Global demographic projections: Future trajectories and associated uncertainty

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CPD Side Event, 14 April 2015

Outline

- Introduction
- UN population projections
  - Variants and scenarios
  - Probabilistic approach
- Drivers of consumption and production
- More on the probabilistic projections
  - Current limitations
  - Value of partnership
- Acknowledgements
- Software and references

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Variants and scenarios

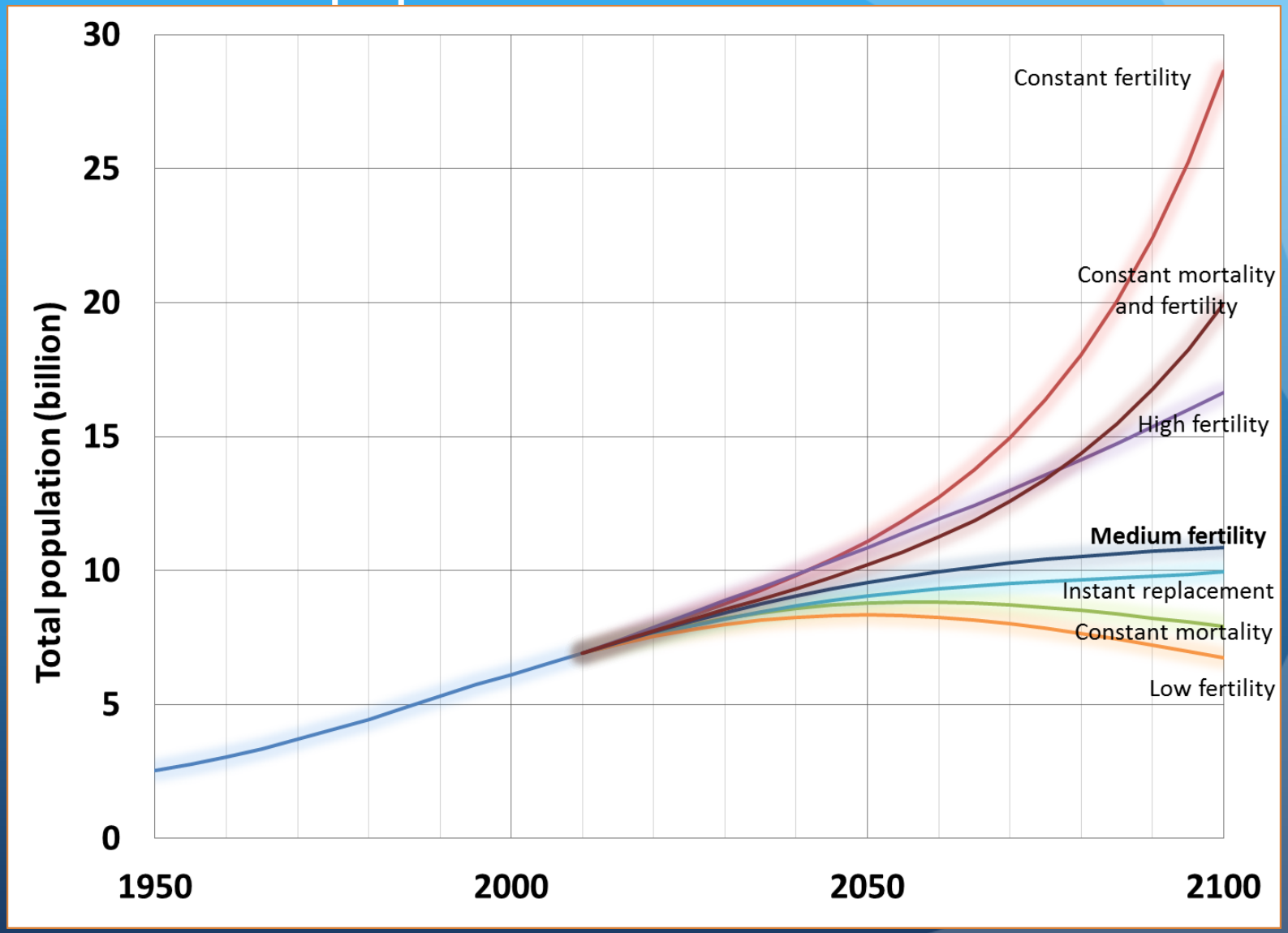
- Different future outcomes can be illustrated using variants and scenarios
- Variants describe a range of assumptions for a particular component of change (e.g. fertility), illustrating the sensitivity of outcomes to changes in assumptions
- Scenarios describe a series of hypothetical (often simplified) future trajectories, illustrating core concepts such as population momentum

UN deterministic projection scenarios

8 scenarios were included in the 2012 Revision of the UN World Population Prospects

		Assumptions		
#	*UN projection scenarios*	*Fertility variant*	*Mortality variant*	*International Migration variant*
1	Low fertility	Low (= medium - 0.5 child)	Normal	Normal
2	**Medium fertility**	**Medium**	**Normal**	**Normal**
3	High fertility	High (= medium + 0.5 child)	Normal	Normal
4	Constant-fertility	Constant as of 2005-2010	Normal	Normal
5	Instant-replacement-fertility	Instant-replacement as of 2010-2015	Normal	Normal
6	Constant-mortality	Medium	Constant as of 2005-2010	Normal
7	No change	Constant as of 2005-2010	Constant as of 2005-2010	Normal
8	Zero-migration	Medium	Normal	Zero as of 2010-2015

