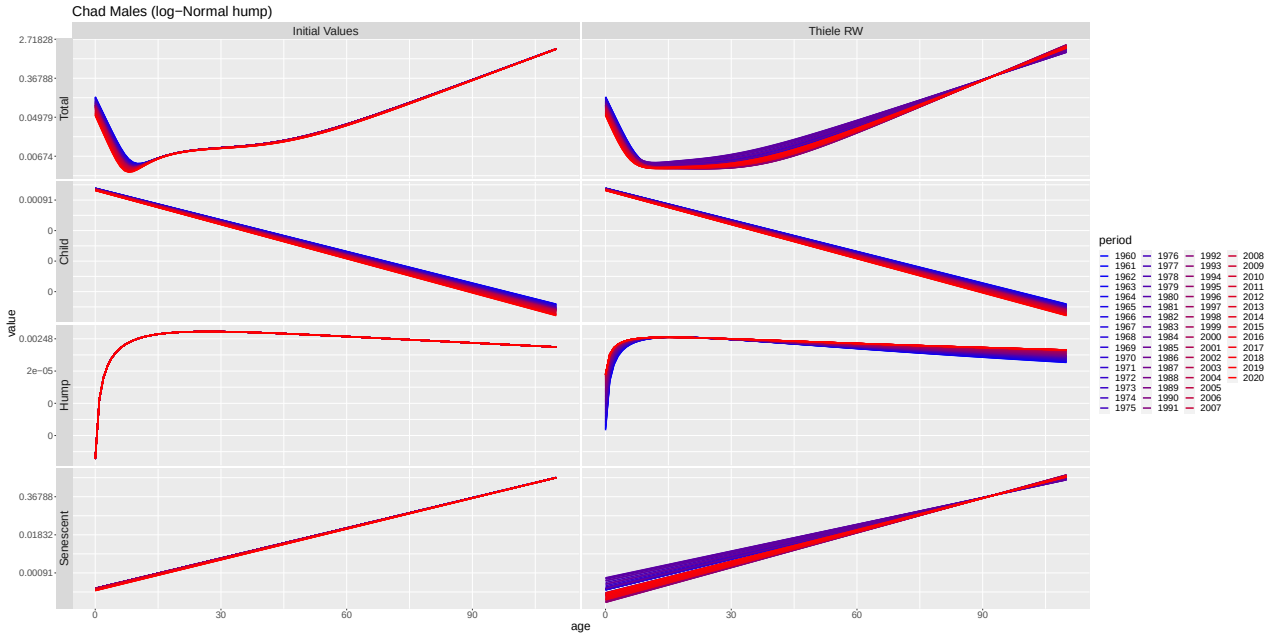

Figure 3: Thiele Decomposed

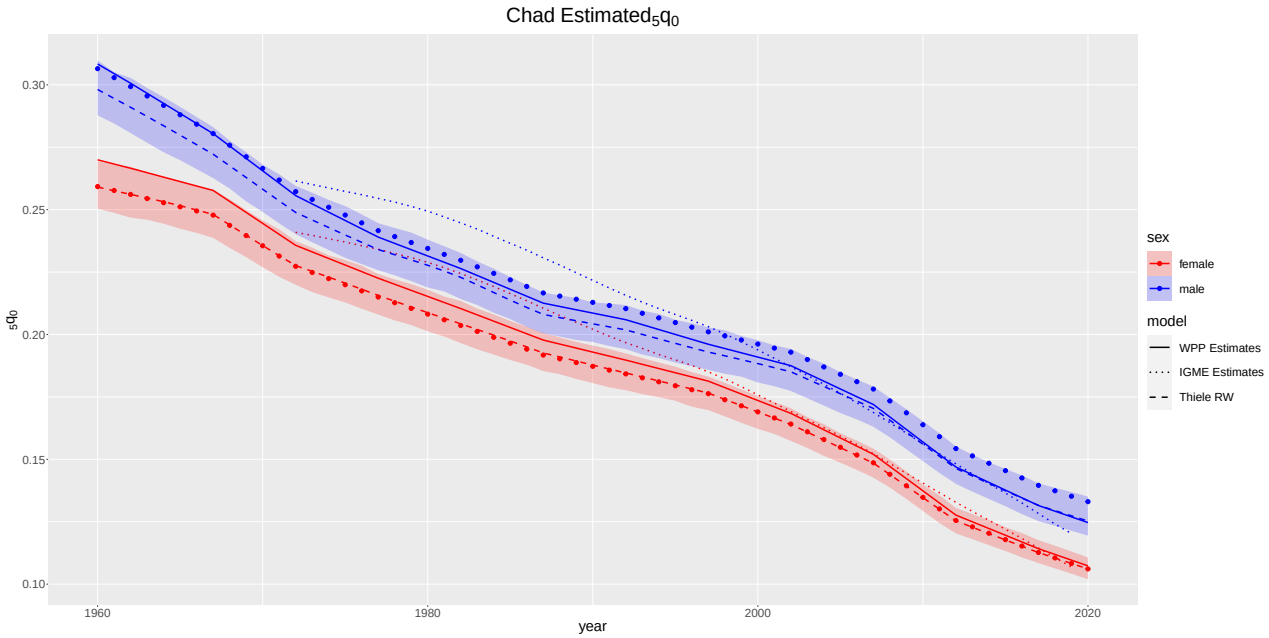

Figure 4: Estimated ${}_5q_0$

