Probabilistic Population Projections for Annual Time Series: Status Report

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Outline

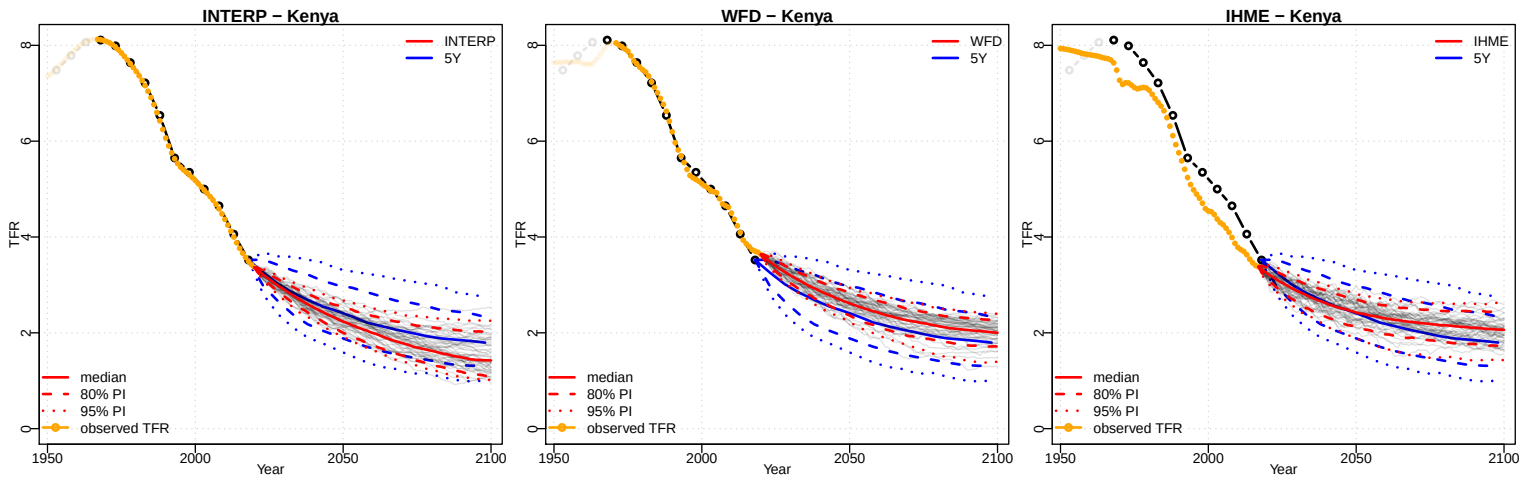
- Changes to the total fertility rate (TFR) model
- Challenges in projecting TFR annually
- Changes to the life expectancy model
- Status of MortCast & bayesPop

Total Fertility Rate: bayesTFR

- Model of Alkema et al. (2011) designed for 5-year time series.
- For 1-year version, changes in prior distribution of two parameters:
  - country's maximum decrement
  - maximum standard deviation of distortions
- Identifying start of Phase III (post-fertility transition):
  - 5-year version: two consecutive increases below 2
  - 1-year version: obtain 5-year averages and use the same rule as above
- Correlation between countries (method not revised yet)
- Tested on three simulations:
  1. using UN (interpolated) annual TFR data [INTERP]
  2. using annual estimates based on UN World Fertility Data (Liu & Raftery 2020) [WFD]
  3. using annual IHME 2017 TFR estimates [IHME]
  - compared to a 5-year WPP simulation [5Y]