UN deterministic scenarios, total population: World 2010-2100



Population Division

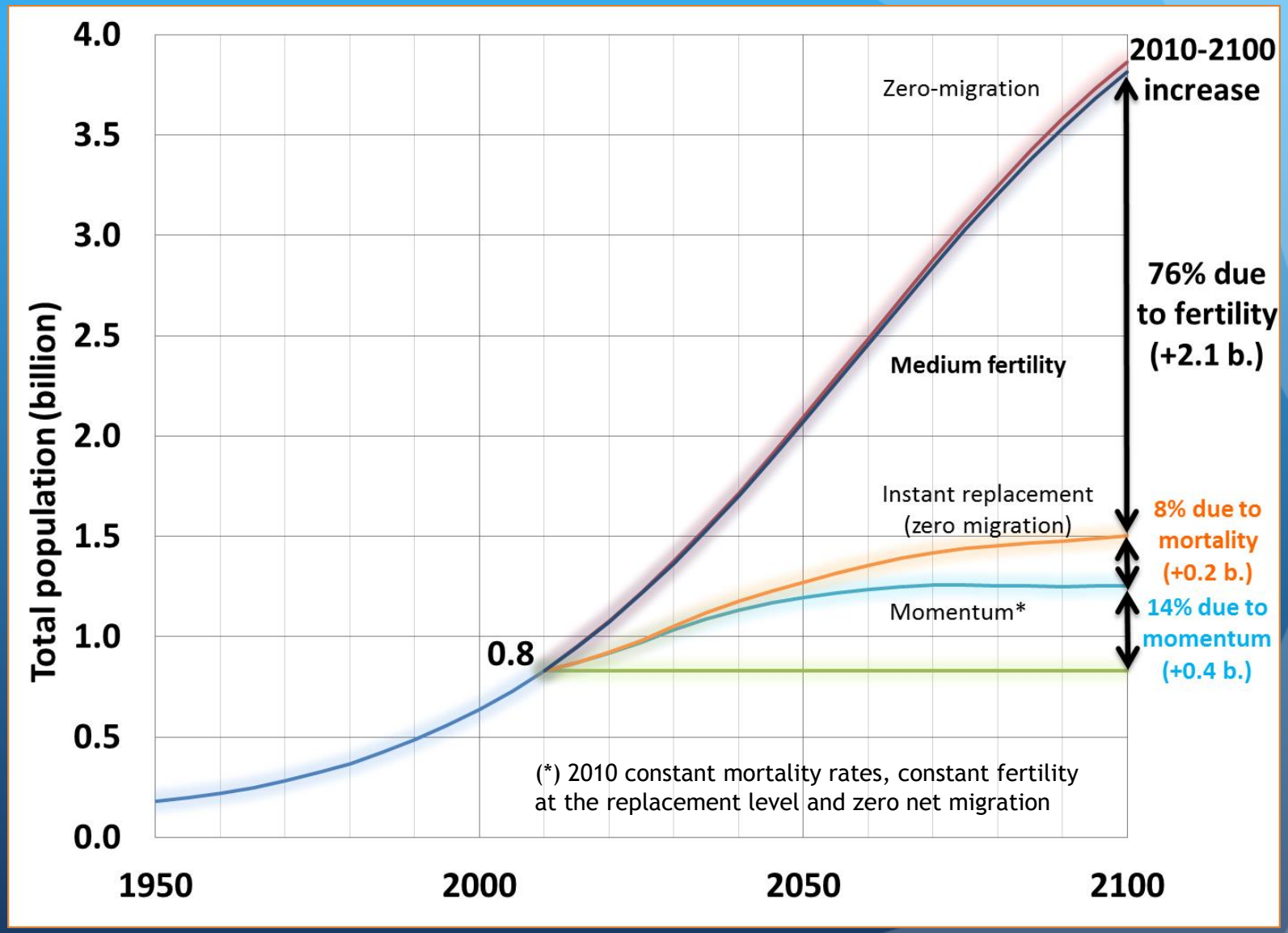
Technical Paper
No. 2013/3

Demographic Components of Future Population Growth

Kirill Andreev, Vladimíra Kantorová and John Bongaarts

United Nations • New York, 2013

Components of growth, total population: Sub-Saharan Africa 2010-2100



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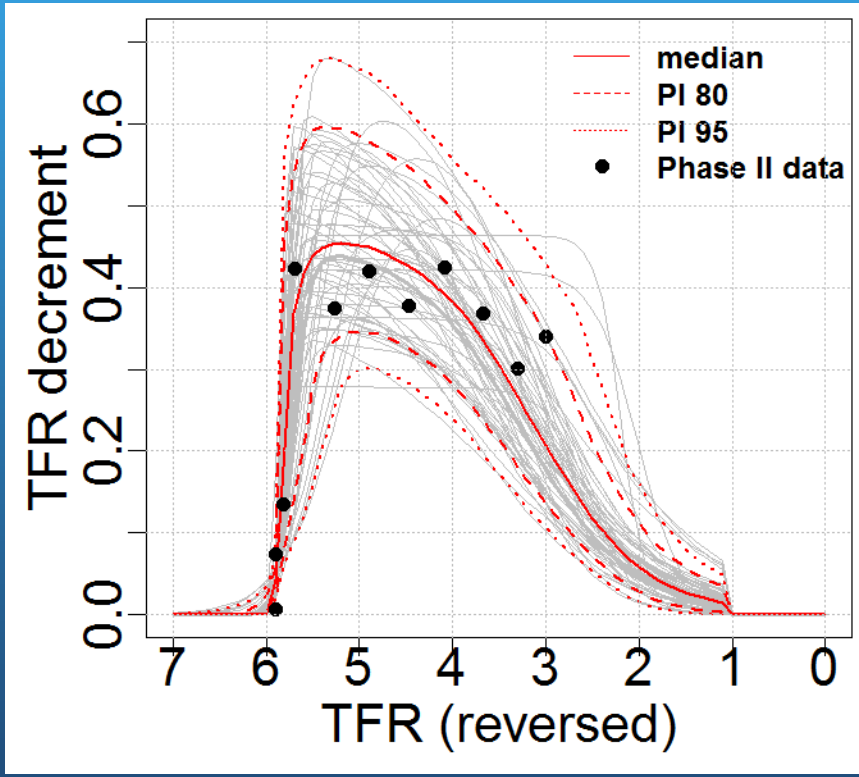
Fertility decline model

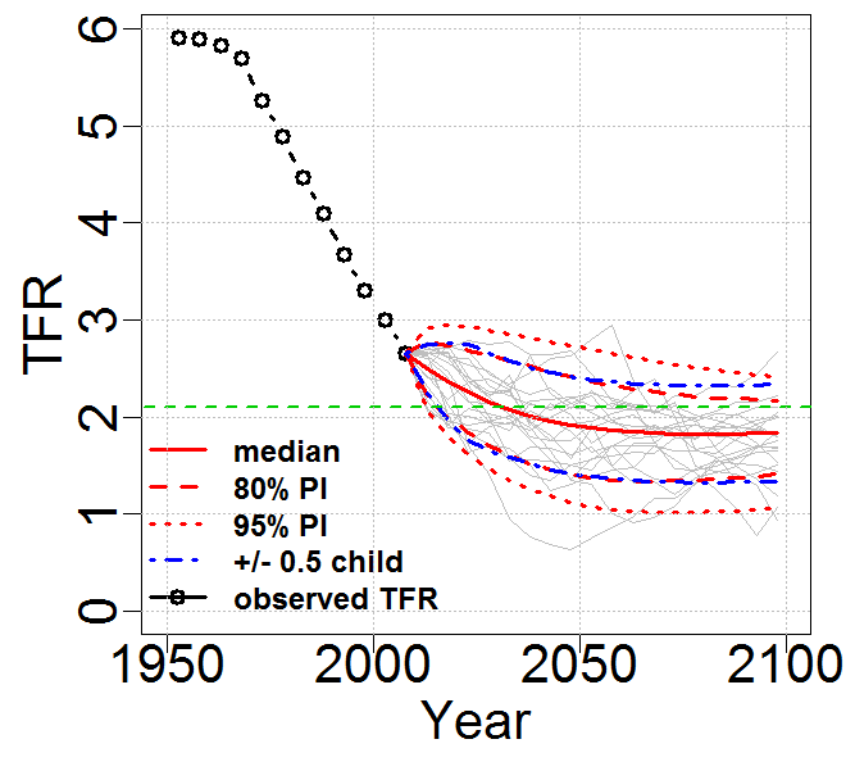
- Rate of TFR decline depends on level of TFR
  - Peak rate of decline around TFR=5
  - Slower decline for TFR > 5
  - Slower decline for TFR < 5
- Bayesian hierarchical model used to estimate model for world and all countries

