Malawi

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

## # A tibble: 86 x 5
##      age  `1987`  `1998`  `2008`  `2018`
##    <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1      0 150512. 185817  255576  263837
## 2      1 130056. 161798. 237534. 255733
## 3      2 137591. 163355. 237811. 255945
## 4      3 142055. 163996. 231596. 260083.
## 5      4 146577. 160454. 224314. 261987.
## 6      5 146247. 158092. 220173. 264751.
## 7      6 140033. 154088. 212261. 266295.
## 8      7 132367. 147606. 201612. 267062.
## 9      8 126294. 139309  192051. 266622.
## 10     9 117420. 133715. 185614. 263807.
## # ... with 76 more rows

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

## # A tibble: 18 x 3
##      age  `1966`  `1977`
##    <dbl>   <dbl>   <dbl>
## 1      0 382092  552376.
## 2      5 301988  416036.
## 3     10 250885. 313031.
## 4     15 209466  273147.
## 5     20 183540. 255764.
## 6     25 164044. 220751.
## 7     30 142858  175355.
## 8     35 121689. 140220.
## 9     40 102922  119257.
## 10    45  83121. 104342.
## 11    50  66045   85701.
## 12    55  49106   67465.
## 13    60  33155   54358.
## 14    65  79545   40983.
## 15    70     NA   28902.
## 16    75     NA   20259.
## 17    80     NA   13773.
## 18    85     NA   24390.

## [1] "Census Males"

## # A tibble: 86 x 5
##      age  `1987`  `1998`  `2008`  `2018`
##    <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1      0 147339. 182508  247809  258965
## 2      1 127821. 160517  232052. 252346.
## 3      2 134432. 160929  232018. 252047.
## 4      3 138672. 161853. 226052. 255496.
## 5      4 143023. 158123. 219009. 256999.
## 6      5 142844. 155530. 214853. 259155.
```

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##  7      6 137182. 151564. 207116. 259989.
##  8      7 129233. 145452  196810. 259862.
##  9      8 123508. 137236. 187436. 258800.
## 10      9 115626. 131935. 181245. 255940.
## # ... with 76 more rows
```

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

```
## # A tibble: 18 x 3
##      age  `1966`  `1977`
##    <dbl>   <dbl>   <dbl>
##  1     0  366133 529521.
##  2     5  295618 410674.
##  3    10 238983. 314866.
##  4    15  189232 253035.
##  5    20 153666. 213954.
##  6    25 128427. 187227.
##  7    30 109493. 156681.
##  8    35  95656. 125964.
##  9    40   84395 106763.
## 10    45  71344.  92944.
## 11    50  59436.  75529.
## 12    55   47722   61111.
## 13    60   33228   50887.
## 14    65   81935   39100.
## 15    70      NA   28168.
## 16    75      NA   19497.
## 17    80      NA   11498.
## 18    85      NA   23975.
```

Thiele log-Normal Hump Spline

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

```
##          log_tau2_logpop_f          log_tau2_logpop_f          log_tau2_logpop_m             log_tau2_
##                  6.4439305                  4.8802133                  6.4247924                     4
##              log_tau2_gx_m          log_lambda_gx_age_f          log_lambda_gx_age_m            log_lambda_g
##                  2.4035489                  6.0678699                  6.8328748                     7
##        log_lambda_gx_agetime_m              log_lambda_tp log_lambda_tp_0_inflated_sd           log_disp
##                  6.9077981                  2.0448331                 -0.8508134                     1
##        log_marginal_prec_psi_f        log_marginal_prec_A_f        log_marginal_prec_B_f        log_marginal_pr
##                  6.8090119                  6.7916640                  6.9349410                     6
##          log_marginal_prec_B_m            log_lambda_phi_f            log_lambda_psi_f             log_lambda_
##                  2.3894958                  4.3137179                  4.3103872                     2
##              log_lambda_A_f              log_lambda_B_f            log_lambda_phi_m               log_lamb
##                  4.3096680                  4.3445840                  4.3173857                     4
##          log_lambda_epsilon_m              log_lambda_A_m              log_lambda_B_m logit_lambda_slo
##                  4.7530103                  4.3008799                  4.8995881                     1
##        logit_lambda_slope_rho_m     logit_delta_slope_rho_m    logit_epsilon_slope_rho_m
##                 -1.2468757                  1.5456587                  0.4294326
```
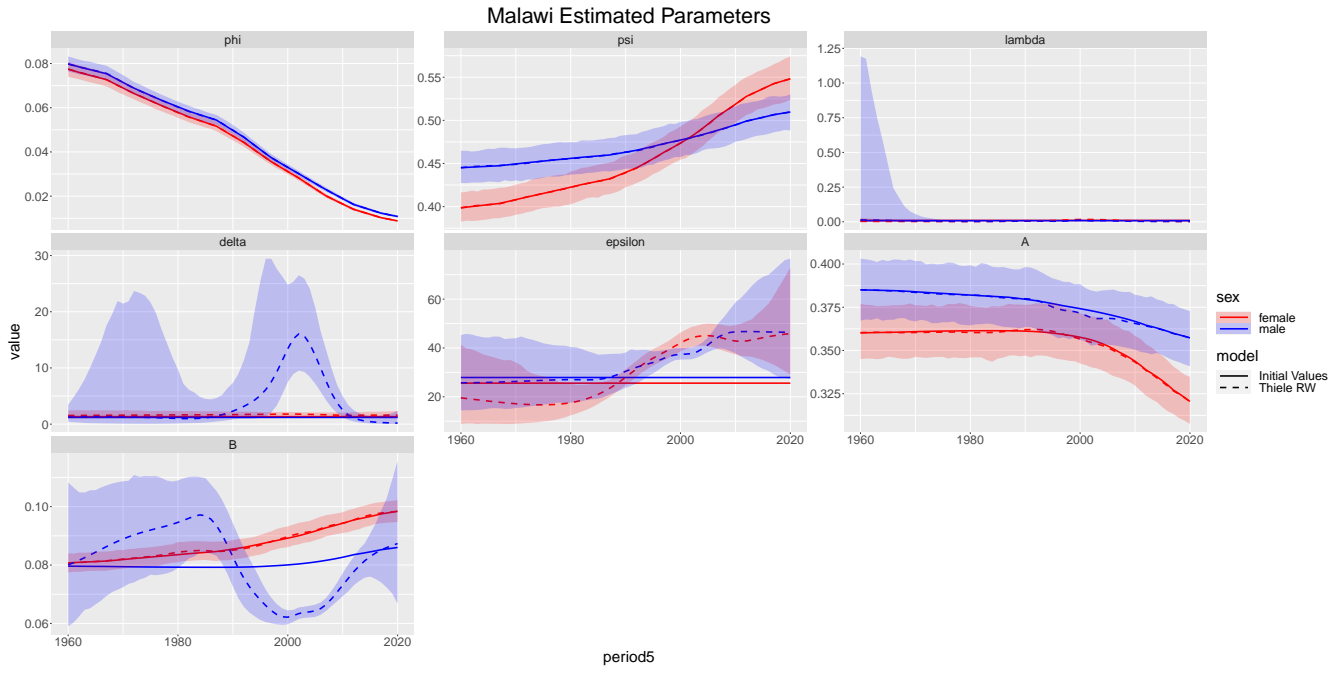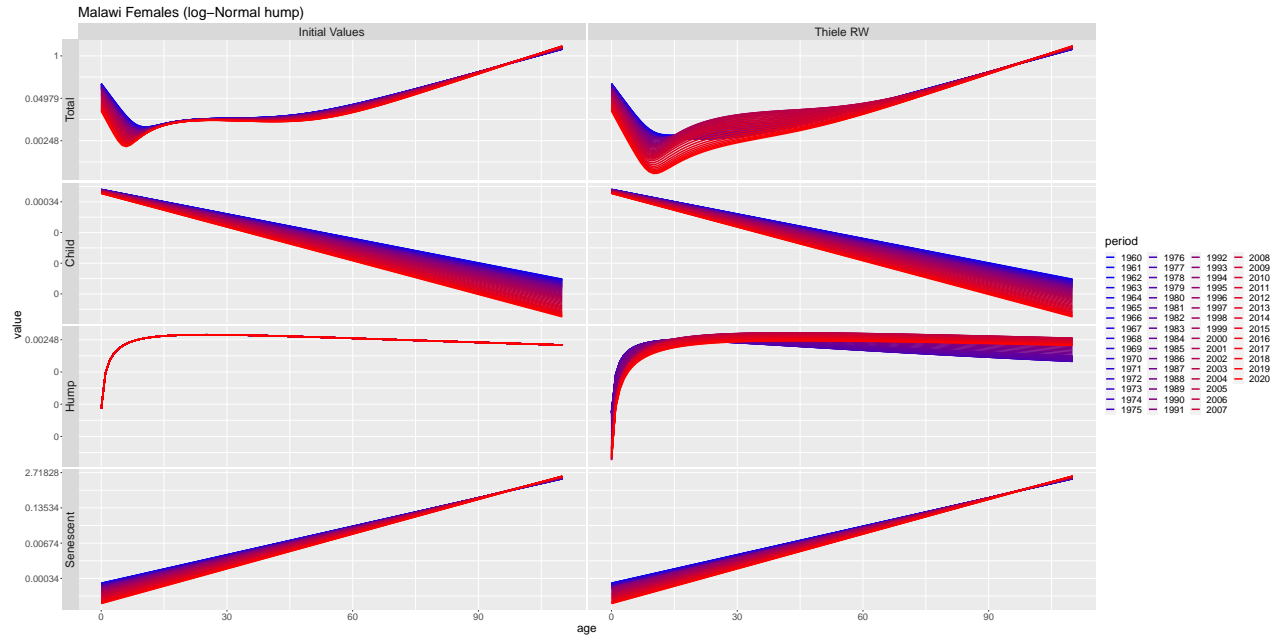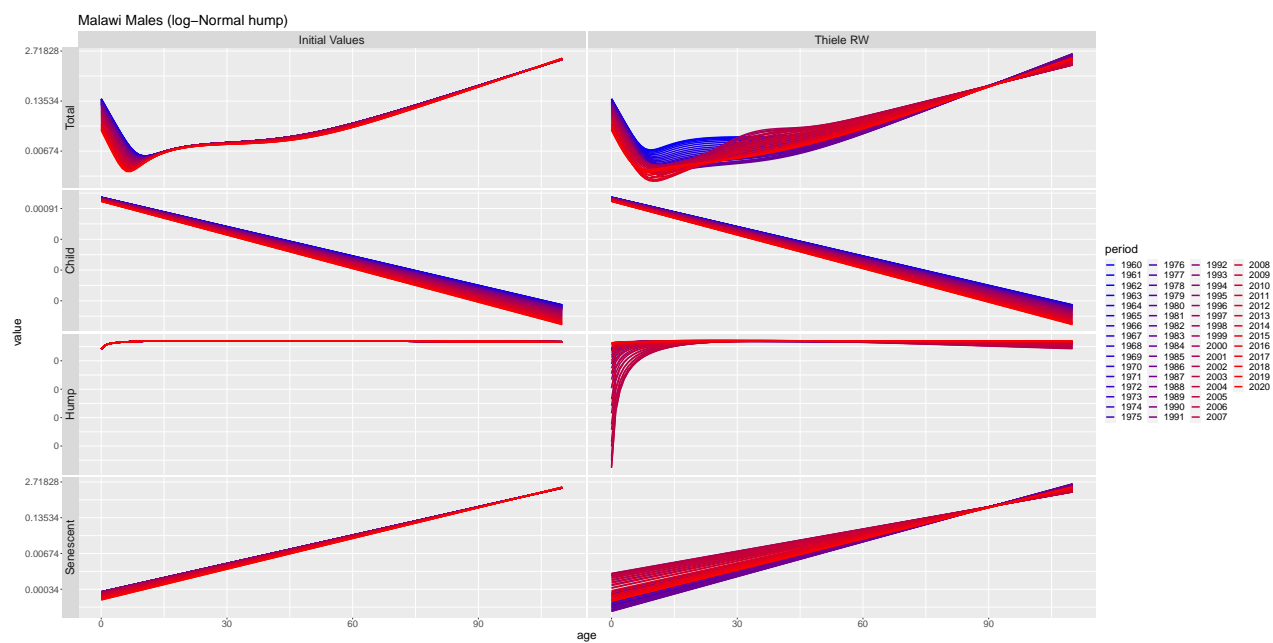
Figure 1: Estimated parameters

