Assessing the Impact of Potential Policies on Fertility in High-Fertility Countries Using Granger Causality and Bayesian Hierarchical Models

Daphne Liu
Statistics, University of Washington
dhliu@uw.edu

Adrian E. Raftery
Statistics & Sociology, University of Washington
raftery@uw.edu

CENTER FOR STUDIES IN DEMOGRAPHY & ECOLOGY
Department of STATISTICS
CENTER for STATISTICS and the SOCIAL SCIENCES

Overview

- The U.N. projects the majority of world population growth will occur in high-fertility countries (United Nations, 2017). It is widely thought these countries would benefit from more rapid fertility decline (Bongaarts, 2013).
- Increasing women's education and access to family planning are the two main policies that can help accelerate fertility decline (Hirschman, 1994).
- We are interested in the likely quantitative demographic effect of policies on women's education and family planning, with preliminary results focusing on education.
- We assess the causal nature of women's education on fertility decline using Granger causality and propose a conditional Bayesian hierarchical model for projections of TFR that conditions on the impact of different education policies.
- This model builds upon the unconditional model for probabilistic fertility projections currently used by the U.N. (Alkema et al. 2011; Raftery et al. 2014, Fosdick and Raftery 2014).

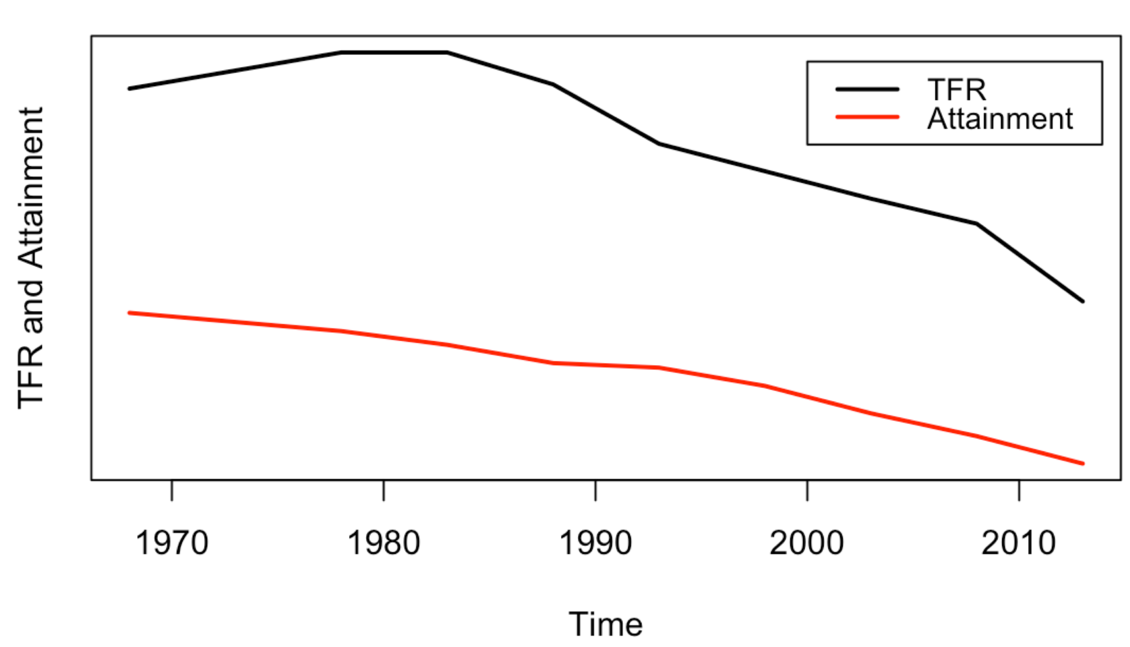

Figure 1: TFR and the proportion of women who did not attain at least Lower Secondary education for Malawi from 1965 to 2015

Methods

- We construct five-year decrements in TFR as a measure of fertility decline using data from the U.N.
- The expected TFR decrement is modeled using a double logistic (DL) function developed by Alkema et al. (2011).
- Educational attainment and enrollment data are obtained from the Wittgenstein Centre and the World Bank.
- We test for Granger causality using a likelihood ratio test. We treat the expected TFR decrement as past values of fertility decline and control for child mortality and GDP.
- For each country c and time t, our models are:

$$\textbf{Full}: \text{ TFR Decr}_{c,t} = \beta_0^{full} + \beta_1^{full}\text{DL}_{c,t} + \beta_2^{full}\text{Controls}_{c,t} + \alpha\left(\text{Education}\right)_{c,t-1} + \varepsilon_{c,t}$$

$$\textbf{Reduced}: \text{ TFR Decr}_{c,t} = \beta_0^{red} + \beta_1^{red}\text{DL}_{c,t} + \beta_2^{red}\text{Controls}_{c,t} + \varepsilon_{c,t}$$

- We estimate our models using generalized least squares via maximum likelihood.
- Drawing from Fosdick & Raftery (2014), we cluster by U.N. region and time and assume exchangeable correlation.
- Using Bayesian model selection, we select the decrement version of the proportion of women who attained lower secondary education or higher (LowSec+ Decr) as our education covariate.

Results

- Our models are summarized below. The estimated within-cluster correlation is 0.23 in the full model and 0.24 in the reduced model.

	Estimate	t-value
(Intercept)	0.14	4.17***
Expected TFR Decr	0.83	17.68***
LowSec+ Decr	-0.87	−2.74**
IMR	-1.30	−4.11***

Table 1: Summary of full model for country-time pairs with Phase II TFR > 2.5, ** denotes P<0.01 and *** denotes P<0.001

	Estimate	t-value
(Intercept)	0.20	7.50***
Expected TFR Decr	0.85	18.15***
IMR	-1.64	−5.63***

Table 2: Summary of reduced model for country-time pairs with Phase II TFR > 2.5, ** denotes P<0.01 and *** denotes P<0.001

- We find sufficient evidence to reject the null hypothesis that LowSec+ Decr does not Granger-cause TFR decrement (P < 0.01).

Future Work

- We will incorporate education into the existing Bayesian hierarchical model for TFR using methodology similar to Godwin & Raftery (2017).
- Drawing upon methods developed by Lutz et al. (2014), we will project our chosen education covariate and incorporate education projection uncertainty into projections of TFR.
- The model will be extended to include measures of family planning.

Conclusion

- Results suggest women's education provides additional information for predicting fertility decline that is not already captured by the expected TFR decrement.
- Incorporating education and family planning covariates into a new, conditional Bayesian hierarchical model for TFR will allow us to produce conditional probabilistic population projections.
- These projections can provide better understanding of the possible demographic payoffs to given education and family planning policies.

References

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