Fertility projection for India

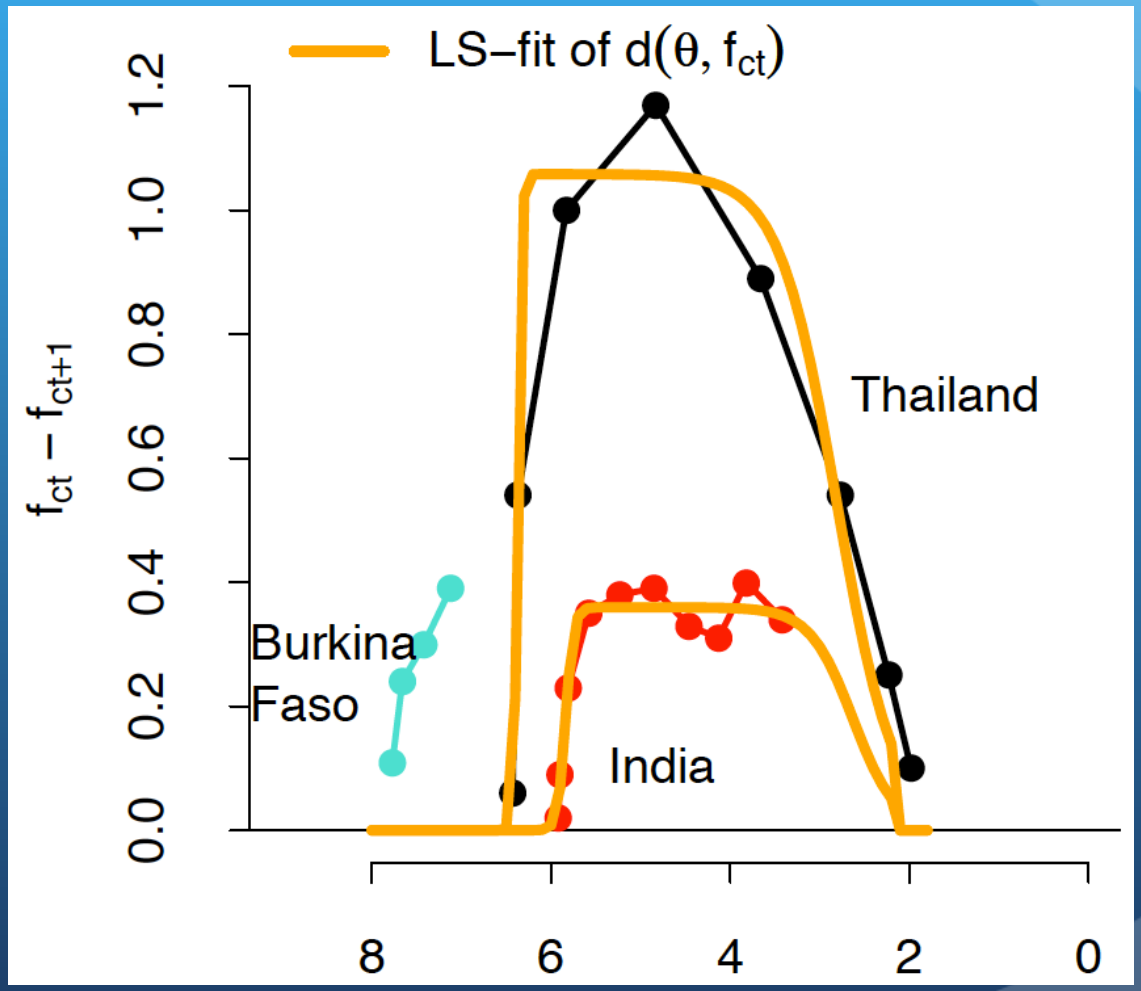
TFR decline function



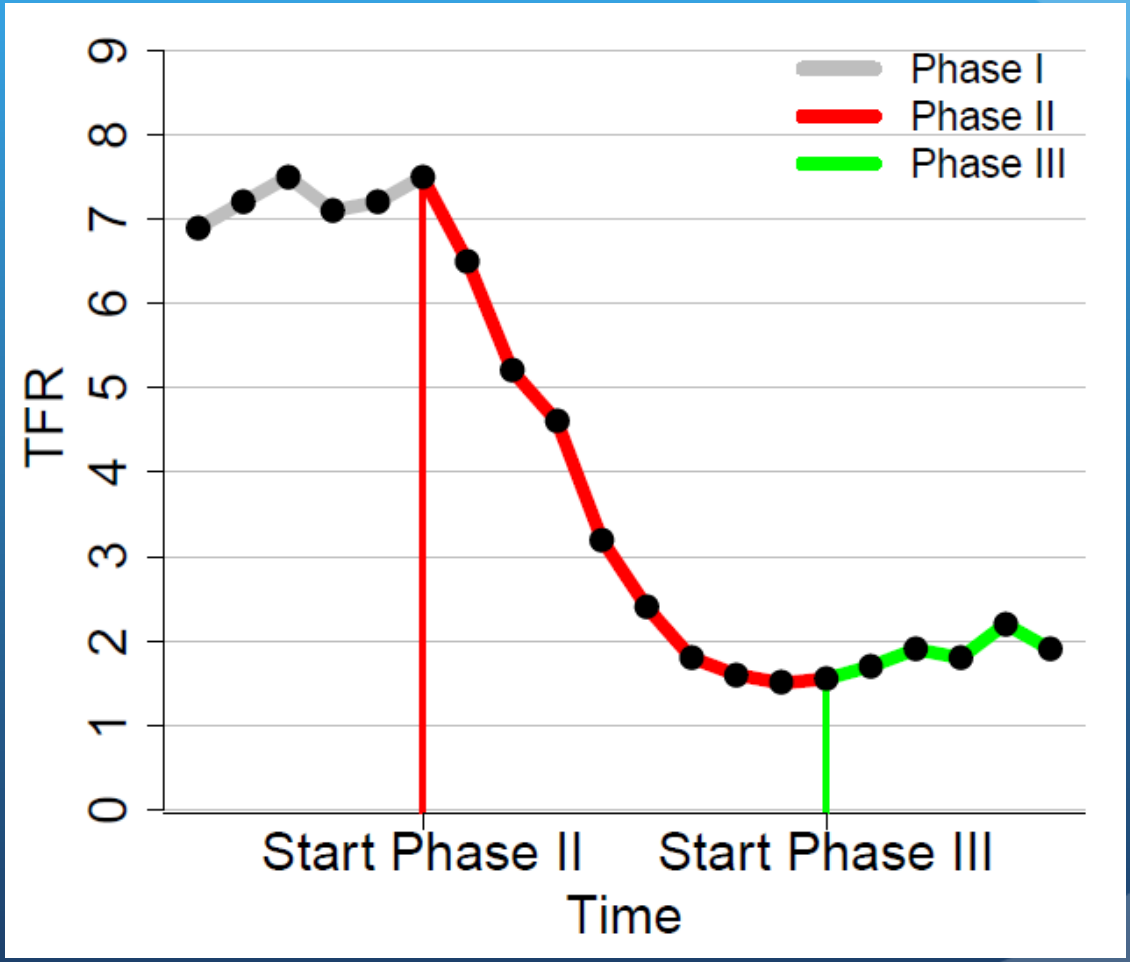
Probabilistic TFR projections



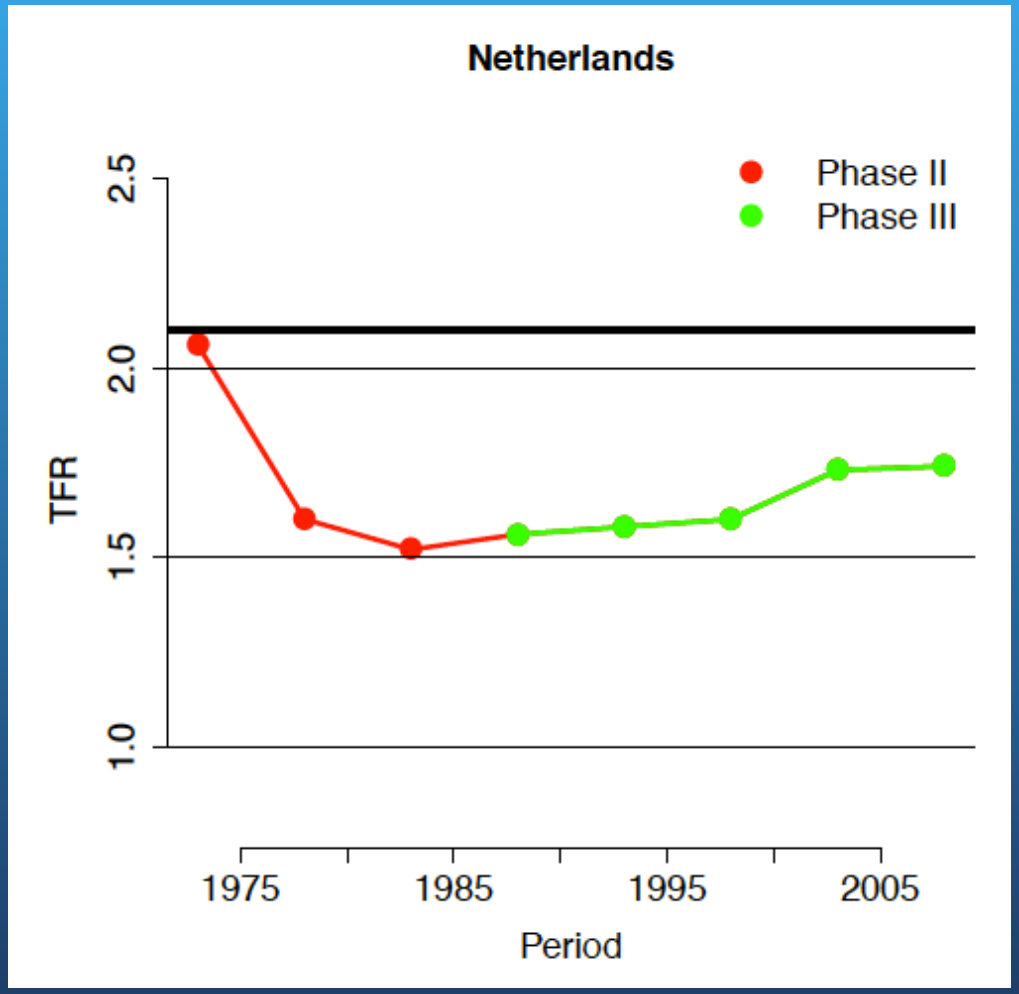
Country-specific models estimated via Bayesian hierarchical model