Figure 2: Thiele Decomposed

Malawi Males (log–Normal hump)

Figure 3: Thiele Decomposed
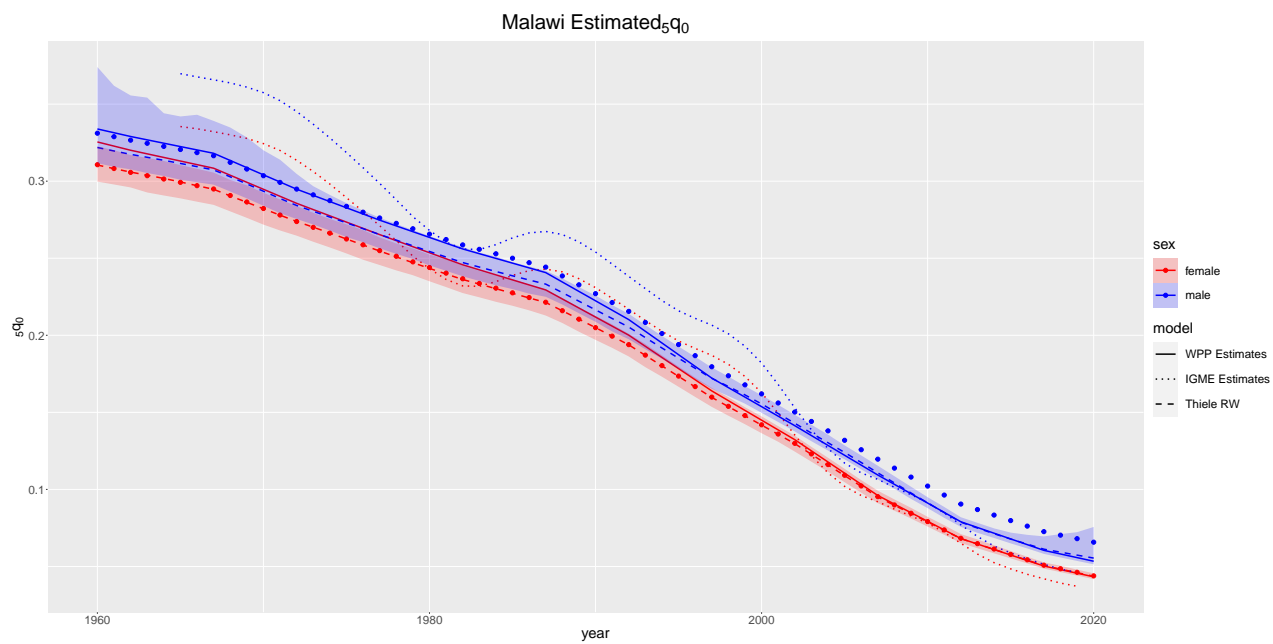
Malawi Estimated $_5q_0$