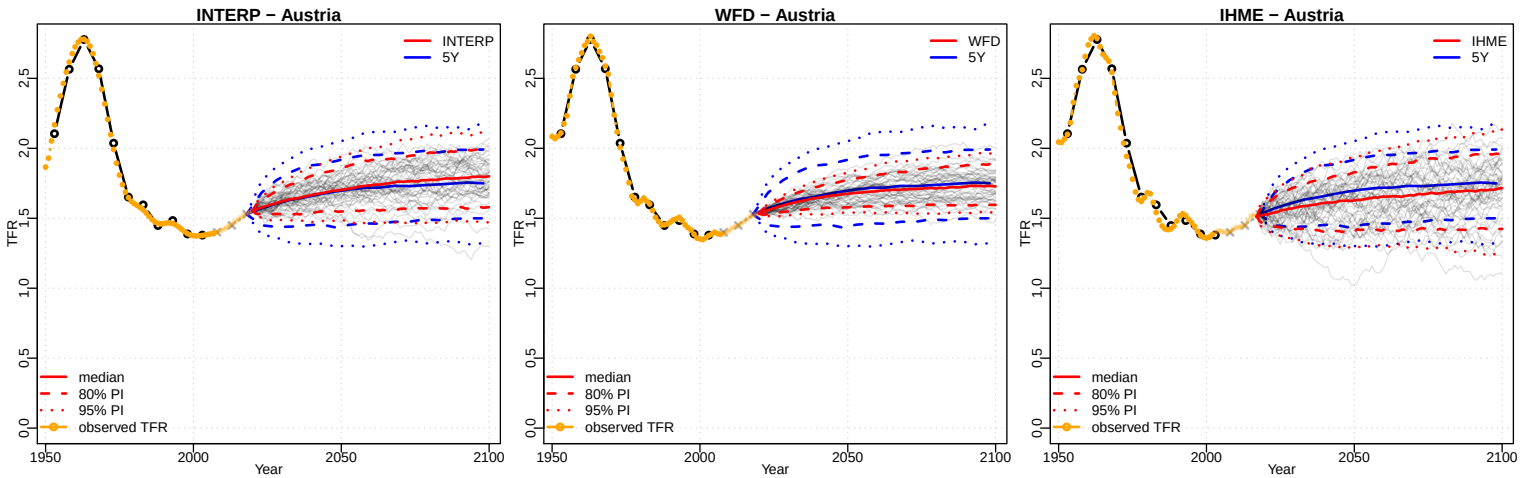
Challenges in annual TFR projection

- Projections can have less uncertainty than the 5Y model.
  - More prevalent for Phase II countries:



Challenges in annual TFR projection (cont.)

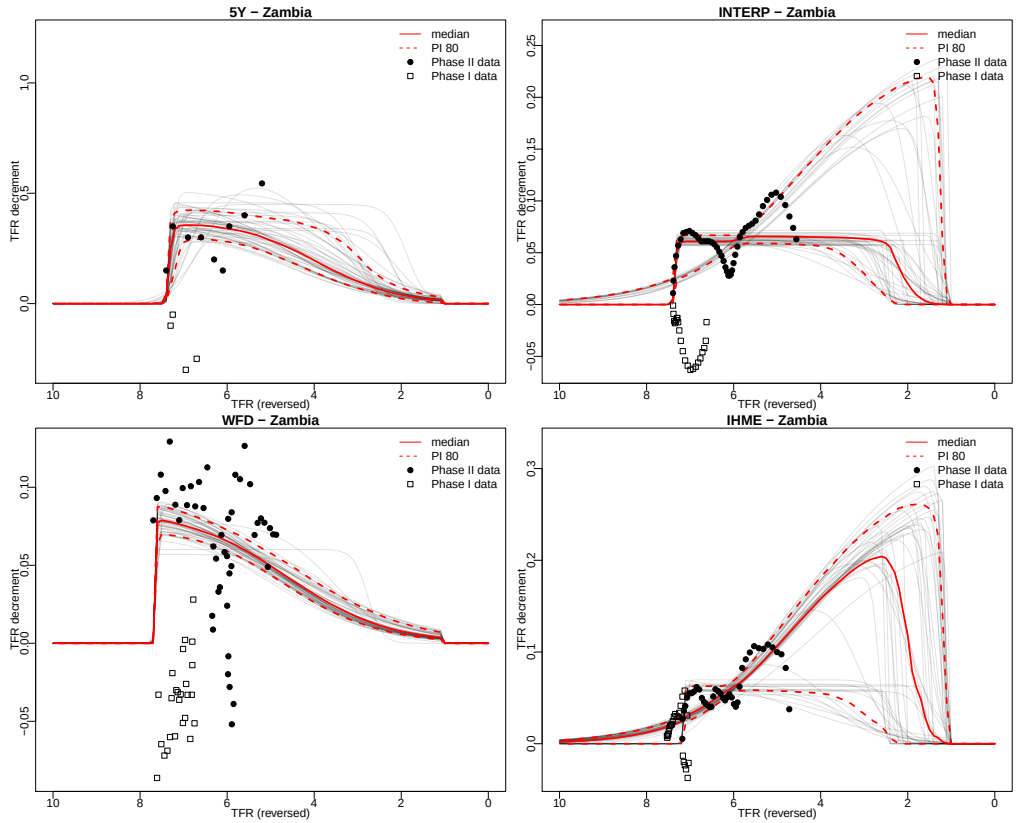
- Uncertainty in Phase III countries:



