ASSESSING THE POPULATION PROJECTION DEBATE

STAT 563 - Term Paper

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Brief History of the Debate

- In 2020, IHME researchers published a paper with a different projection framework. (Vollset, 2020)
- According to their models, world population will peak at 9.7 billion in 2064, then decline to 8.8 billion in 2100.
- IHME's main claim is that TFR is fragile to "tempo effect."
- Alternative: Complete Cohort Fertility Rate at age 50 (CCF50)
- IHME argues that their estimates are better than alternatives.
- They warn policymakers about the **declining fertility threat.**

Critiques

- Upward bias of contraceptive met need forecasts leading to downward bias of fertility forecasts. (Alkema 2020)
- Potential overfitting: (Stuart Gietel-Basten and Tomáš Sobotka, 2020)
  - IHME uses one birth per woman lower limit
  - No upper limit
- Data quality issues with GBD past data.
- Lack of out-of-sample prediction test.

IHME'S ESTIMATION METHOD

$$CCF50 = \beta_0 + \beta_1 * mn + ns(edu)$$

$$ASFR(a) = PASFR(a) * CCF50$$

$CCF50$: completed cohort fertility rate at age 50

mn : contraceptive need met

$ns(edu)$: natural cubic spline of female educational attainment

$ASFR(a)$: single-year age standardized fertility rate

$PASFR(a)$: single-year proportional age standardized fertility rate

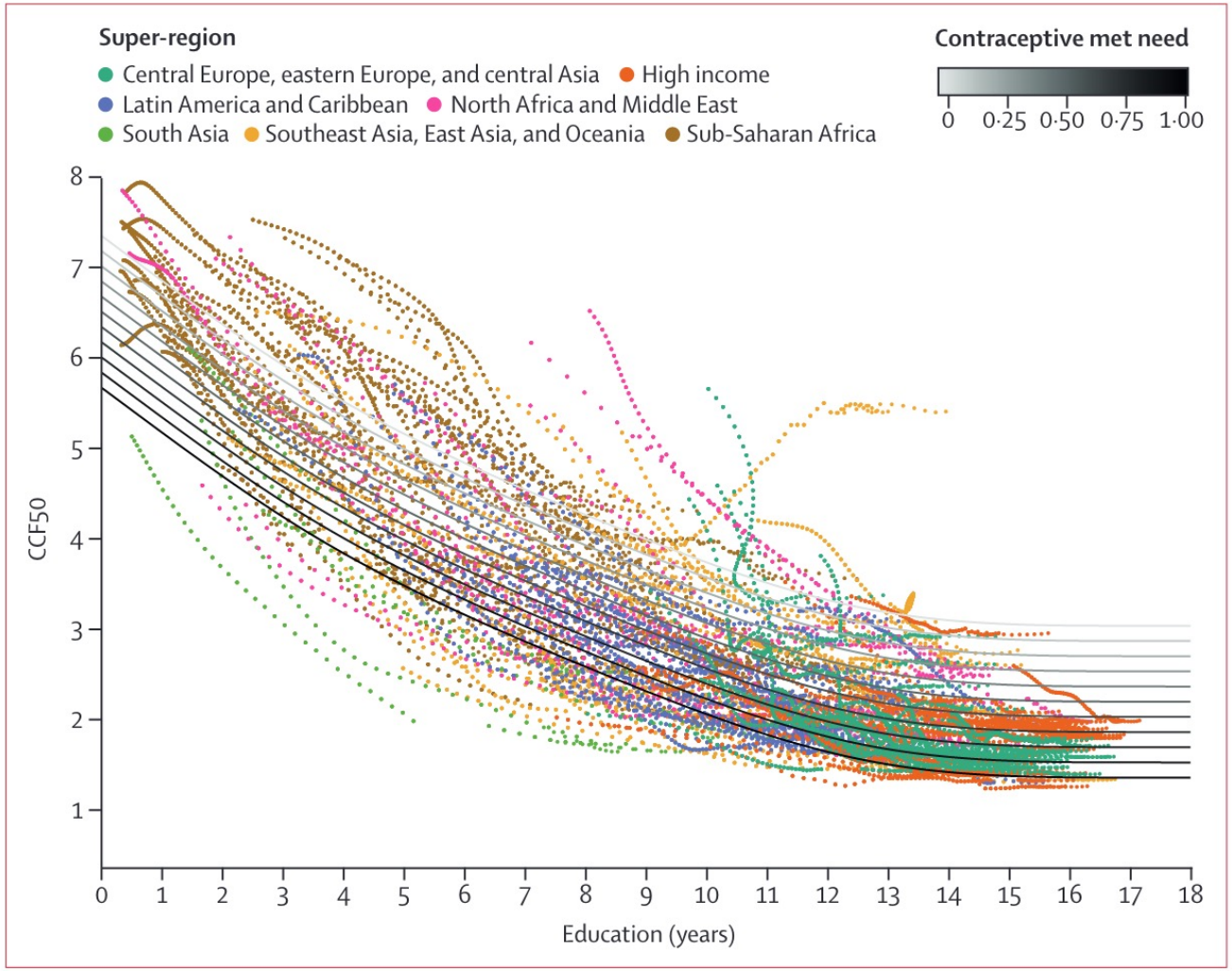
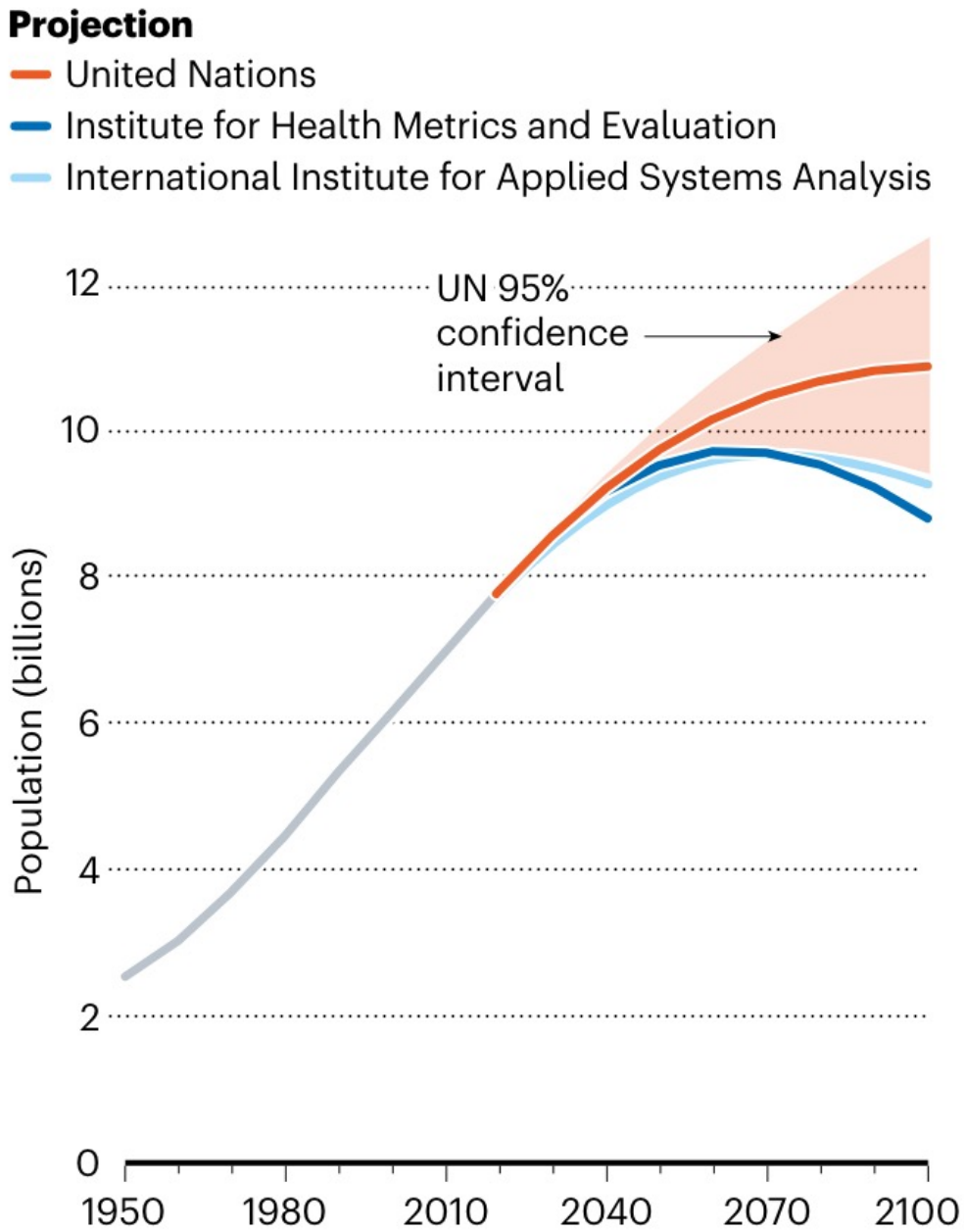