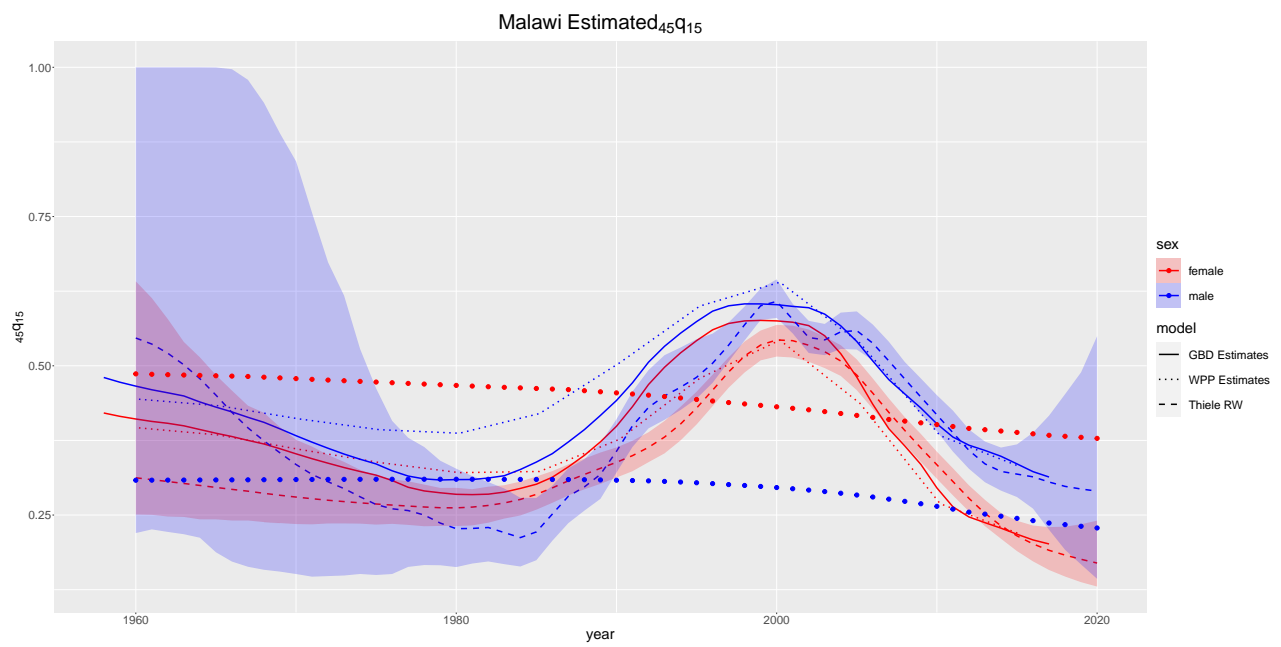Figure 4: Estimated $_5q_0$

4
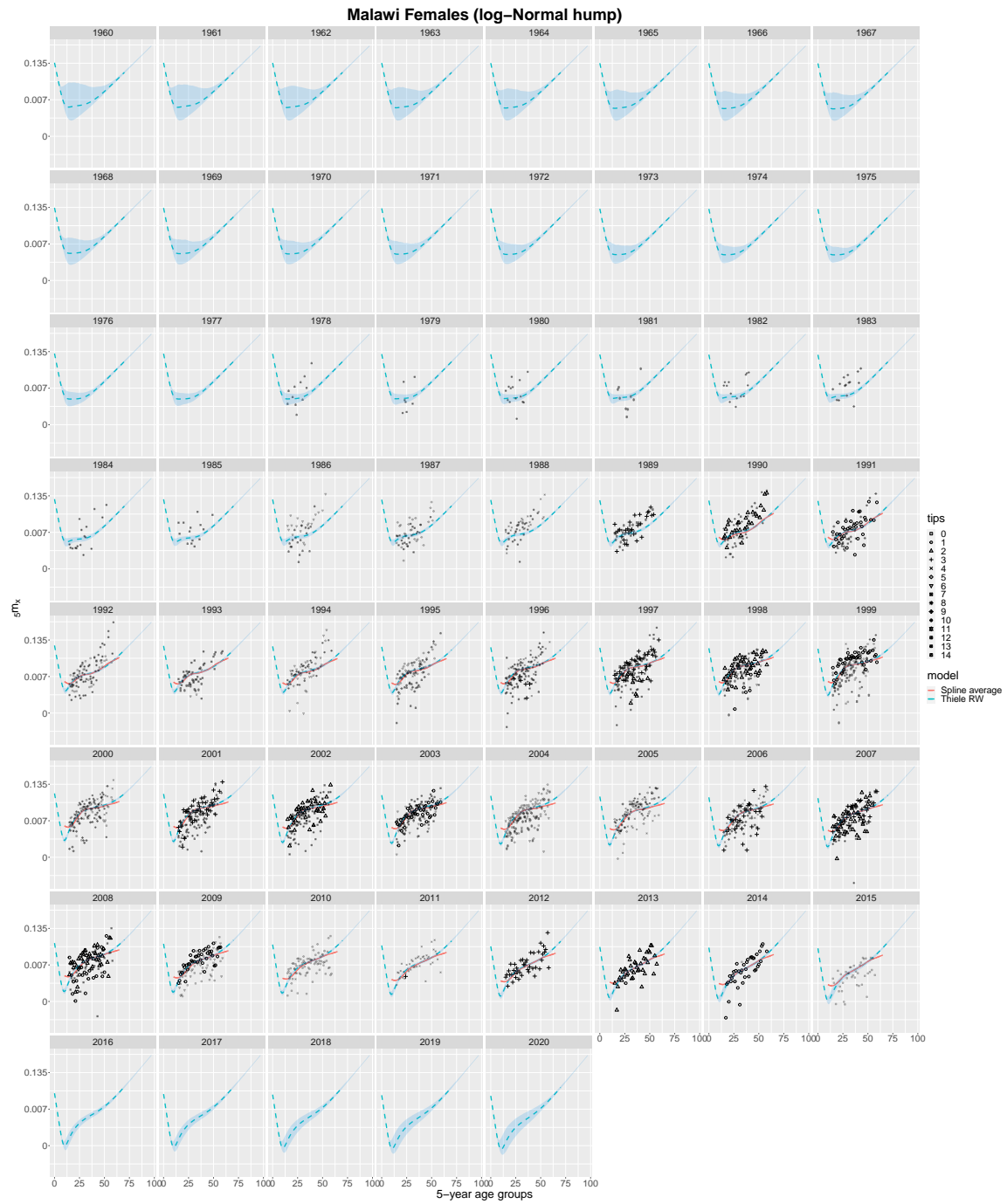
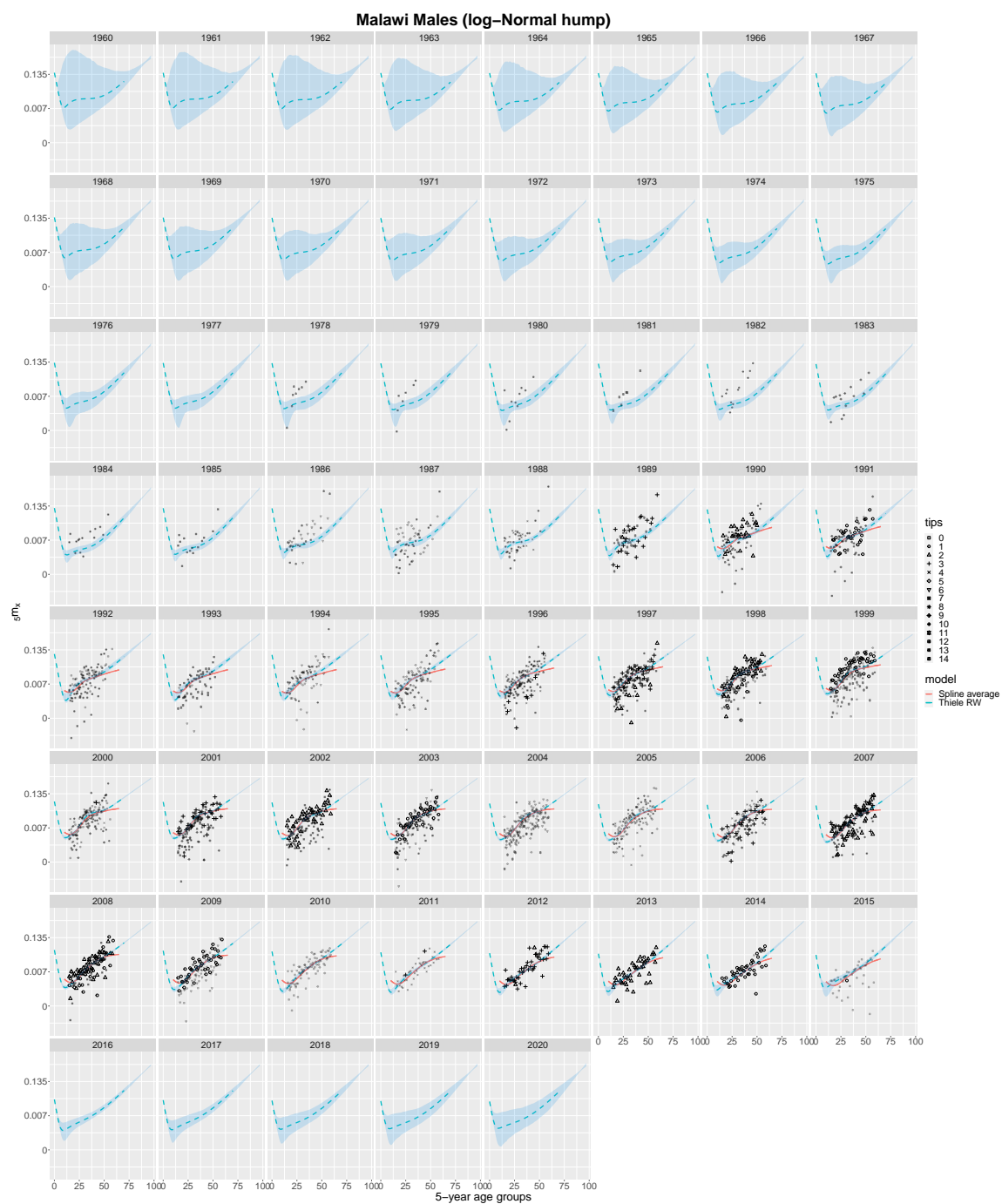Figure 5: Estimated $_{45}q_{15}$