- We found additional autocorrelation in model residuals that is not yet taken into account by the model.

Challenges in annual TFR projection (cont.)

- MCMCs do not like interpolated data! For the INTERP simulation they often do not converge.
- Double logistic fit can be different from the 5-year model:



- Thus medians of the annual model can differ from the 5-year model.
  - Agreement best with WFD-based data.

Possible solutions

Solution 1 (more difficult but possibly more satisfactory):

1. Modify the annual bayesTFR model to capture additional autocorrelation.
2. Use WFD-based data for estimation.
3. Project annually.
4. Optionally for consistency, adjust trajectories so that the medians match the 5-year medians.

Solution 2 (simpler but maybe less satisfying):

1. Use the five-year bayesTFR model for estimation and projection (using aggregated 5-year data).
2. Interpolate each trajectory to get annual trajectories.
   - 1-year medians and intervals will match 5-year ones.

Status of bayesTFR

- Package usable for annual simulations as shown above.
- Projections take 5 $\times$ more time – need to parallelize projections.
- Liu & Raftery (2020) method for including estimation uncertainty is being incorporated into bayesTFR.
- All code on GitHub – branch "annual".

Life expectancy at birth: bayesLife

- Changes in prior distribution of parameters related to:
  - the maximum increment (k)
  - the long-term increment (z)
- In the process of recomputing parameters related to UN scenarios (Castanheira et al. 2017)
- Need to assess if autocorrelation is captured correctly or if the uncertainty is underestimated.
- Need to assess if the gap model should be revised.
- Annual e_0 estimates should NOT be interpolated.
- Alternative: Instead of projecting annually, interpolate each trajectory from the 5-year model.

Life expectancy at birth with HIV: bayesLifeHIV

- After updating bayesLife, necessary changes to bayesLifeHIV should be straightforward.
- Will need annual data on:
  - past HIV prevalence
  - trajectories of future HIV prevalence for uncertainty assessment
  - past and future ART coverage

Projecting mortality: MortCast

- Functions `kannisto`, `cokannisto`: work with 1-year age groups
- Function `lileecarter.estimate`: work with 1-year age groups
- Function `mortcast`: currently wired only for 5-year age groups
  - Should not be difficult to update for 1-year ages, since functions for computing 1-year life tables available in the package.
  - Check if changes needed in the Li, Lee, Gerland (2013) rotation methodology
- Inputs needed from UNPD:
  - Functions `pmd`, `copmd`: need updated ρ_x coefficients
  - Function `mlt`: needs 1-year age tables
  - Function `logquad`: needs an update

Population projections: bayesPop

- After updating MortCast, changes in mechanics for 1x1 projections should be straightforward.
- Working with Mark Wheldon on using the same code for CCM (package CCMPP).
- Kantorová method for projecting PASFR needs an update.
- bayesPop with probabilistic migration in advanced progress.
- Computing challenges:
  - run times (expecting 25 $\times$ longer)
  - amount of data generated/stored (about 25 $\times$ more)
- Important to continue to compute 5-year projections
  - for upward compatibility
  - to check annual results
  - as a fallback

Summary

- Work on supporting the Division for WPP 2021 is on target
- Solutions to challenges in moving the fertility and mortality models to a one-year basis have been proposed
- All R packages needed for probabilistic population are being updated and made available for the Division to test.