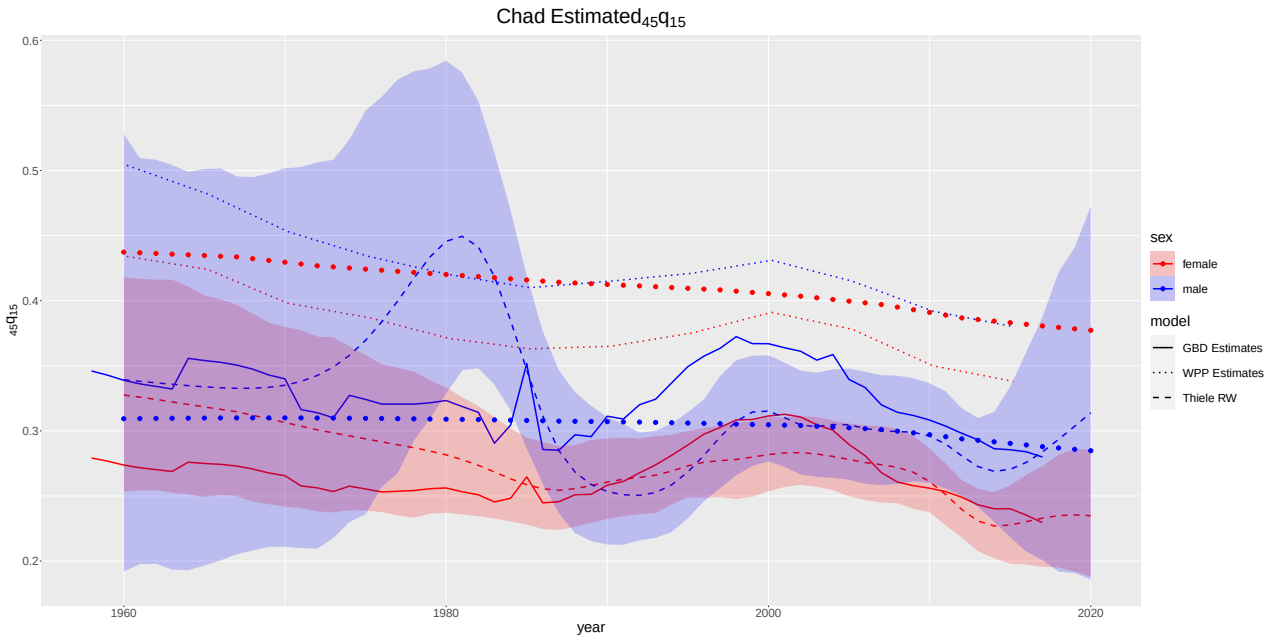

Figure 5: Estimated ${}_{45}q_{15}$

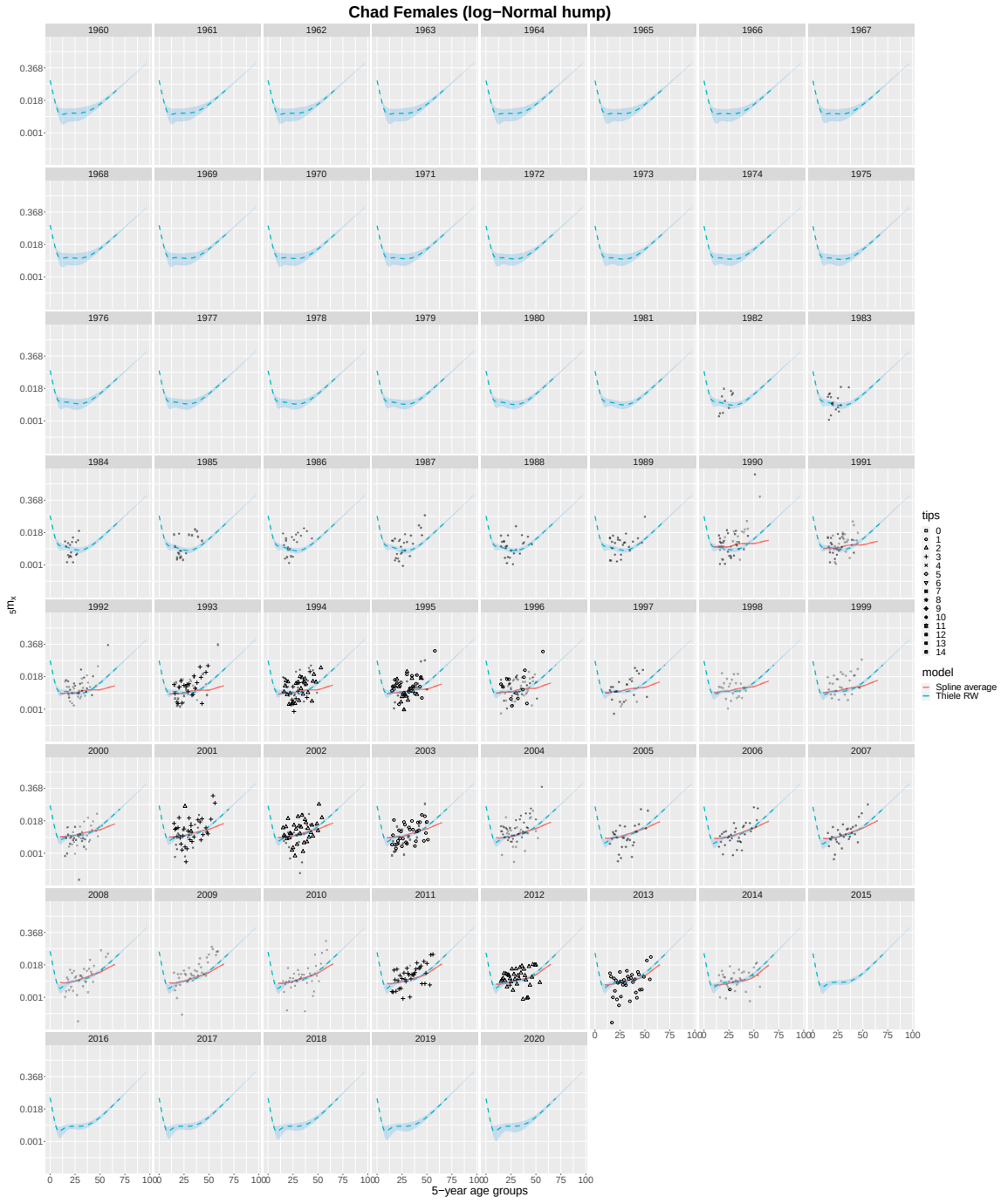

Figure 6: Mortality Schedules

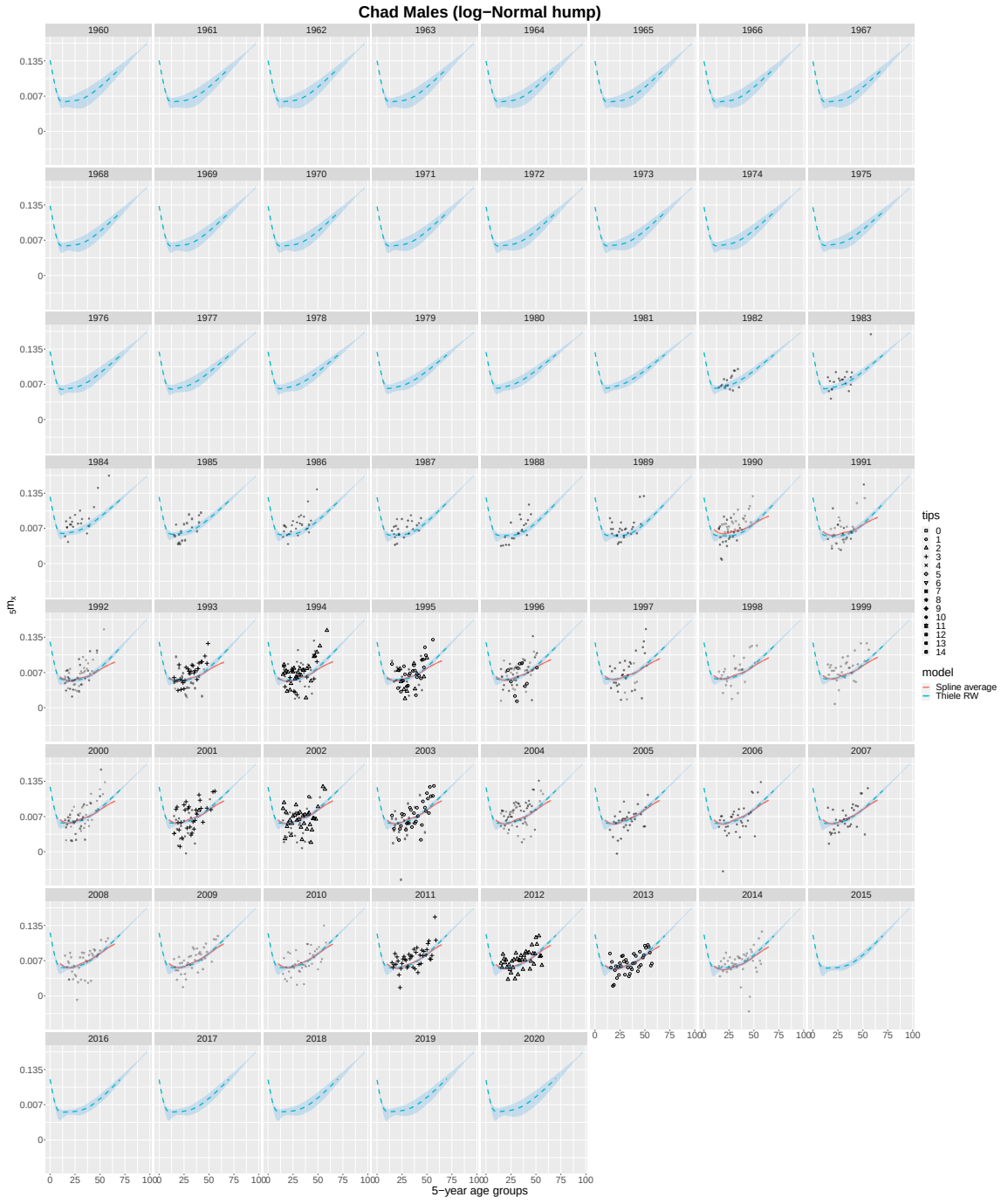