Three phases of TFR trends: pre-decline, decline, post-decline

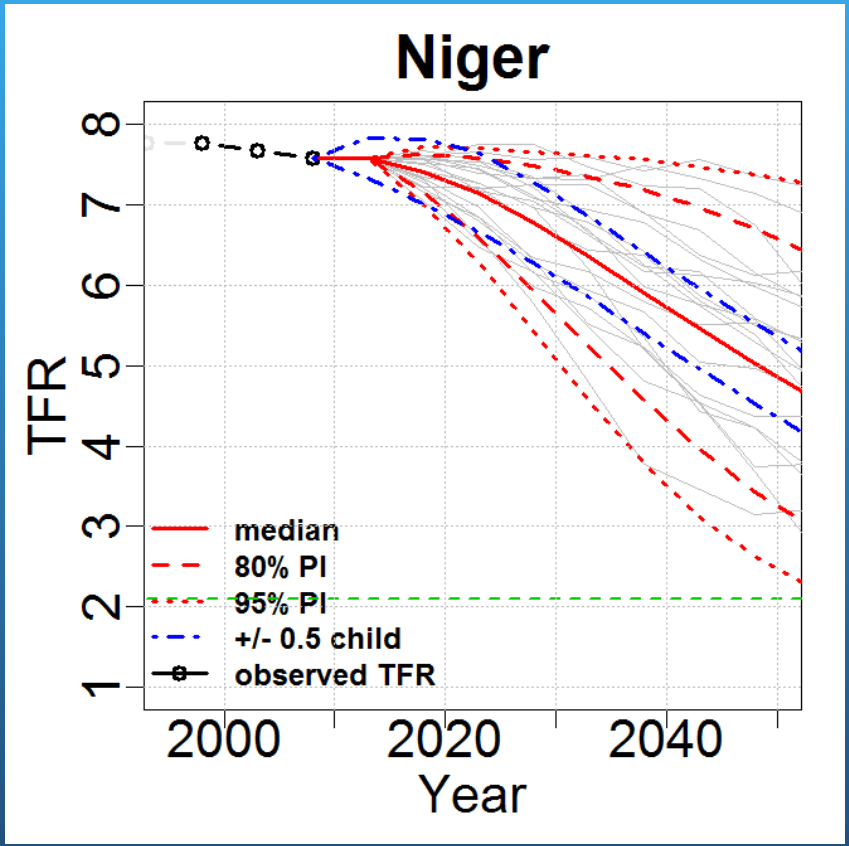


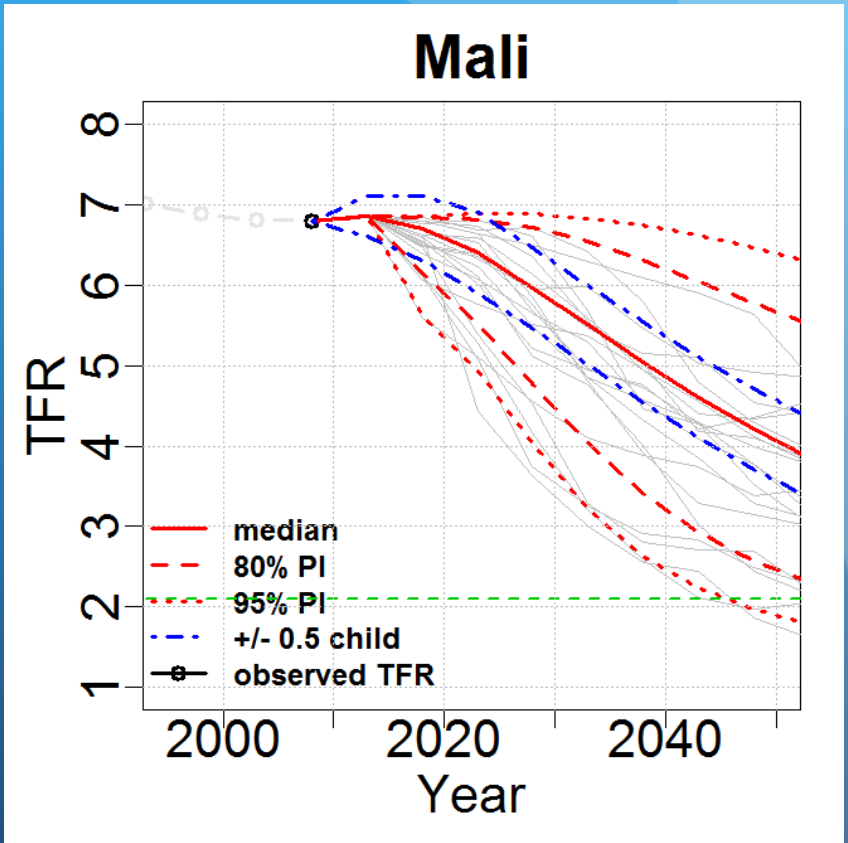
Phase III: Post-transition low-fertility rebound



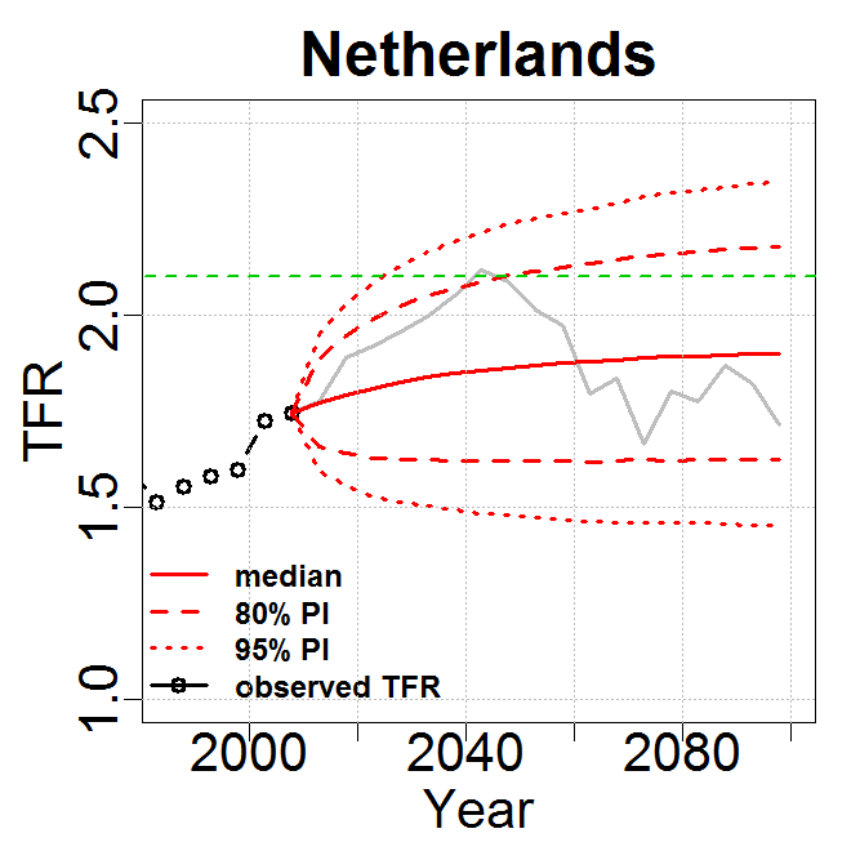
- Start of Phase III defined by two earliest consecutive 5-year increases when TFR < 2
- Observed in 25 countries/areas: 20 European countries, plus USA, Canada, Barbados, Hong Kong, and Singapore

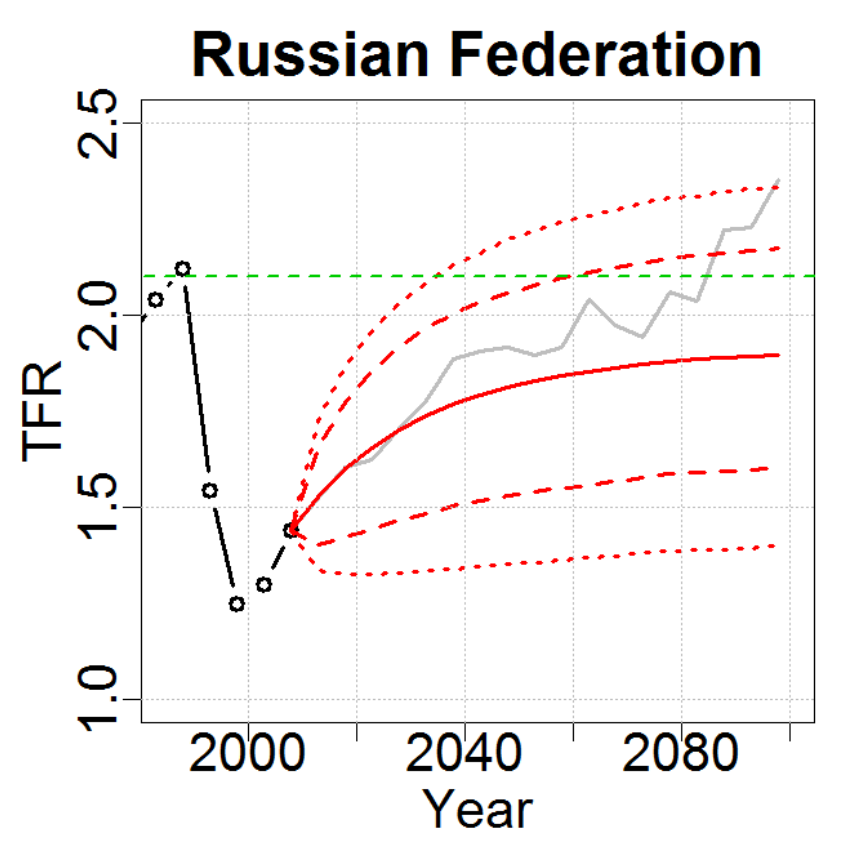
Projections for high-fertility countries



