ACTUARIAL SOCIETY OF SOUTH AFRICA

2012 CONVENTION

16-17 OCTOBER

Taking Charge of Uncertainty

The United Nations Approach to Population Projections

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The UN Population Projections

Periodicity:	Revised every two years
Coverage:	Produced for 230 units
Method:	By components of change
Age groups:	Five years in length
Step size:	Five-year intervals
Estimates:	1950 – 2010
Projections:	2015 – 2100 (2010 Revision)

Components of change

Fertility: Future trend in total fertility

Age distribution of fertility

Mortality: Future trend in life expectancy

Mortality rates by age and sex

AIDS: Future incidence by age and sex

Migration: Future net number of migrants

Migrants by age and sex

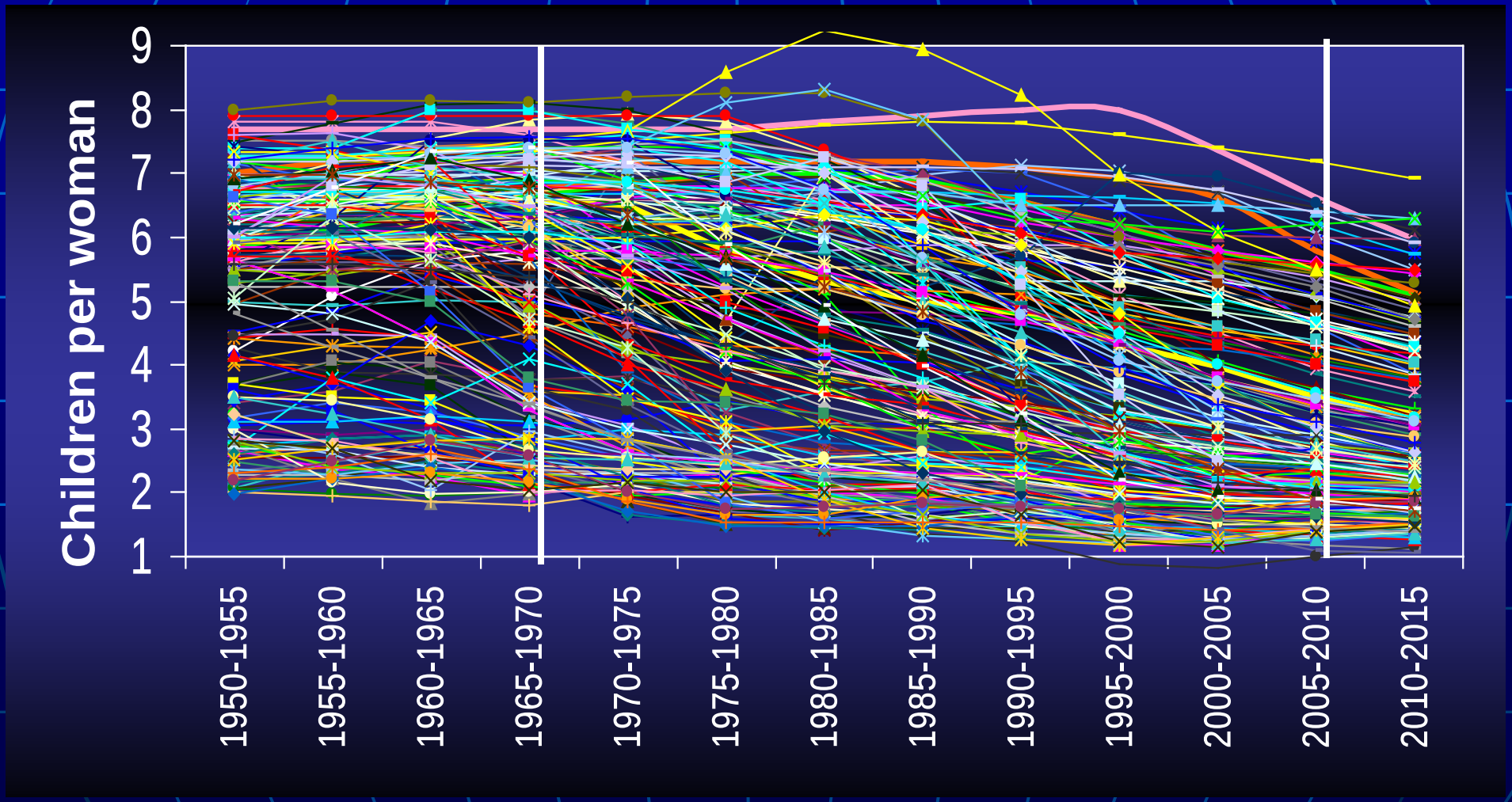
PROJECTING THE FIRST COMPONENT OF CHANGE:

FERTILITY

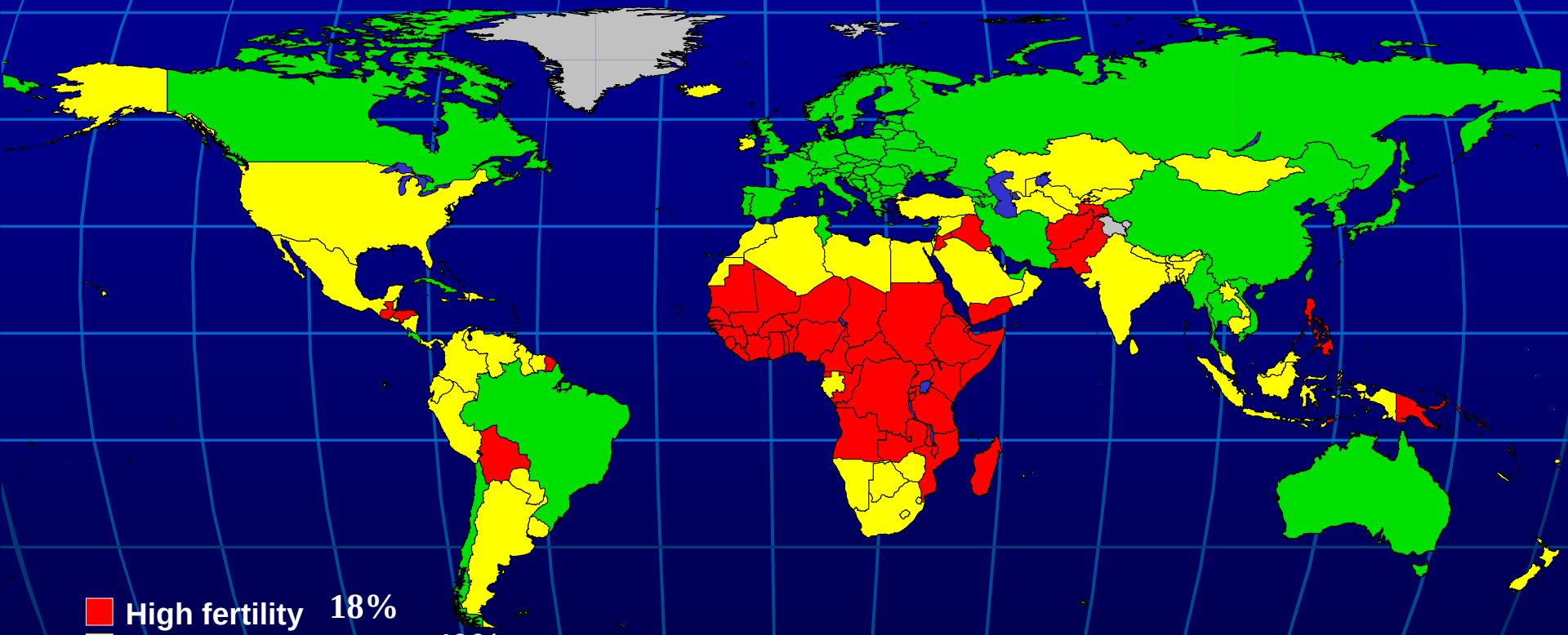
In projecting future fertility trends one can take advantage of two things:

- The availability of a complete set of past estimates of fertility change
- The empirical existence of a "typical" pattern of fertility change as described by the demographic transition