Figure 7: Mortality Schedules

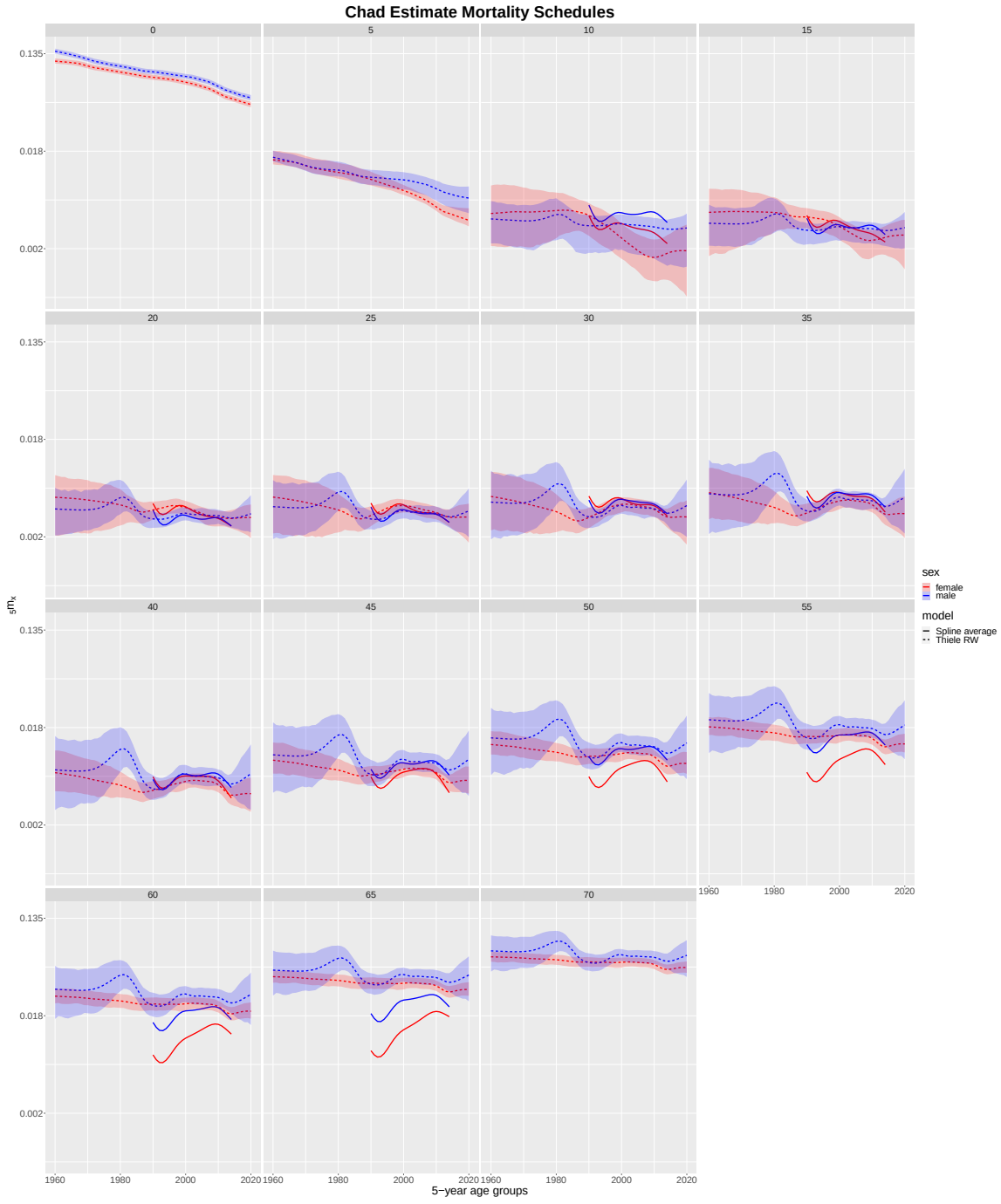

Figure 8: Mortality Schedules

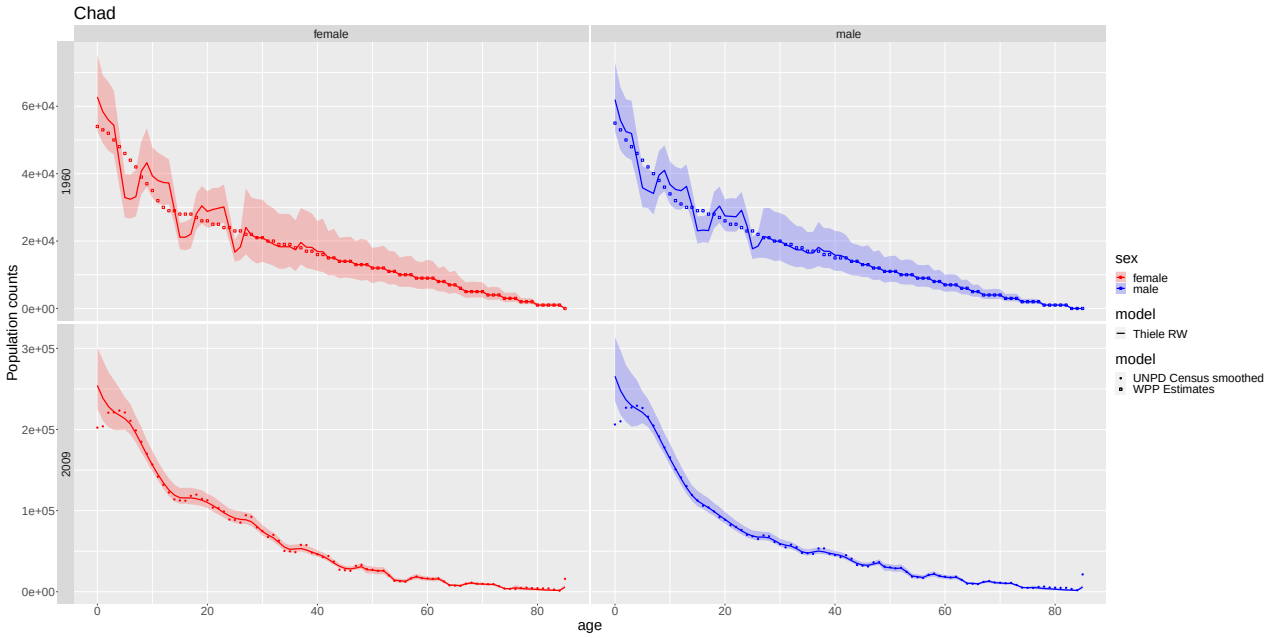