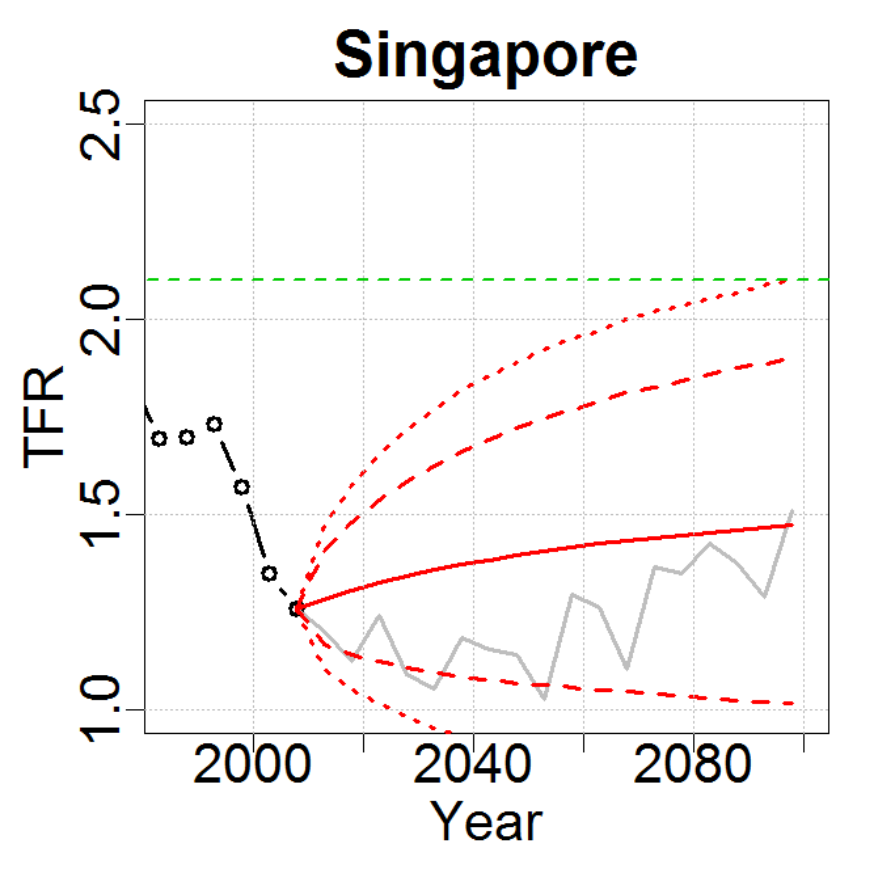


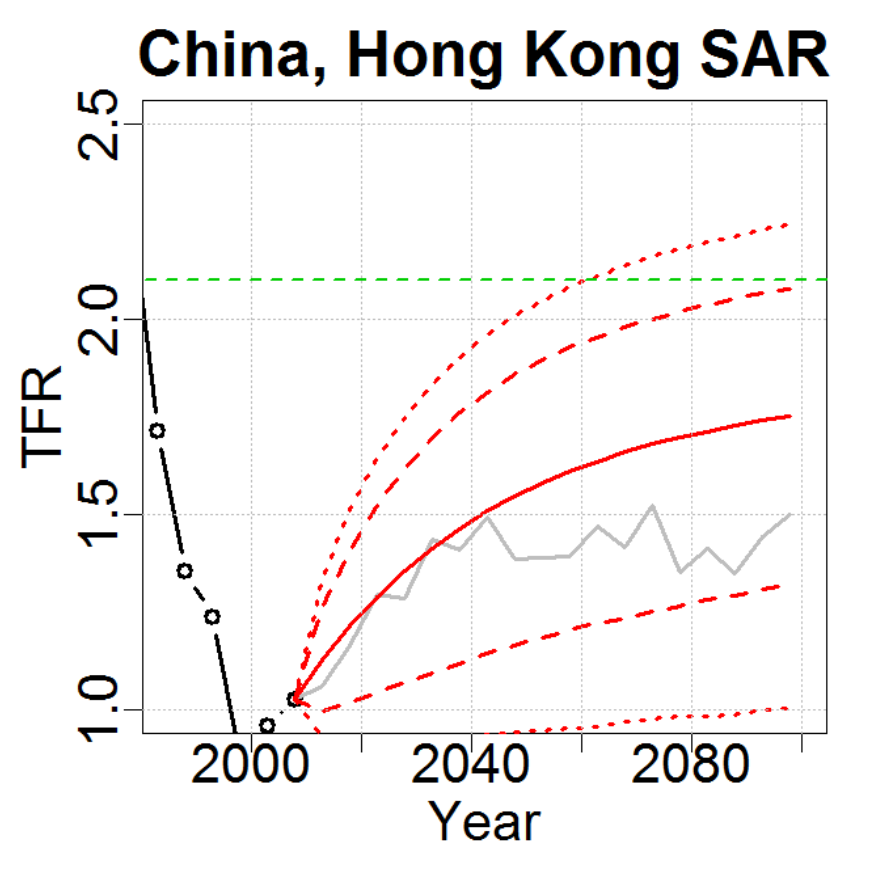
Projections for low-fertility countries



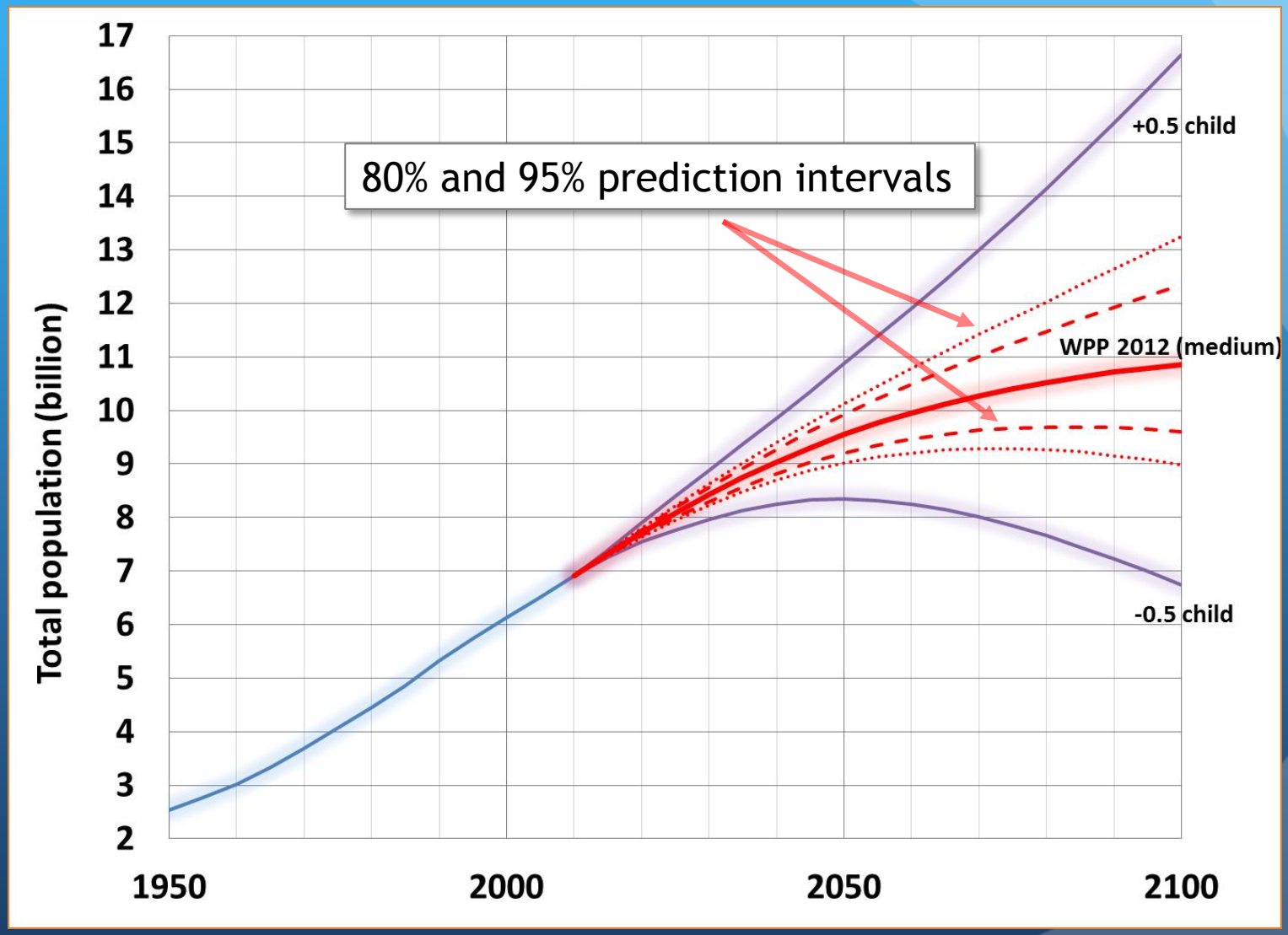


Projections for lowest-fertility countries



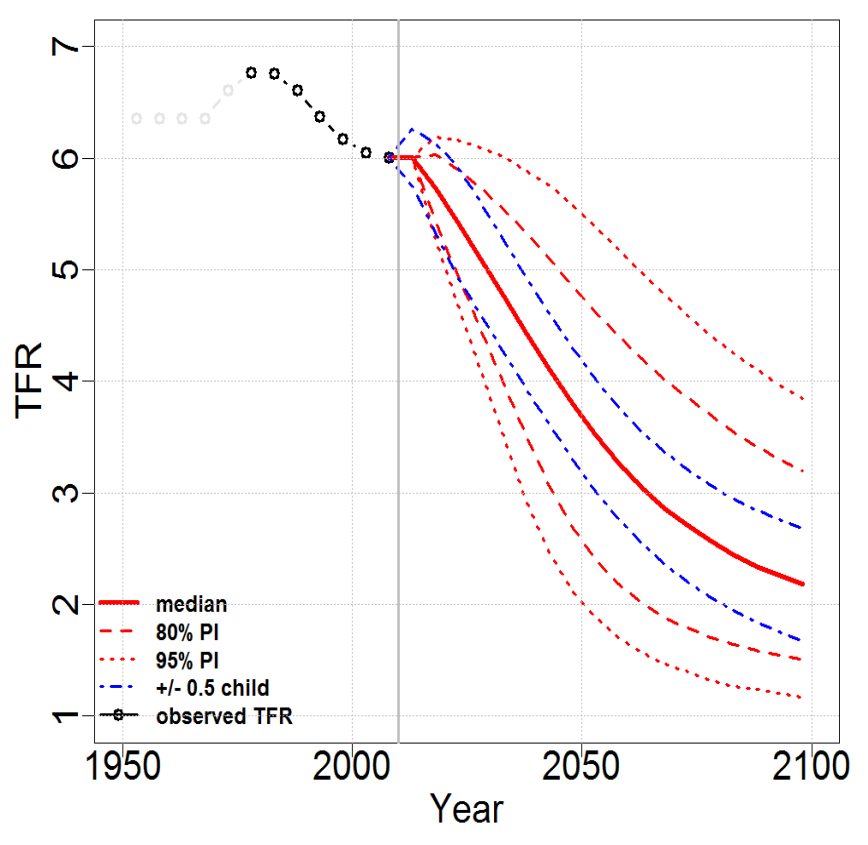


World population projections

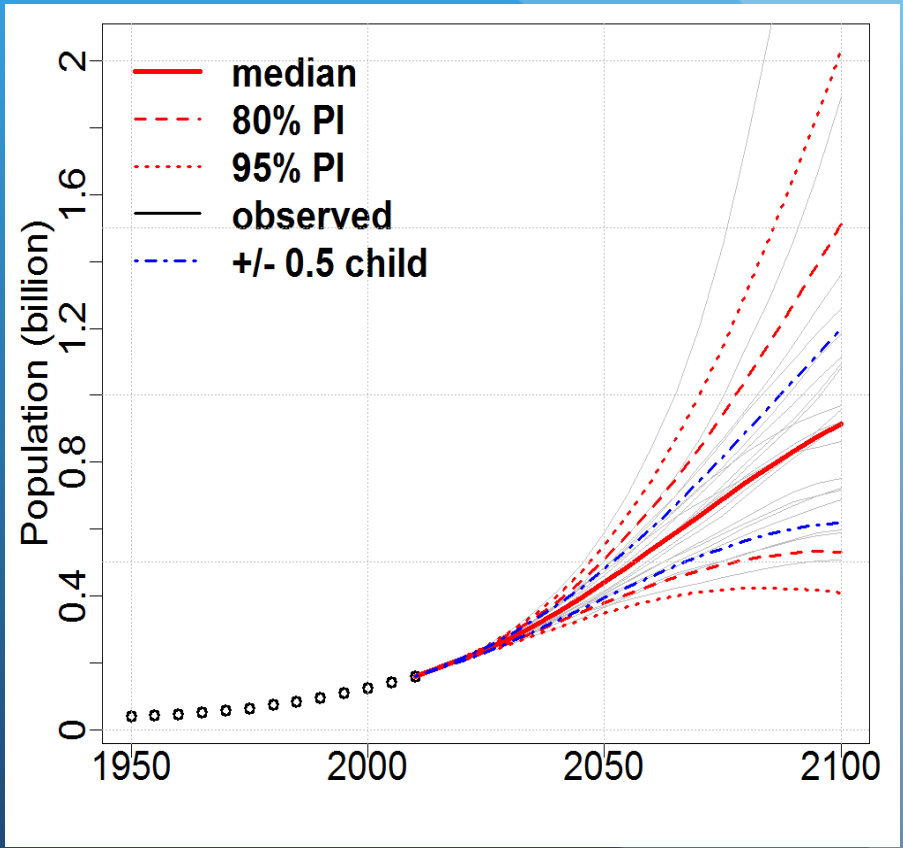


Nigeria

Total fertility rate

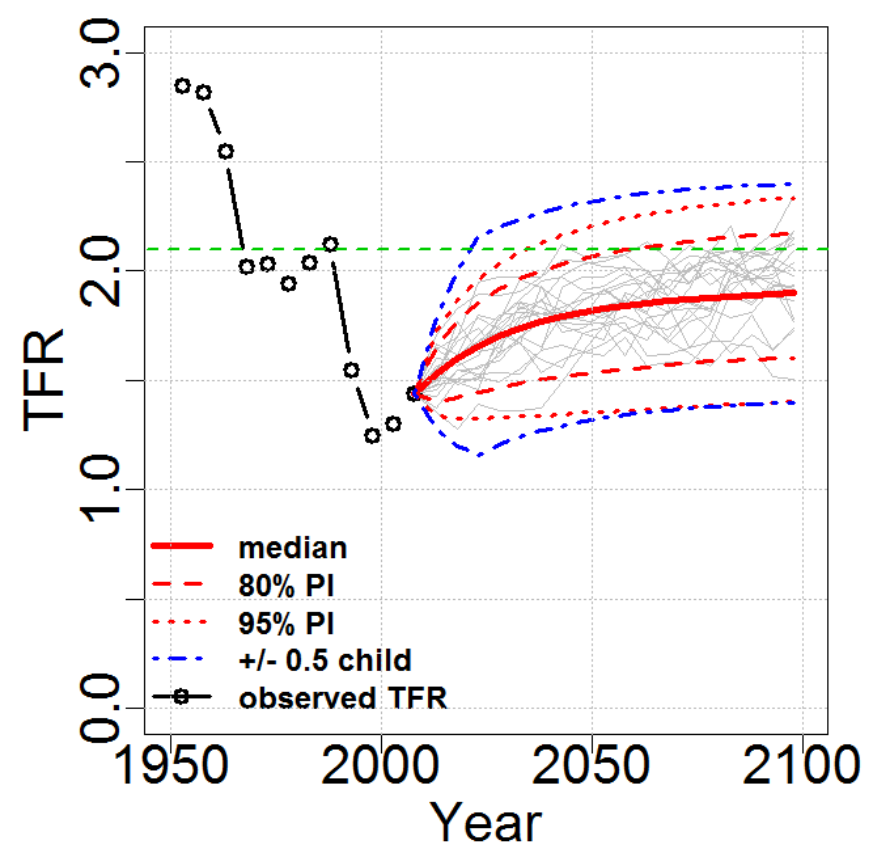