Figure 6: Mortality Schedules
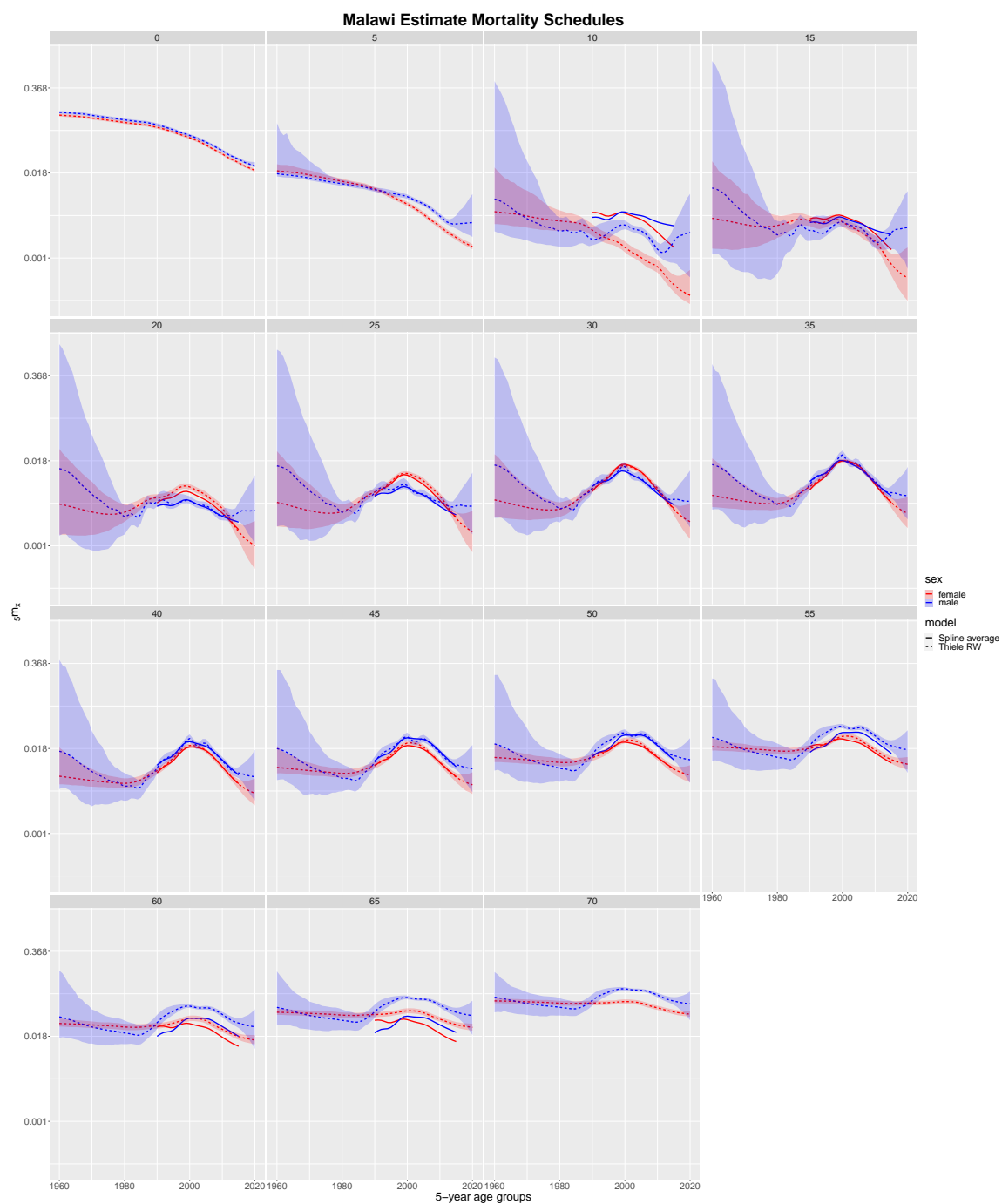
Figure 7: Mortality Schedules
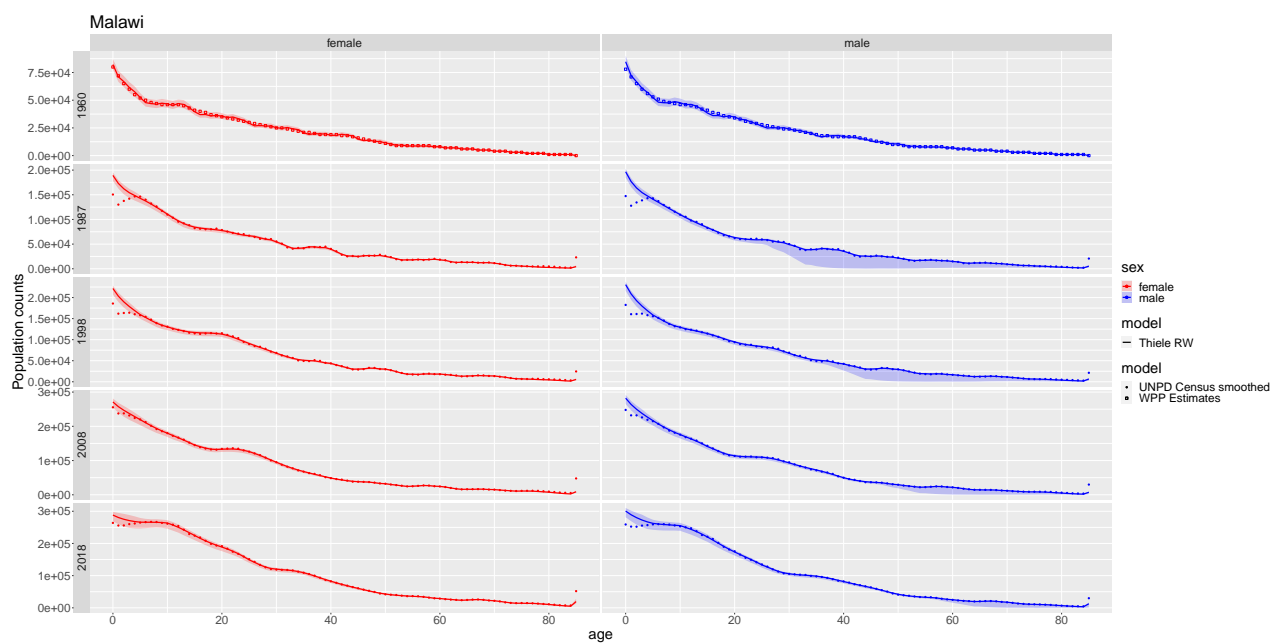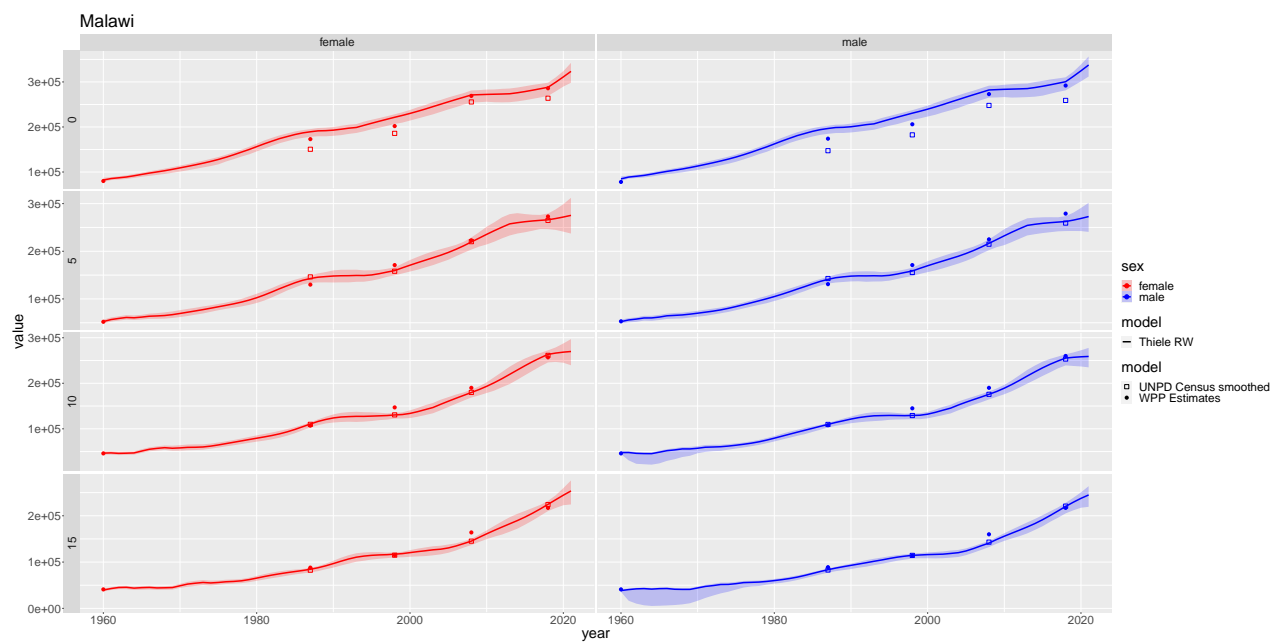
Figure 8: Mortality Schedules