Fertility estimates from 1950 to 2015



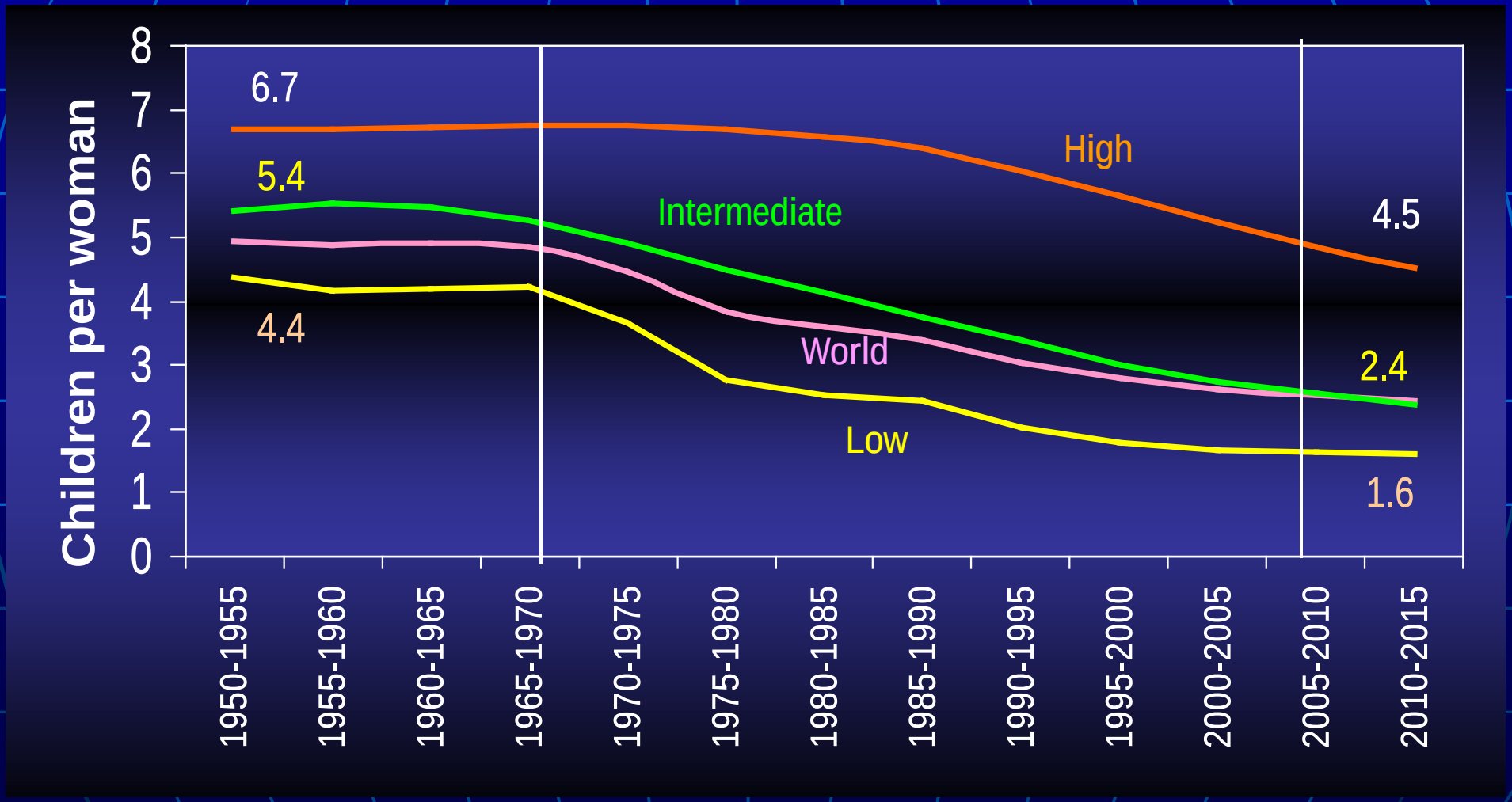
Countries classified by fertility level



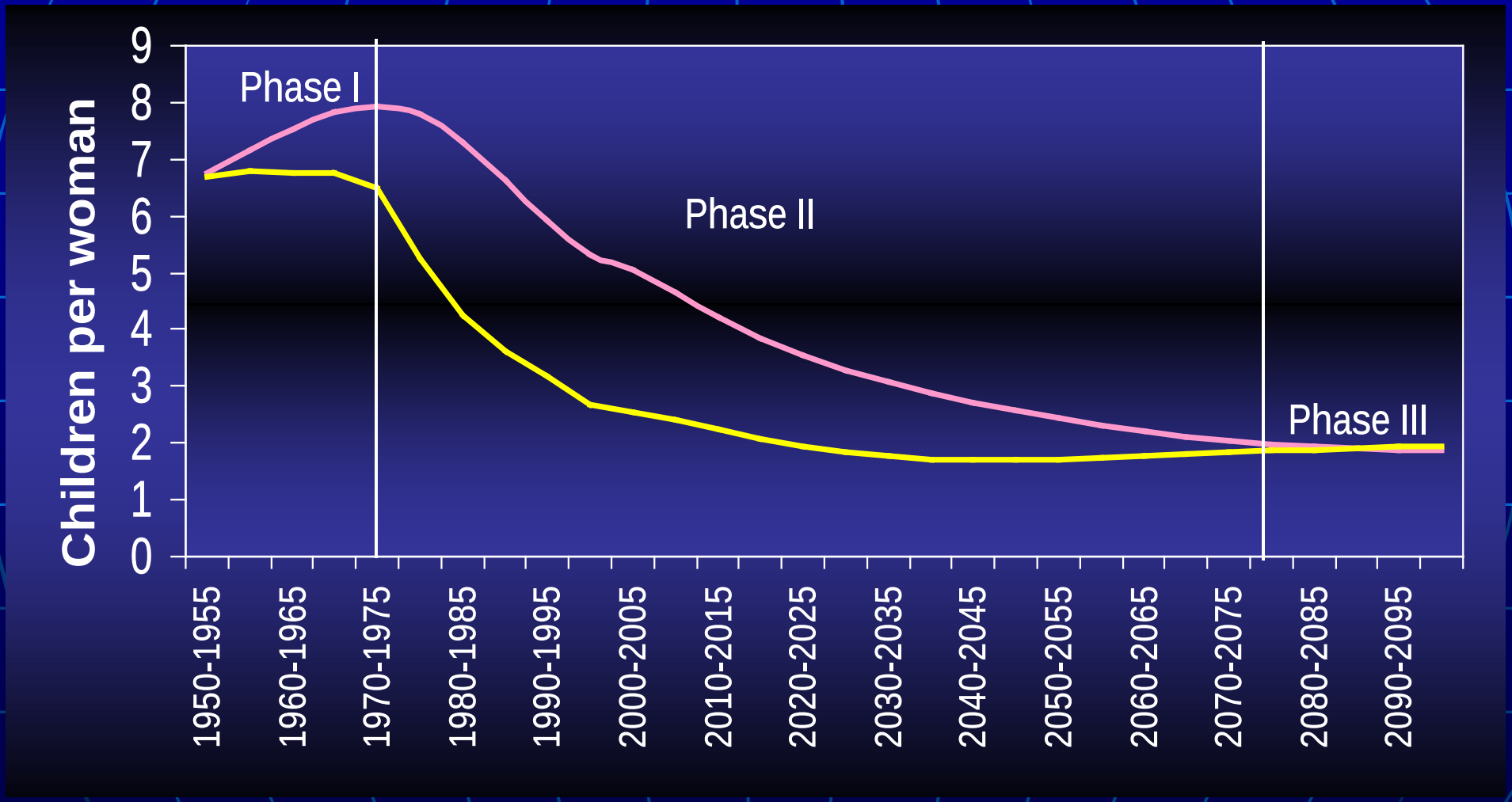
High fertility 18%
Intermediate fertility 40%
Low fertility 42%

Note: The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations.