Figure 9: Population

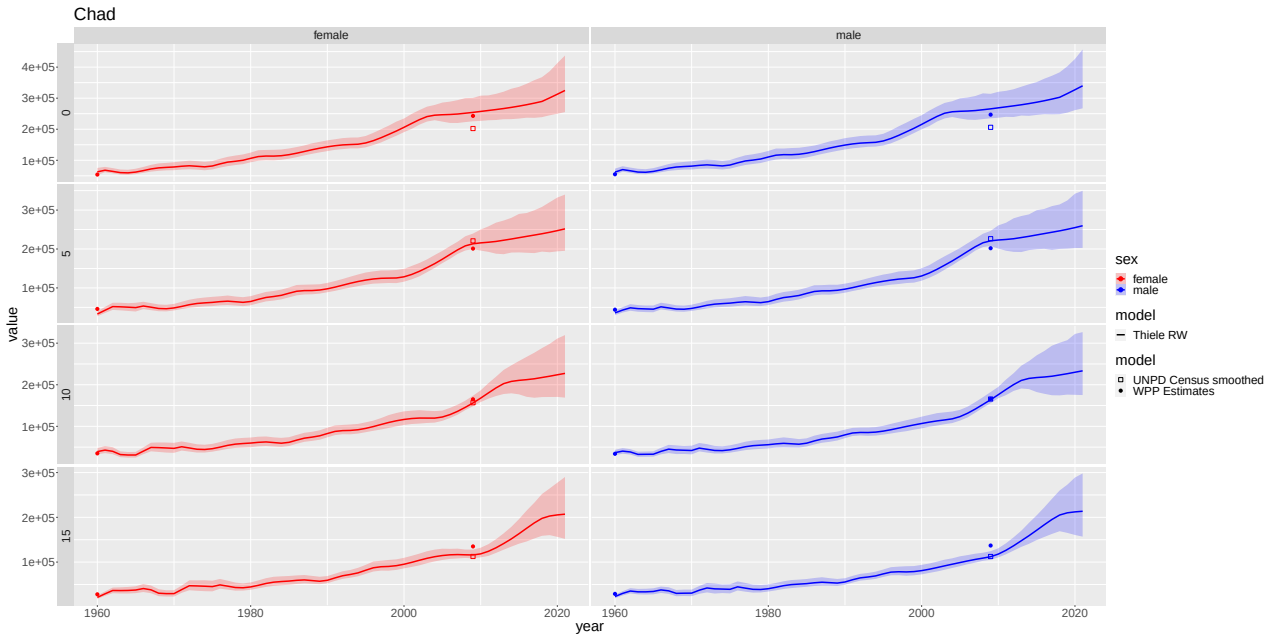

Figure 10: Population

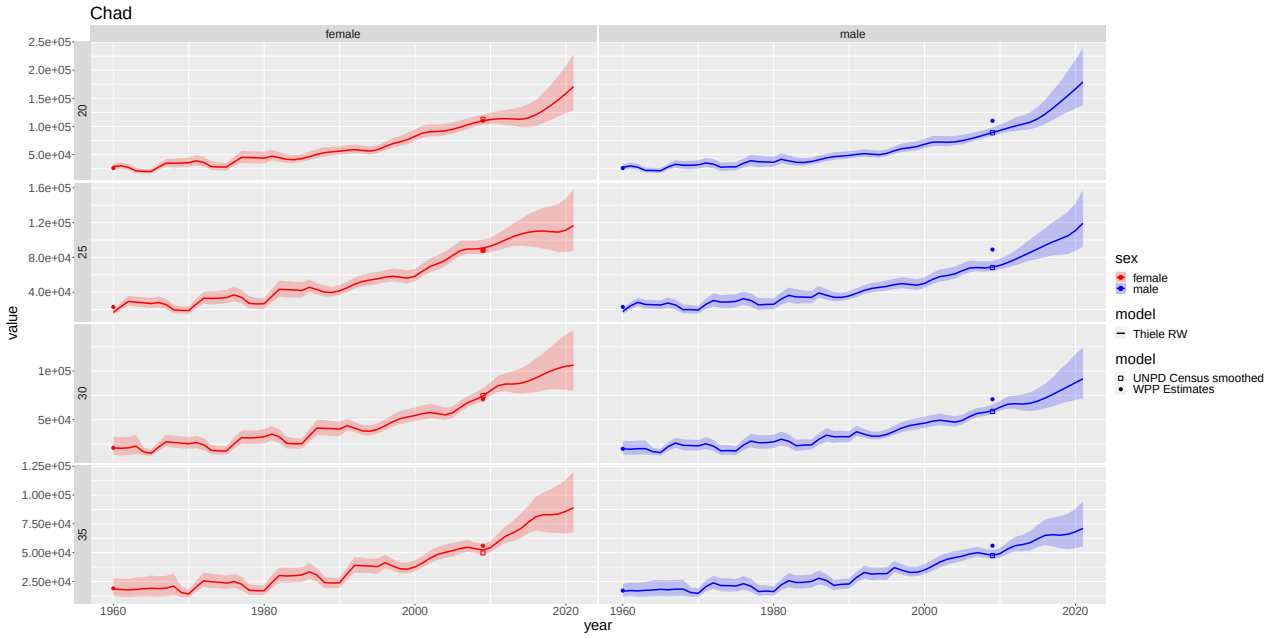

Figure 11: Population