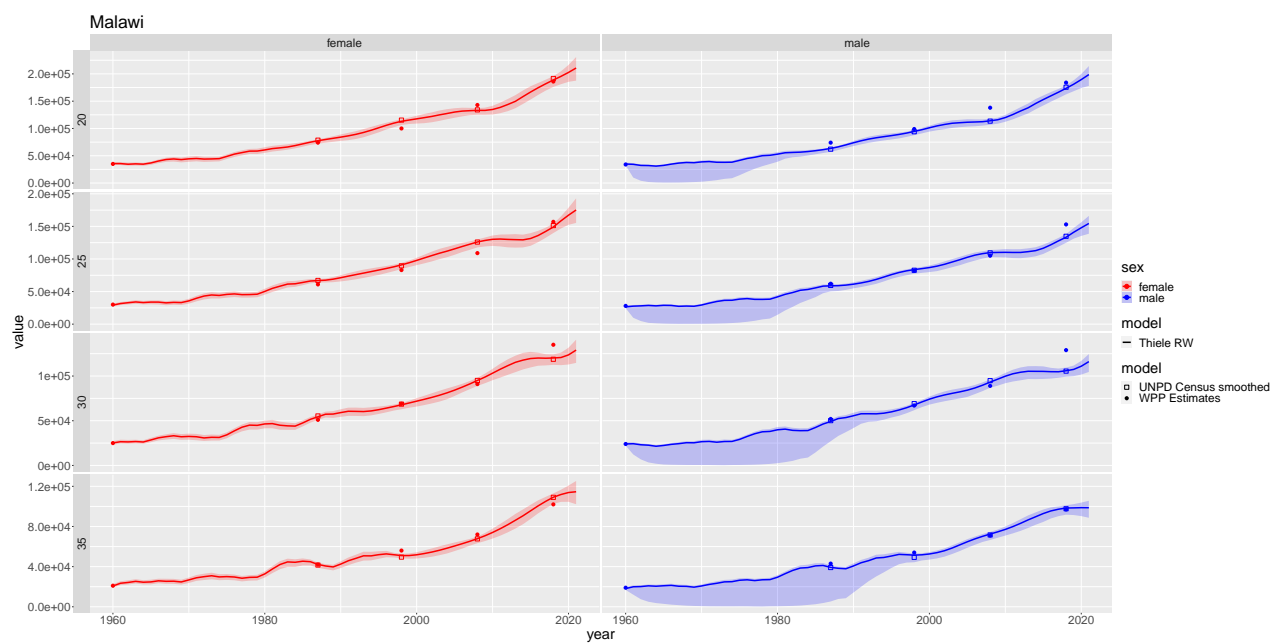Figure 9: Population

Figure 10: Population

9
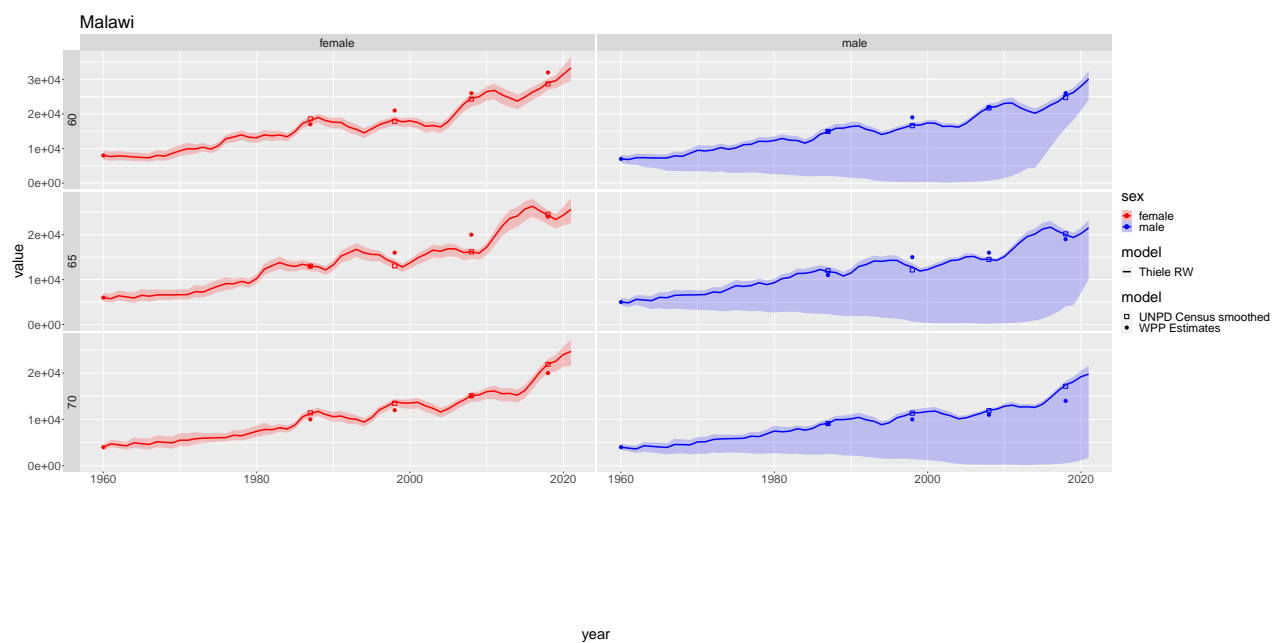
Figure 11: Population

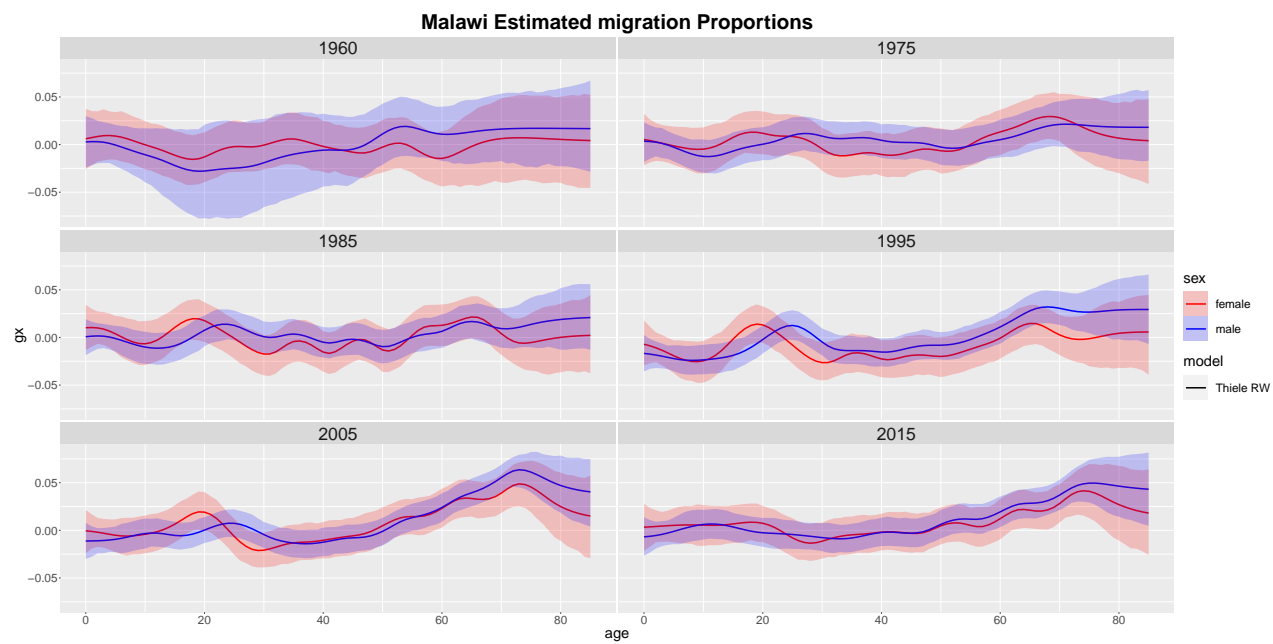Figure 12: Population
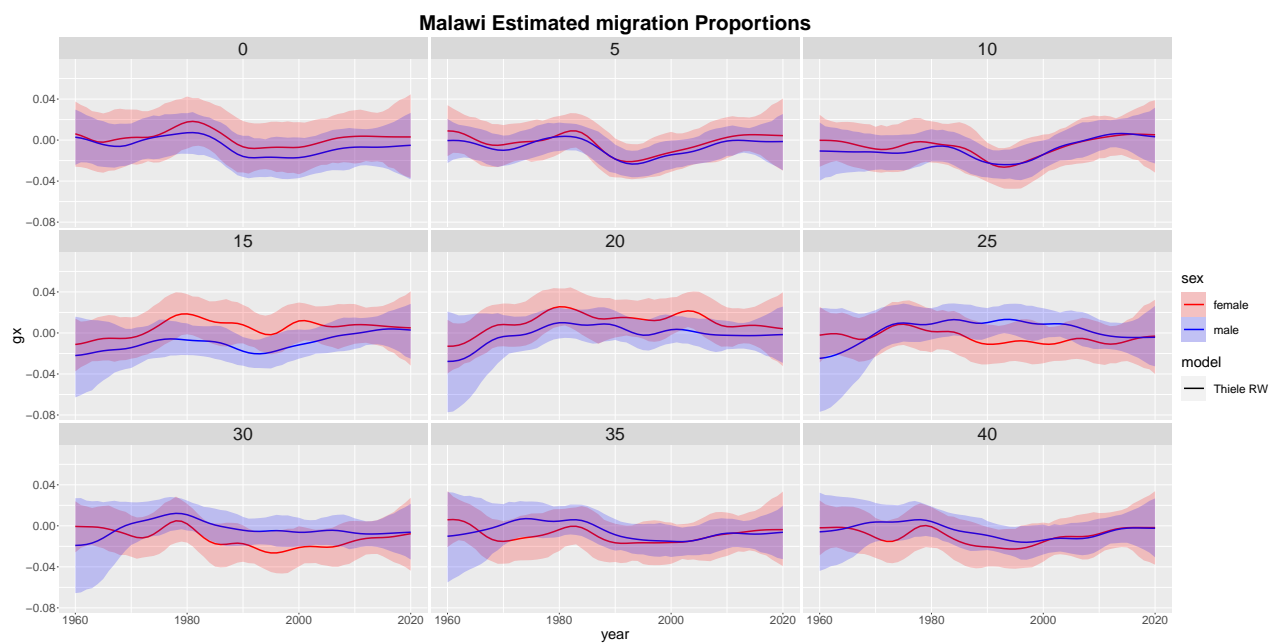
10