Total population

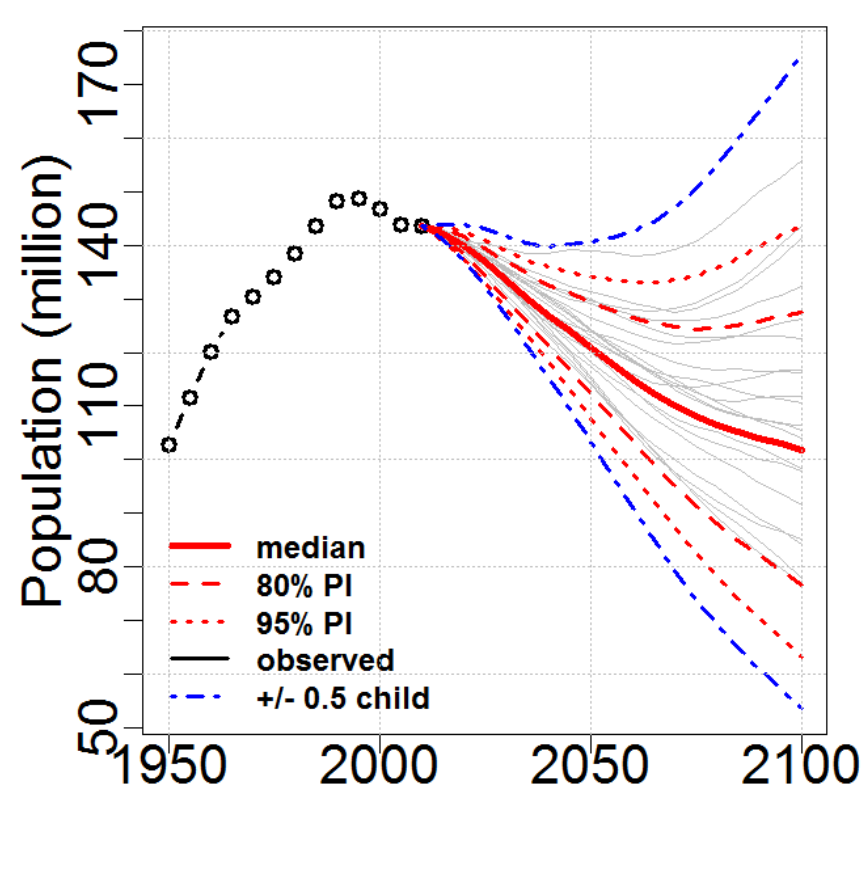


Russian Federation

Total fertility rate



Total population



What have we learned from probabilistic projections?

- UN fertility variants (+/- half child)
  - Overstate the "uncertainty" of future trends at the global level, and also for some low-fertility countries
  - Understate the "uncertainty" of future trends for high-fertility countries
