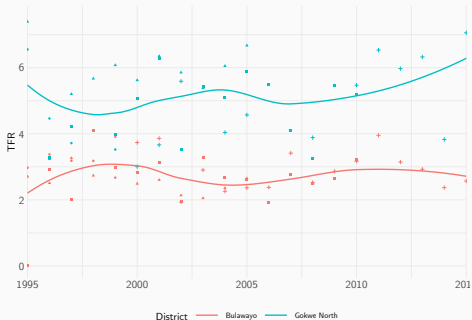# Small area estimation of district-level fertility in sub-Saharan Africa

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- UNAIDS Reference Group for Estimates, Modelling and Projections provides technical recommendations to UNAIDS for the creation of annual HIV estimates
- Newly created subnational estimation model - Naomi
  - District-level estimates of prevalence, incidence, ART coverage by sex and 5 year age groups

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- District level estimates of fertility desired for:
  - Estimation of children living with HIV
    - Key epidemic indicator
    - Resource allocation for prevention of mother-to-child transmission
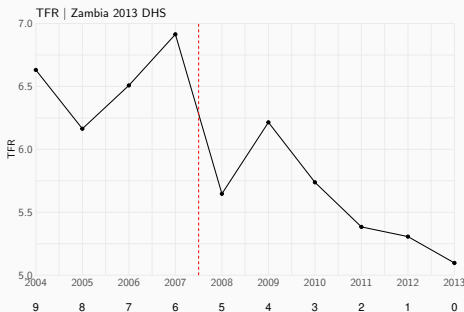 - Improved projections at district level

- Demographic Health Surveys
  - Geomasked coordinates assigned to district
  - 1999, 2005, 2010, 2015
- Multiple Indicator Cluster Survey
  - Survey region indicator
  - 2009, 2014, 2019
- Birth history data:
  - DHS, MICS: 15 years
  - (Malaria Indicator Survey/AIDS Indicator Surveys): 5 years

- R packages *rdhs* and *demogsurv*
- Reconstruct survey-weighted births and observed person years, by single year, 5 year age groups, and district
    - CMC respondent's birth
    - CMC respondent's births
    - CMC interview

- DHS collects full birth histories for children in the previous 5 years, and an abbreviated question set thereafter
- Interviewers can reduce workload by:
    - Displacing
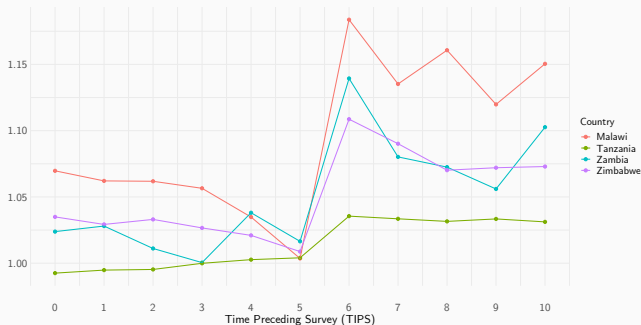   - Omitting

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TFR | Zambia 2013 DHS

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Model specification

$$b_{ait} \sim Po(\lambda_{ait}.E_{ait})$$

$$log(\lambda_{ait}) = \mu + \alpha_a + \gamma_t + \delta_i + \eta_{a,t} + \eta_{a,i} + \eta_{i,t}$$

$$\mu \sim N(0,5)$$

$$\alpha_a \sim RW1(\sigma_\alpha^2) \qquad\qquad a \in \{15-19, 20-24...45-49\}$$

$$\delta_i \sim BYM2(\sigma_\delta^2) \qquad\qquad i \in \{1...n_i\}$$

$$\gamma_t \sim RW2(\sigma_\gamma^2) \qquad\qquad t \in \{1995 : 2020\}$$

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$$\eta_{a,t} \sim N(0, \sigma^2_{\eta_{a,t}}) \qquad\qquad AR1 \otimes AR1$$

$$\eta_{a,i} \sim N(0, \sigma^2_{\eta_{a,i}}) \qquad\qquad AR1 \otimes ICAR$$

$$\eta_{i,t} \sim N(0, \sigma^2_{\eta_{i,t}}) \qquad\qquad ICAR \otimes AR1$$

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Observation model

$$log(\hat{b}_{ait}) = log(\lambda_{ait} \times E_{ait}) + \beta_1 TIPS_d + \omega_{TIPS}$$

$$TIPS_d = \begin{cases} 0, & \text{if TIPS} < 5 \\ 1, & \text{otherwise} \end{cases}$$

$$\omega_{tips} \sim RW1(\sigma_\omega^2) \qquad\qquad tips \in \{0 : 14\}$$

Results

tfr maps at 3 admin levels

tfr trend at admin 1

asfr from all districts in overlay plot to see distribution

Future work

- Projections –> leontine
- Survey effects - not necessarily surveyid iid, but survey type iid? probs not identifiable. TZA example where AIS and MIS far from DHS
- Census data, other surveys, summary birth histories