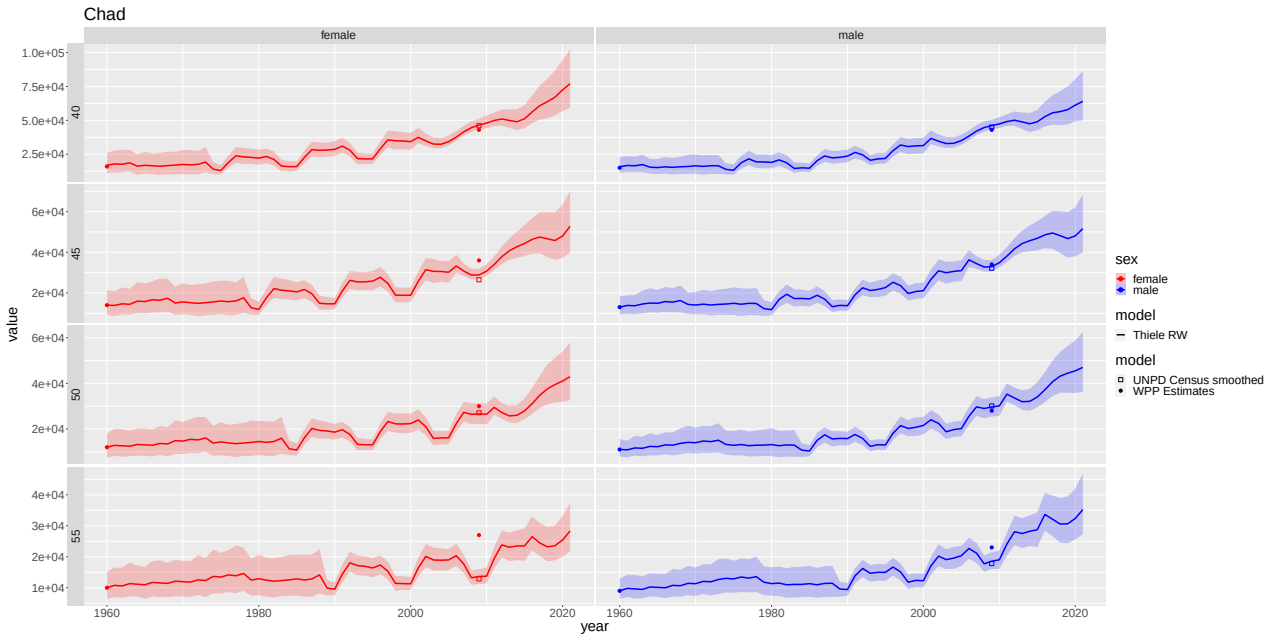

Figure 12: Population

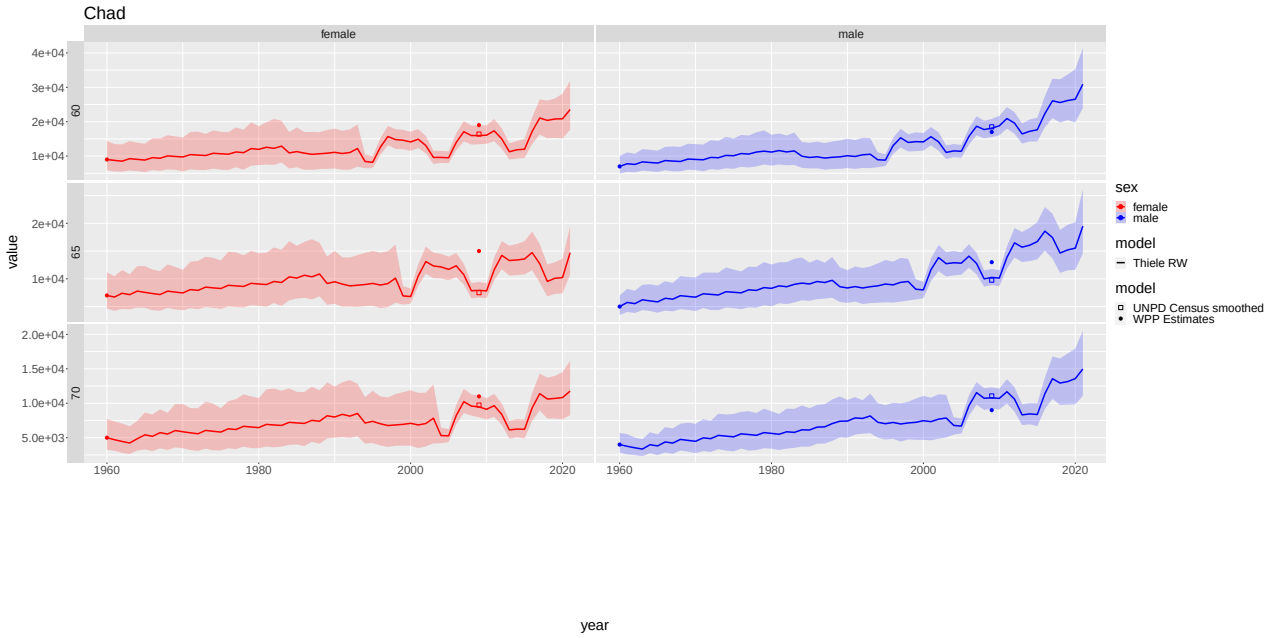

Figure 13: Population

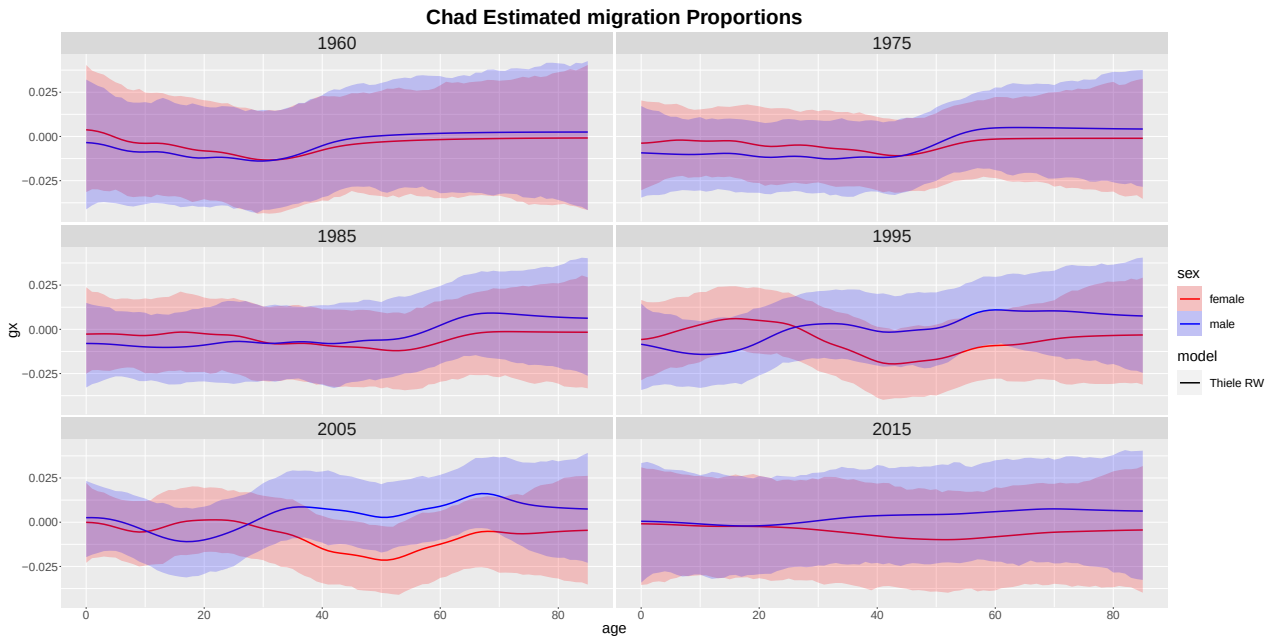