- World population growth
  - 95% prediction interval for 2050: 9.0 – 10.1 billion
  - 95% prediction interval for 2100: 9.0 – 13.2 billion
  - Population stabilization unlikely in this century, but not impossible (probability ~30%)

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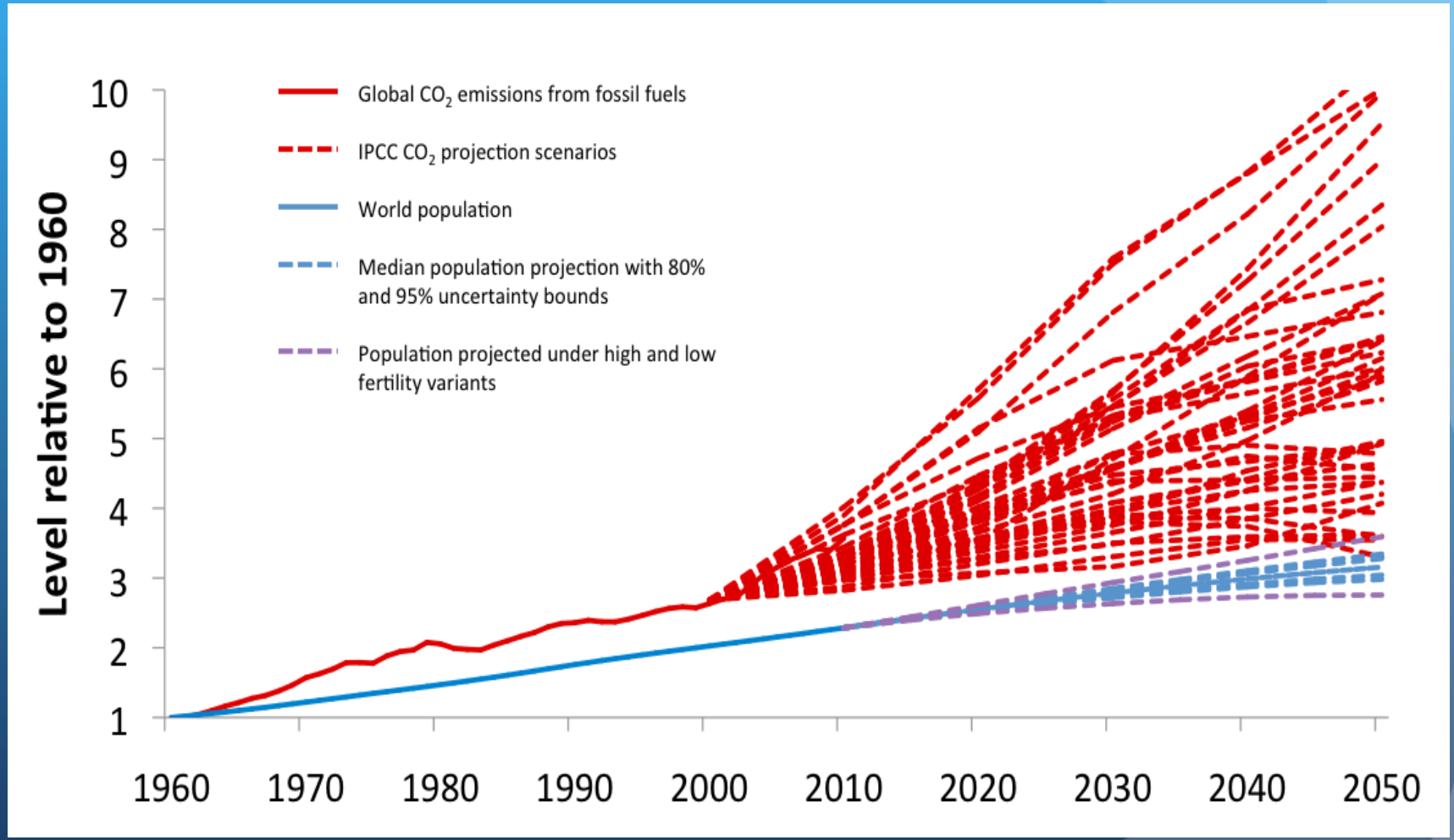
Uncertainty in future CO_2 emissions is far greater than population uncertainty