Figure 13: Population

Figure 14: Migration

Figure 15: Migration
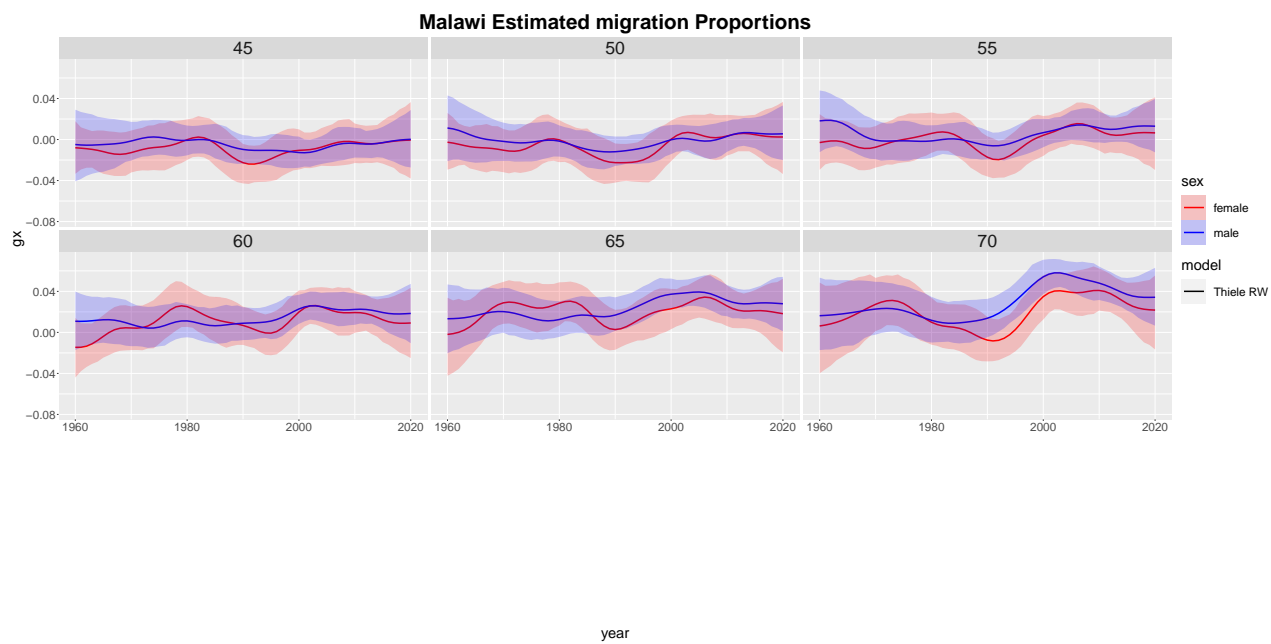
Figure 16: Migration
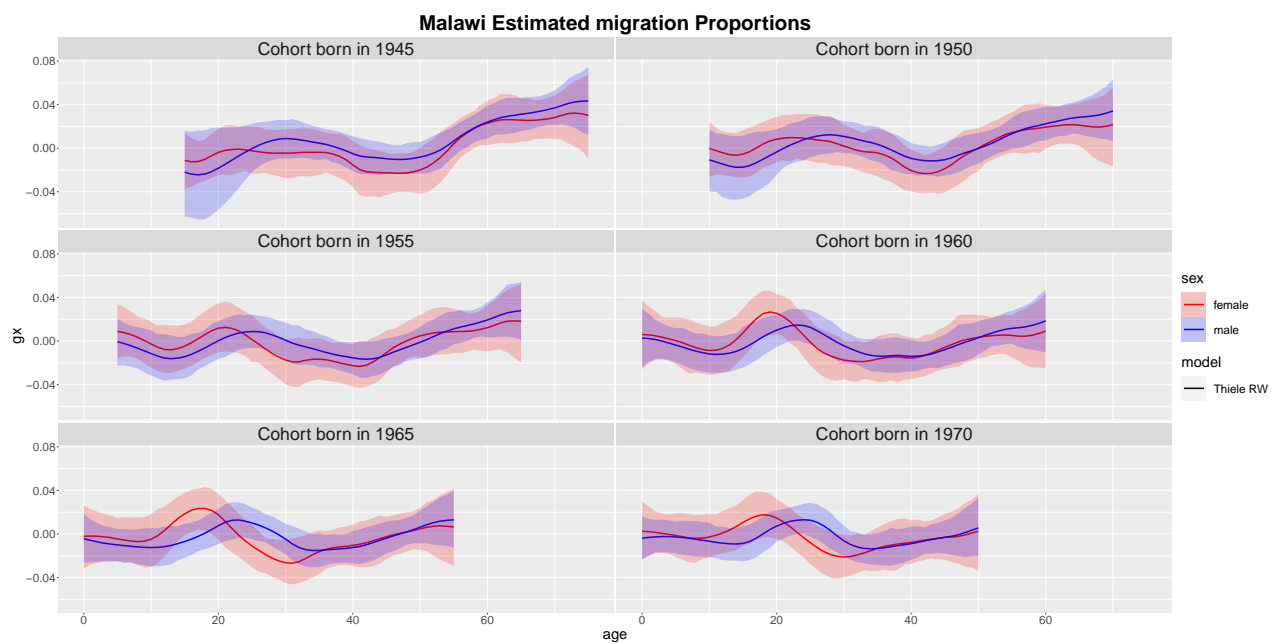