Figure 14: Migration

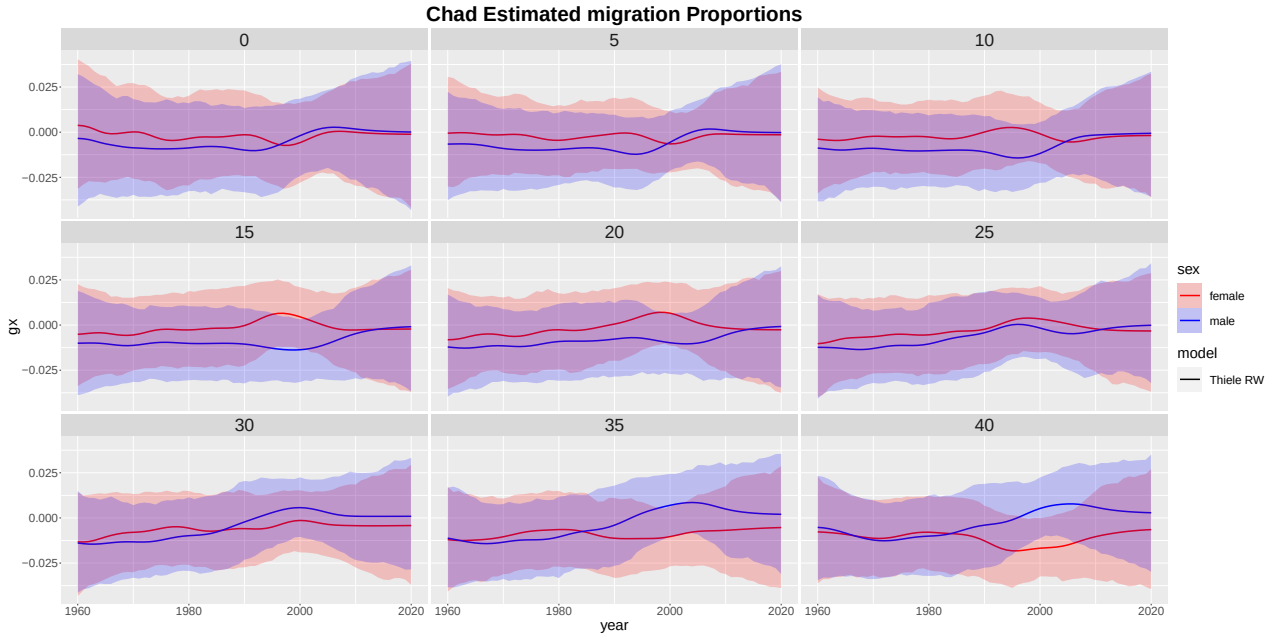

Figure 15: Migration

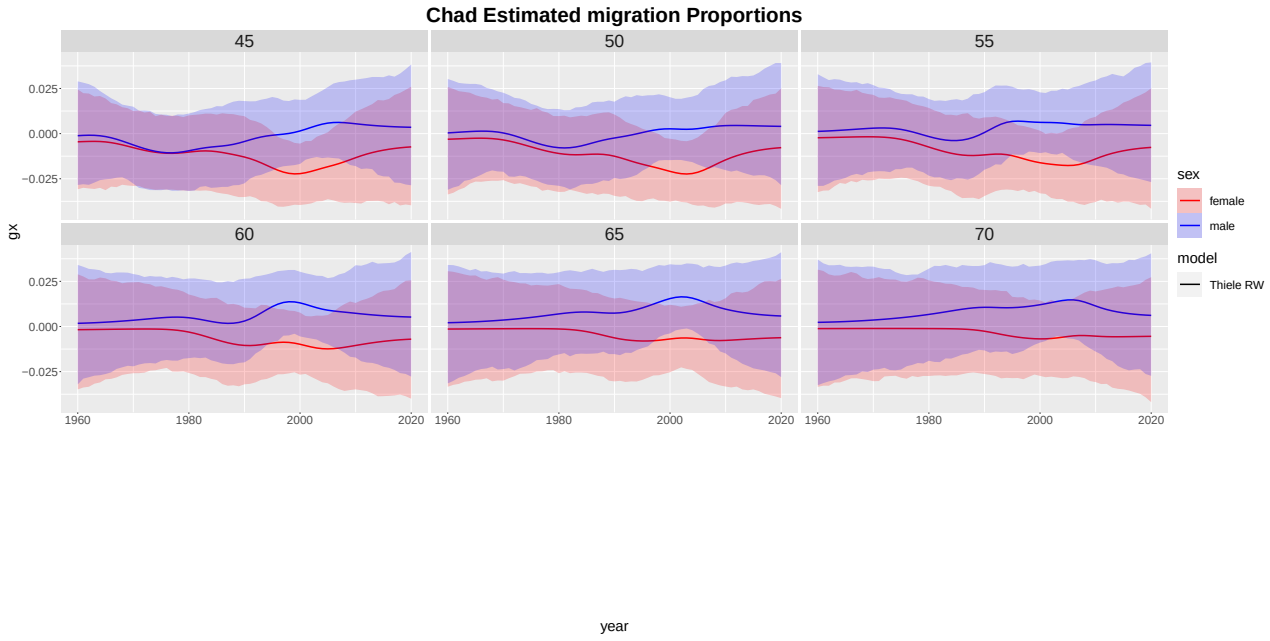

Figure 16: Migration