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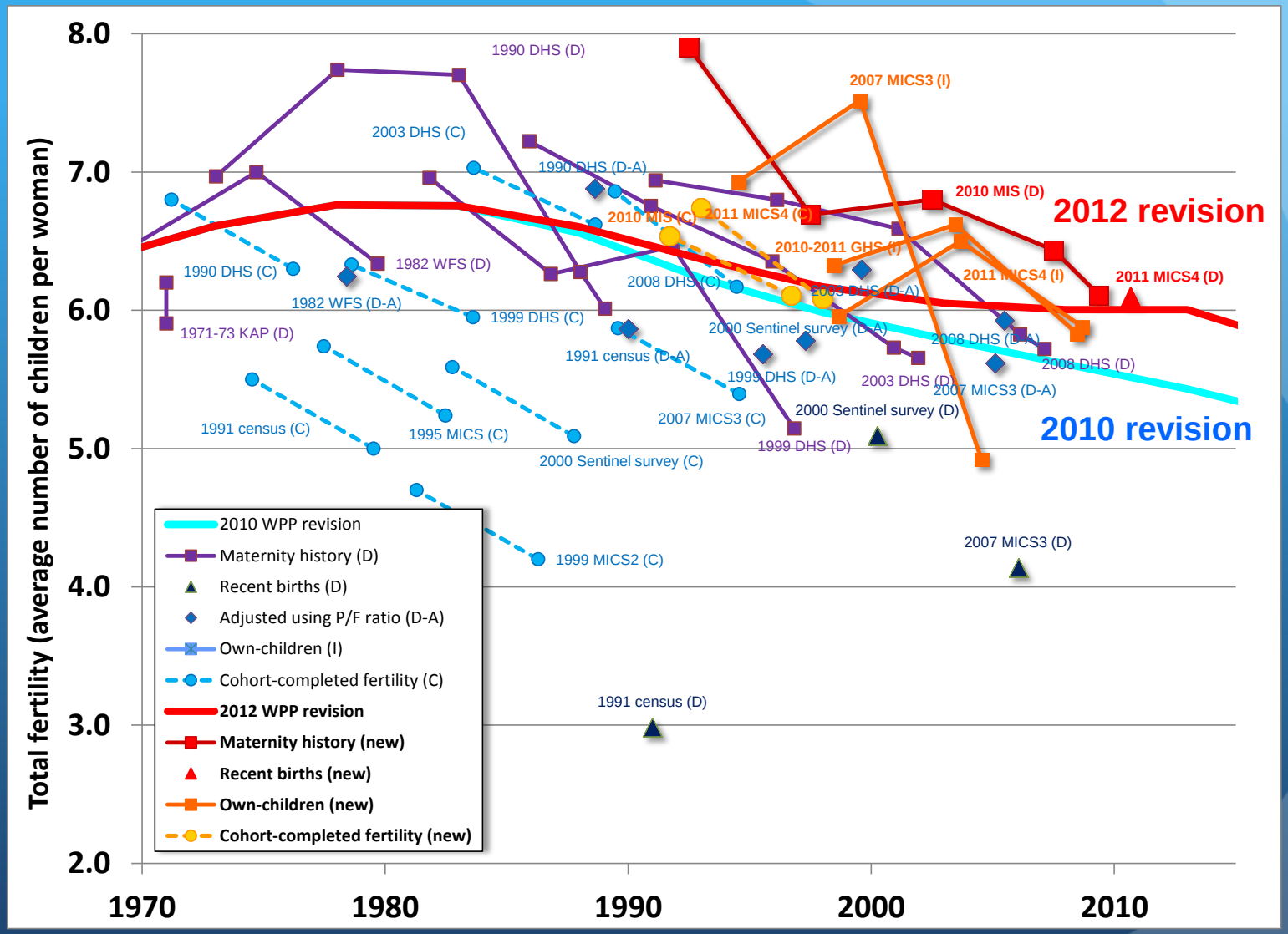
What uncertainty is not (yet) accounted for?

- Uncertainty about the baseline population and current levels of fertility, mortality and migration
- Uncertainty about model specification (e.g., asymptotic rate of increase in e_0)
- Uncertainty about future age patterns of fertility and mortality
- For countries with high prevalence of HIV, uncertainty about the future path of the epidemic
- Uncertainty about future sex ratios at birth
- Uncertainty about future trends in international migration

Uncertainty in past demographic estimates



Source: United Nations (2014). *World Population Prospects: The 2012 Revision - Methodology*

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Acknowledgements

More than 8 years and ongoing of research and collaboration between the UN Population Division and Prof. Adrian Raftery (Department of Statistics of the University of Washington) and his team:

- All the team responsible (UN Population Division) for the 2012 revision of the World Population Prospects, especially Kirill Andreev, Thomas Buettner, Patrick Gerland, Danan Gu, Gerhard Heilig, Nan Li, Francois Pelletier and Thomas Spoorenberg
- Team members of the UW Probabilistic Population Projections (BayesPop) Project: Adrian Raftery, Leontine Alkema, Jennifer Chunn, Bailey Fosdick, Nevena Lalic, Jon Azose and Hana Ševčíková

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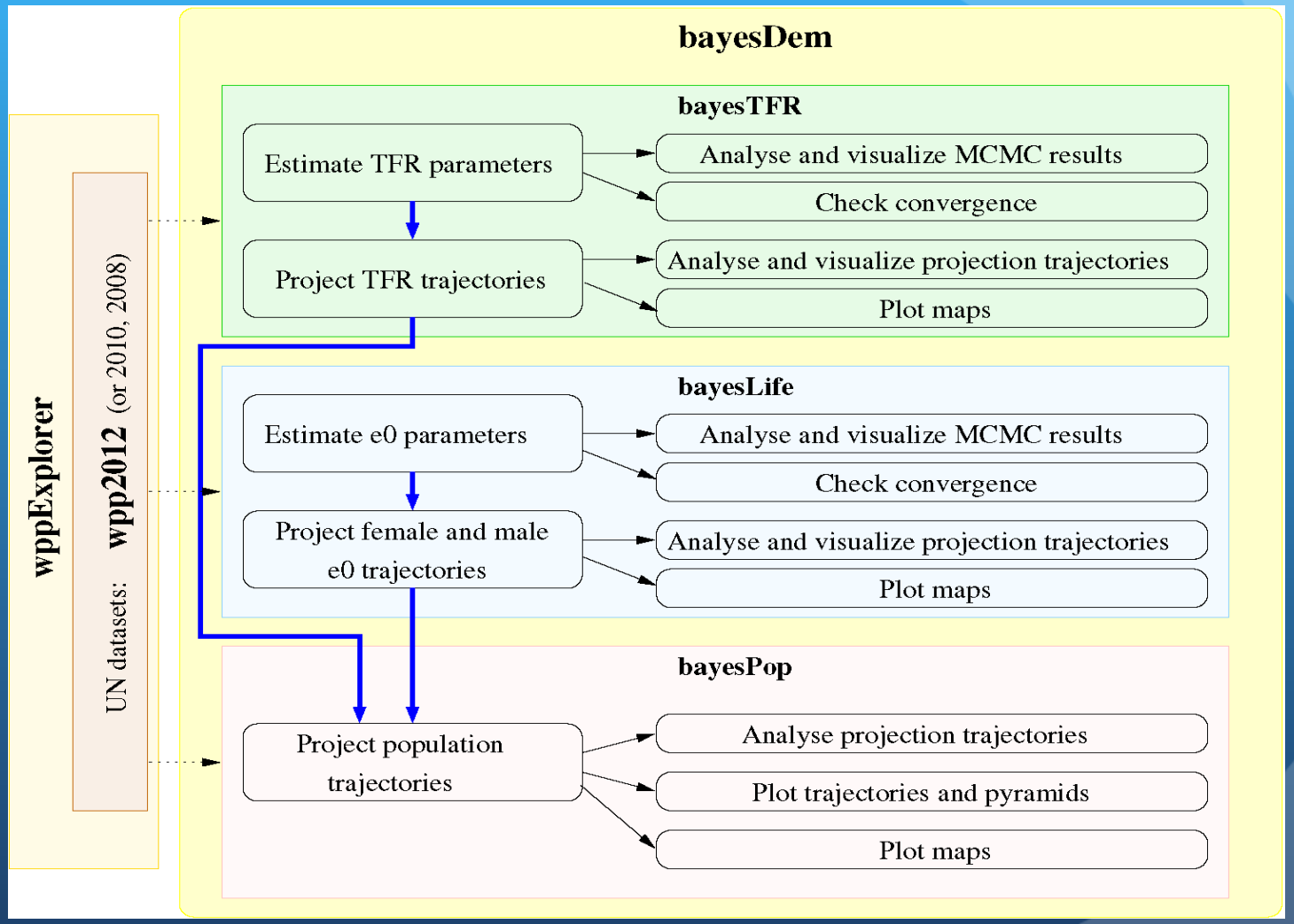
R packages (free open source) available at http://cran.r-project.org

- Probabilistic projections of total fertility rate: bayesTFR
- Probabilistic projections of life expectancy at birth: bayesLife
- Probabilistic population projections: bayesPop
- Graphical user interface: bayesDem, wppExplorer
- UN datasets: wpp2012, wpp2010, wpp2008

R packages


bayesDem
bayesTFR
Estimate TFR parameters
Analyse and visualize MCMC results
Check convergence
Project TFR trajectories
Analyse and visualize projection trajectories
Plot maps
bayesLife
Estimate e0 parameters
Analyse and visualize MCMC results
Check convergence
Project female and male e0 trajectories
Analyse and visualize projection trajectories
Plot maps
bayesPop
Project population trajectories
Analyse projection trajectories
Plot trajectories and pyramids
Plot maps
wppExplorer
wpp2012 (or 2010, 2008)
UN datasets:

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