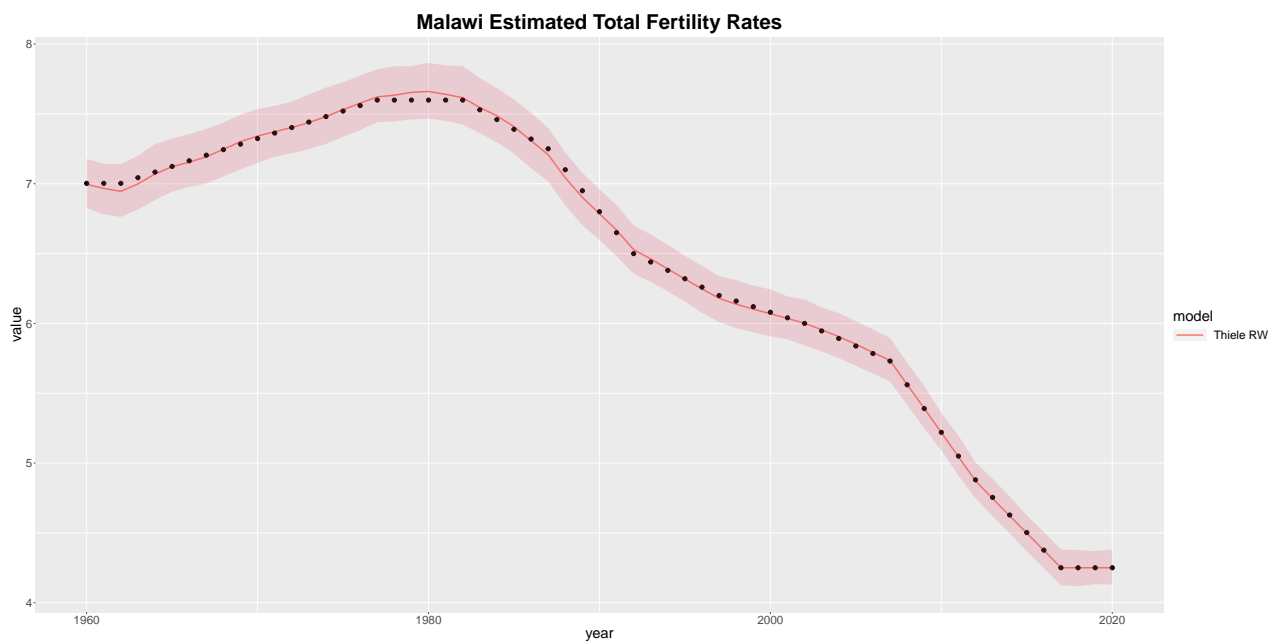
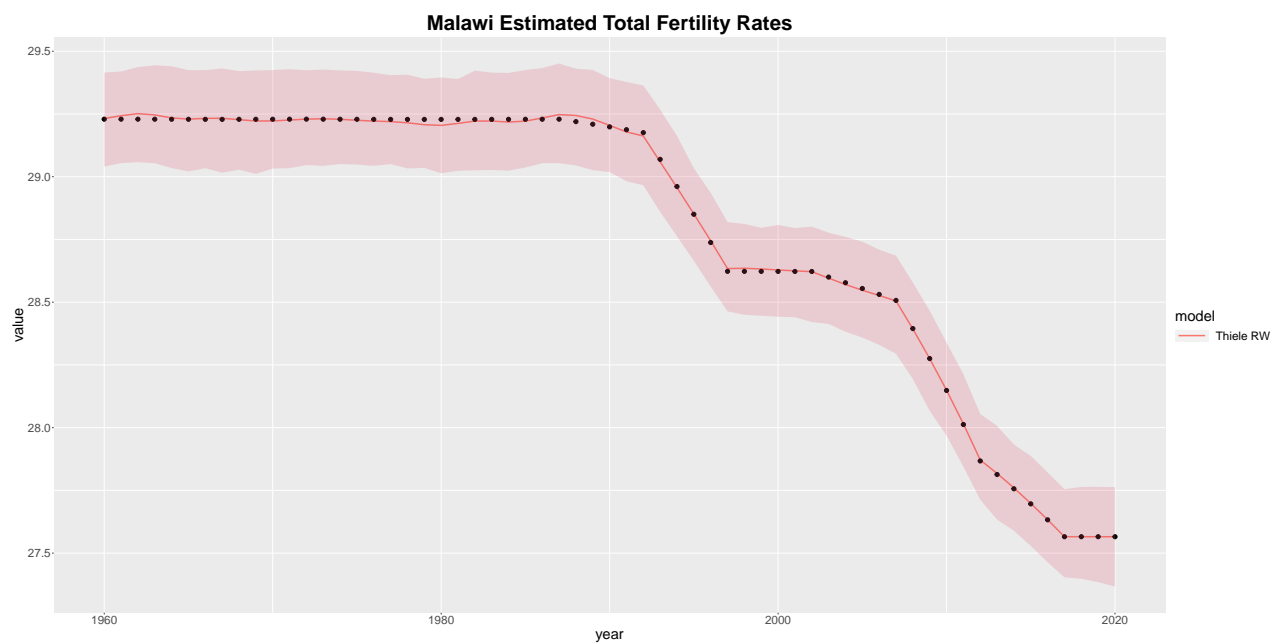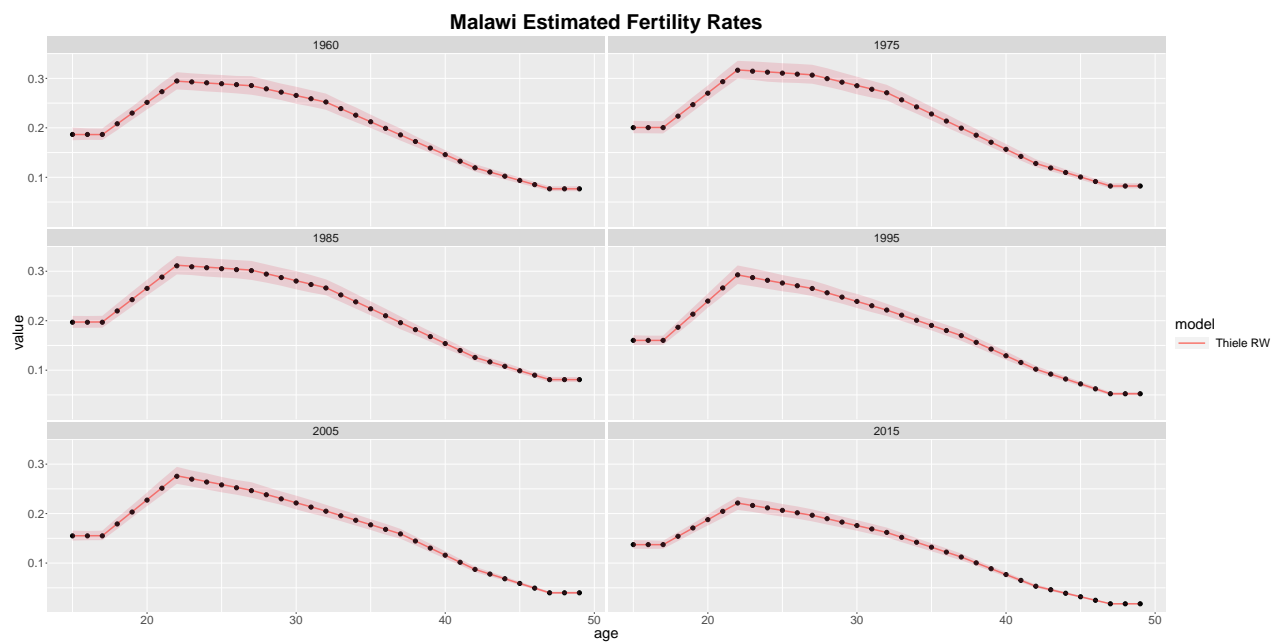Figure 17: Migration