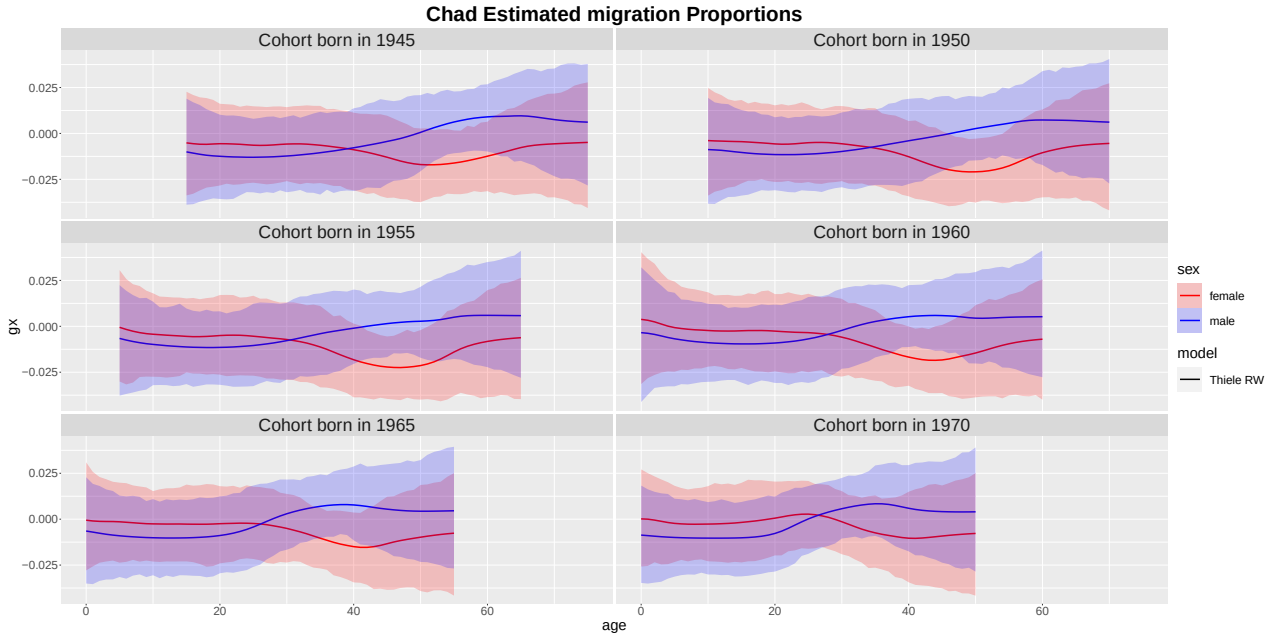

Figure 17: Migration

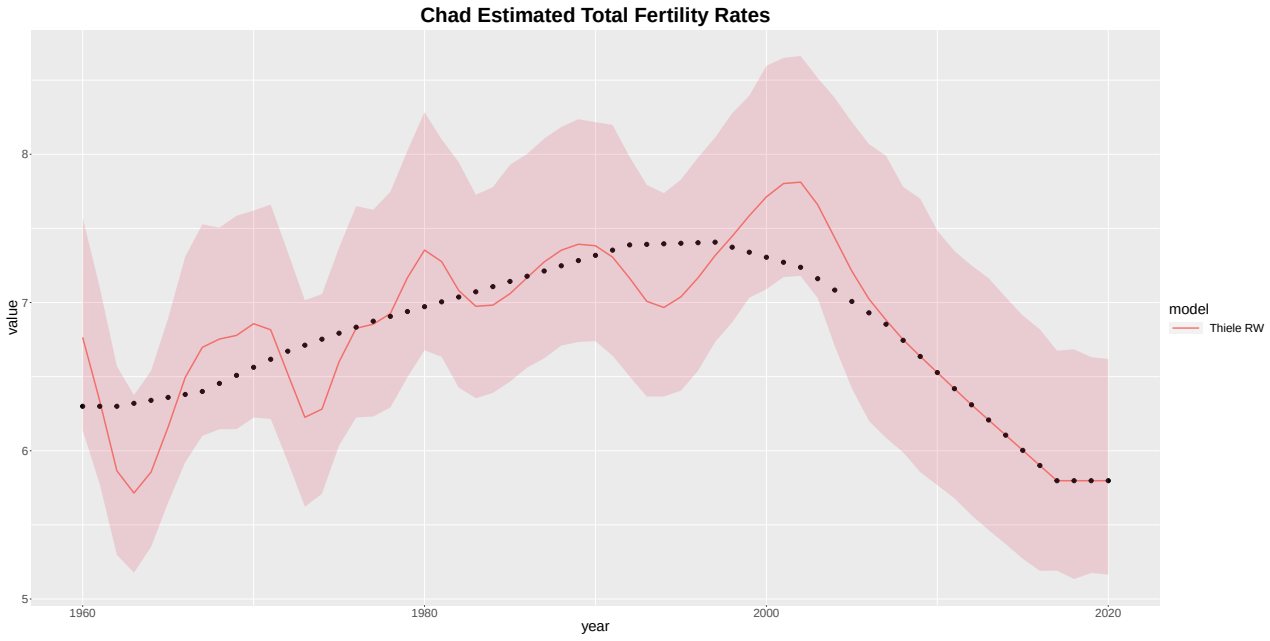

Figure 18: Total Fertility

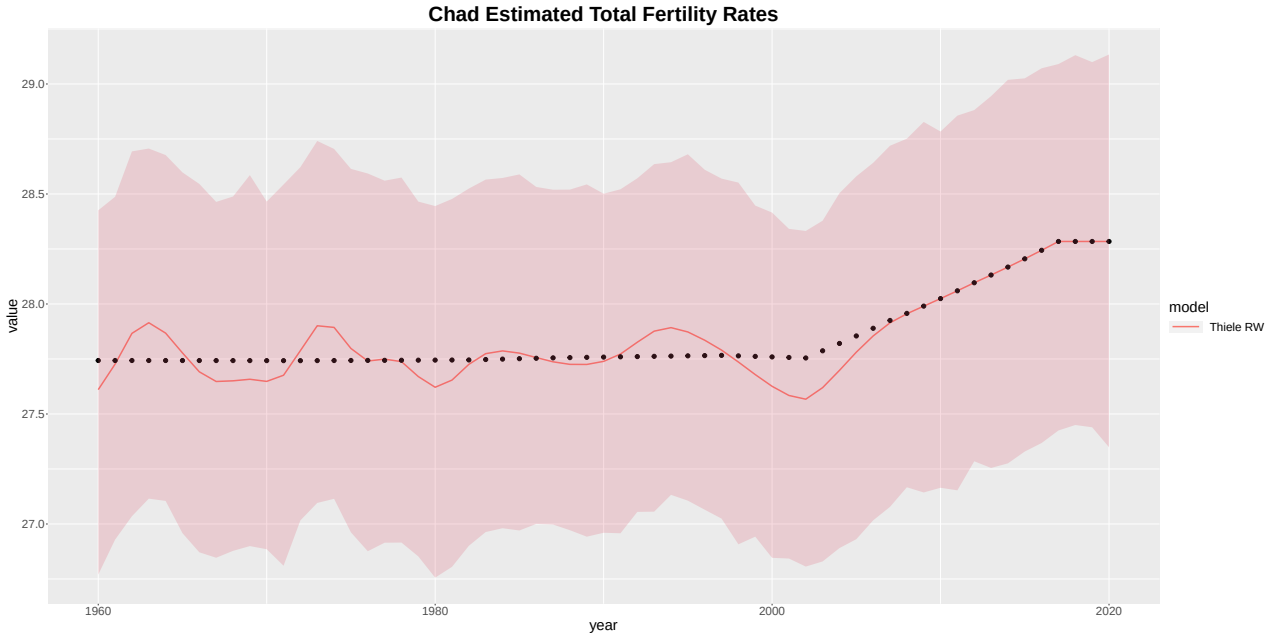