Figure 1: **Model fit for CCF50**
CCF50-fitted trends are presented as a function of education across varying levels of contraceptive met need. Each point represents a single location-year of past data, and they are coloured by GBD 2017 super-regions. Education is measured in years of attainment (0–18 years), and contraceptive met need is measured on a scale of 0% to 100%, reflecting the portion of the female population whose need for contraception has been met. CCF50=completed cohort fertility by age 50 years. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.



Proposal: Does CCF50 provide better estimates?

- Probabilistic modeling of TFR
- Bayesian Hierarchical Model:
  - Using IHME/GBD past data (for reproducibility)
  - Parameters for educational attainment & contraceptive met need
  - First estimating CCF50, then TFR
  - Using bayesTFR R package.
- Challenge: computational power
- Solution: small sample of countries:
  - 3-5 number of countries from each fertility ranges. (low-mid-high)

Works Cited:

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- Gietel-Basten, Stuart, and Tomas Sobotka. 2020. *Uncertain Population Futures: Critical Reflections on the IHME Scenarios of Future Fertility, Mortality, Migration and Population Trends from 2017 to 2100*. *preprint*. SocArXiv. doi: 10.31235/osf.io/5syef.
- Vollset, Stein Emil, Emily Goren, Chun-Wei Yuan, Jackie Cao, Amanda E. Smith, Thomas Hsiao, Catherine Bisignano, Gulrez S. Azhar, Emma Castro, Julian Chalek, Andrew J. Dolgert, Tahvi Frank, Kai Fukutaki, Simon I. Hay, Rafael Lozano, Ali H. Mokdad, Vishnu Nandakumar, Maxwell Pierce, Martin Pletcher, Toshana Robalik, Krista M. Steuben, Han Yong Wunrow, Bianca S. Zlavog, and Christopher J. L. Murray. 2020. “Fertility, Mortality, Migration, and Population Scenarios for 195 Countries and Territories from 2017 to 2100: A Forecasting Analysis for the Global Burden of Disease Study.” *The Lancet* 396(10258):1285–1306. doi: 10.1016/S0140-6736(20)30677-2.