Figure 18: Total Fertility

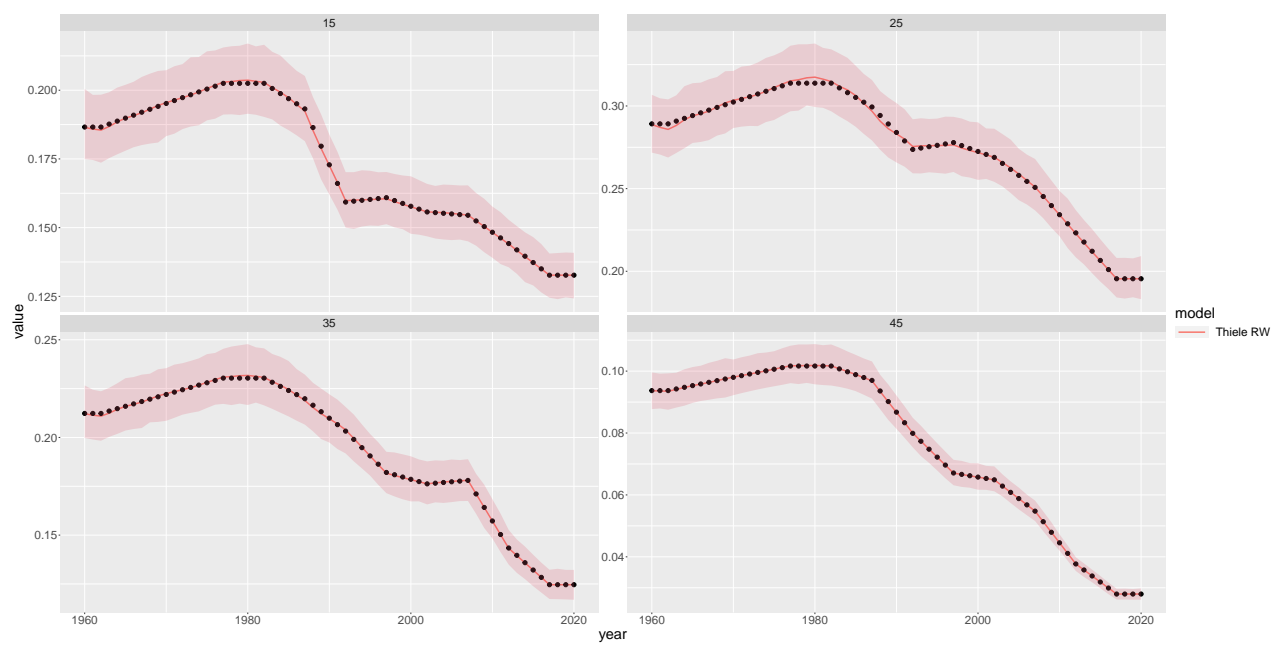Figure 19: Mean age at births

Figure 20: Fertility

Figure 21: Fertility