Figure 19: Mean age at births

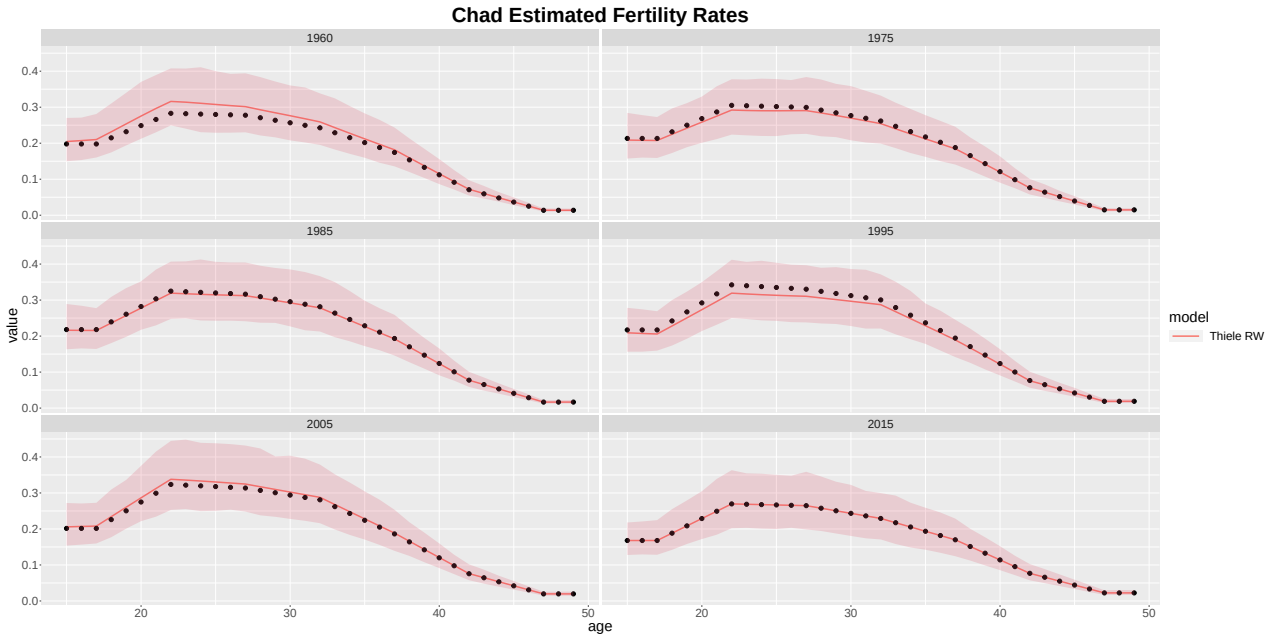

Figure 20: Fertility

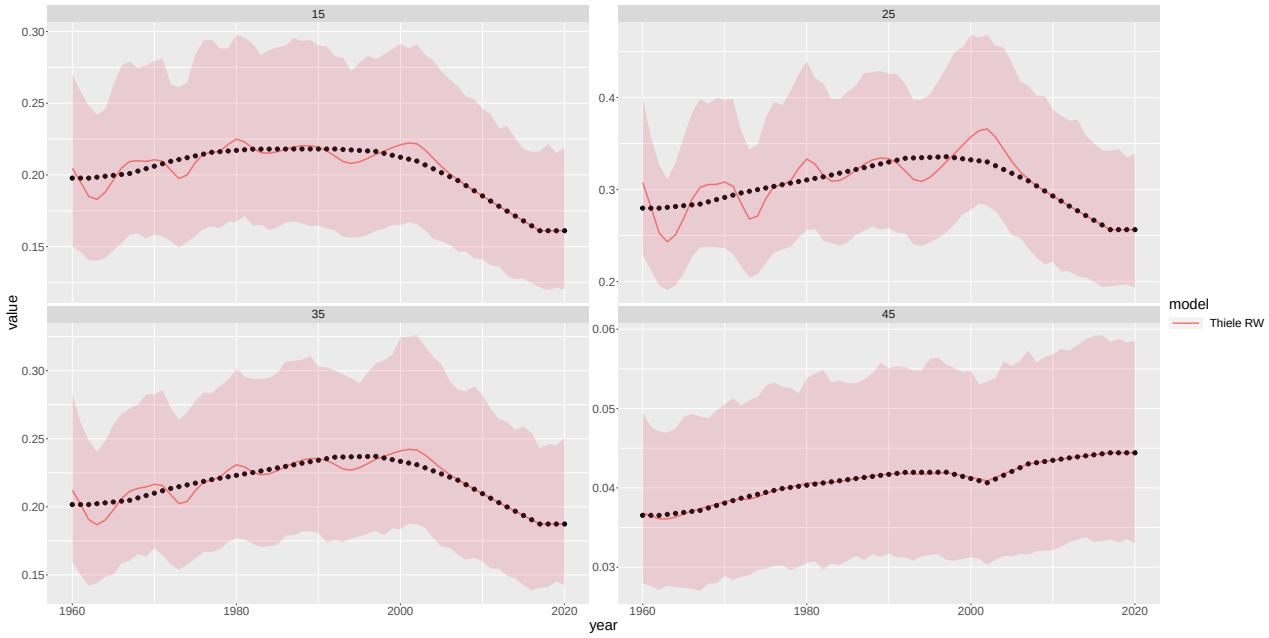

Figure 21: Fertility