Fertility trends from 1950 to 2015



Typical fertility trend from high to low



PROJECTING FERTILITY FOR COUNTRIES IN PHASE II

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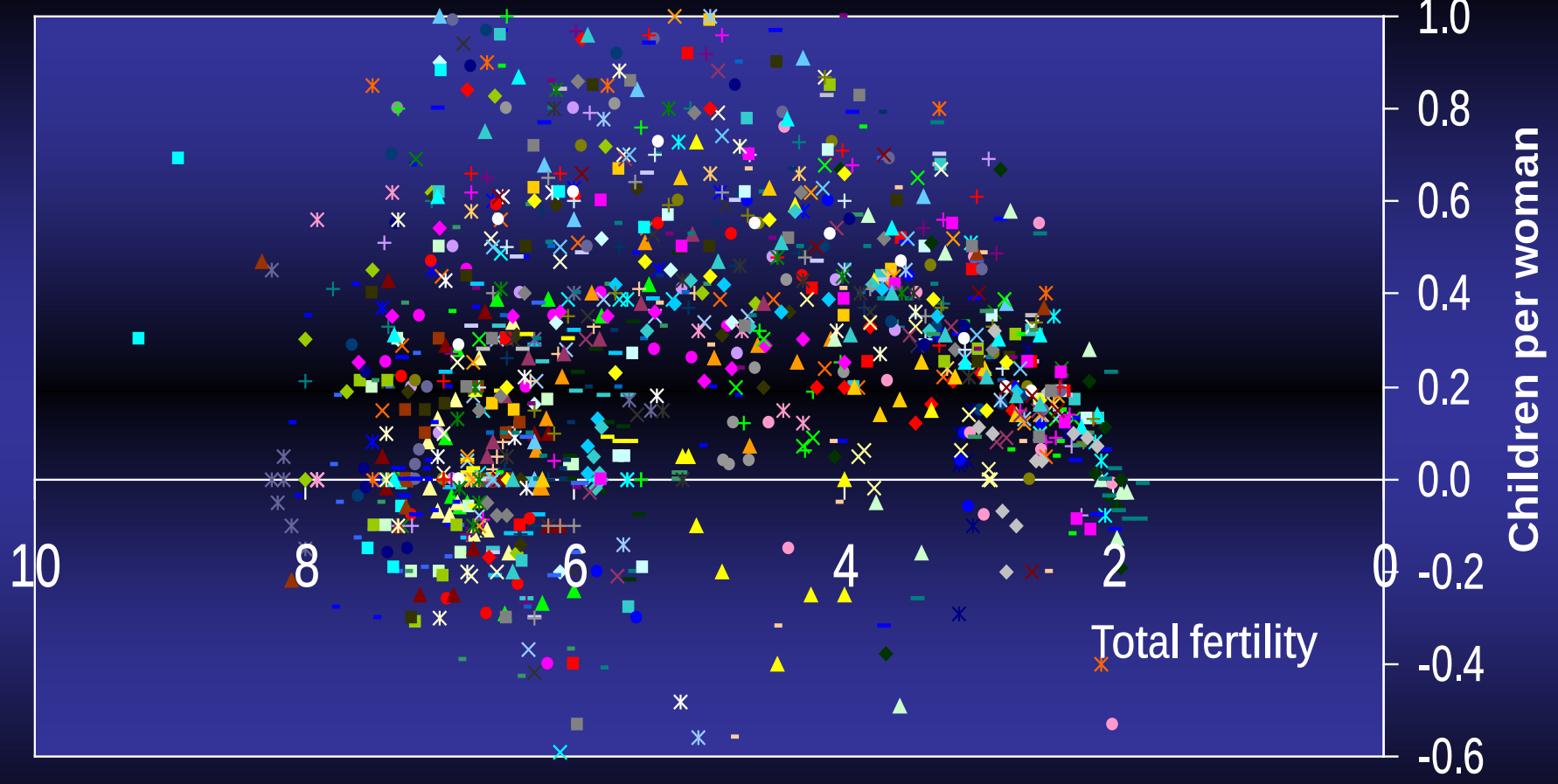
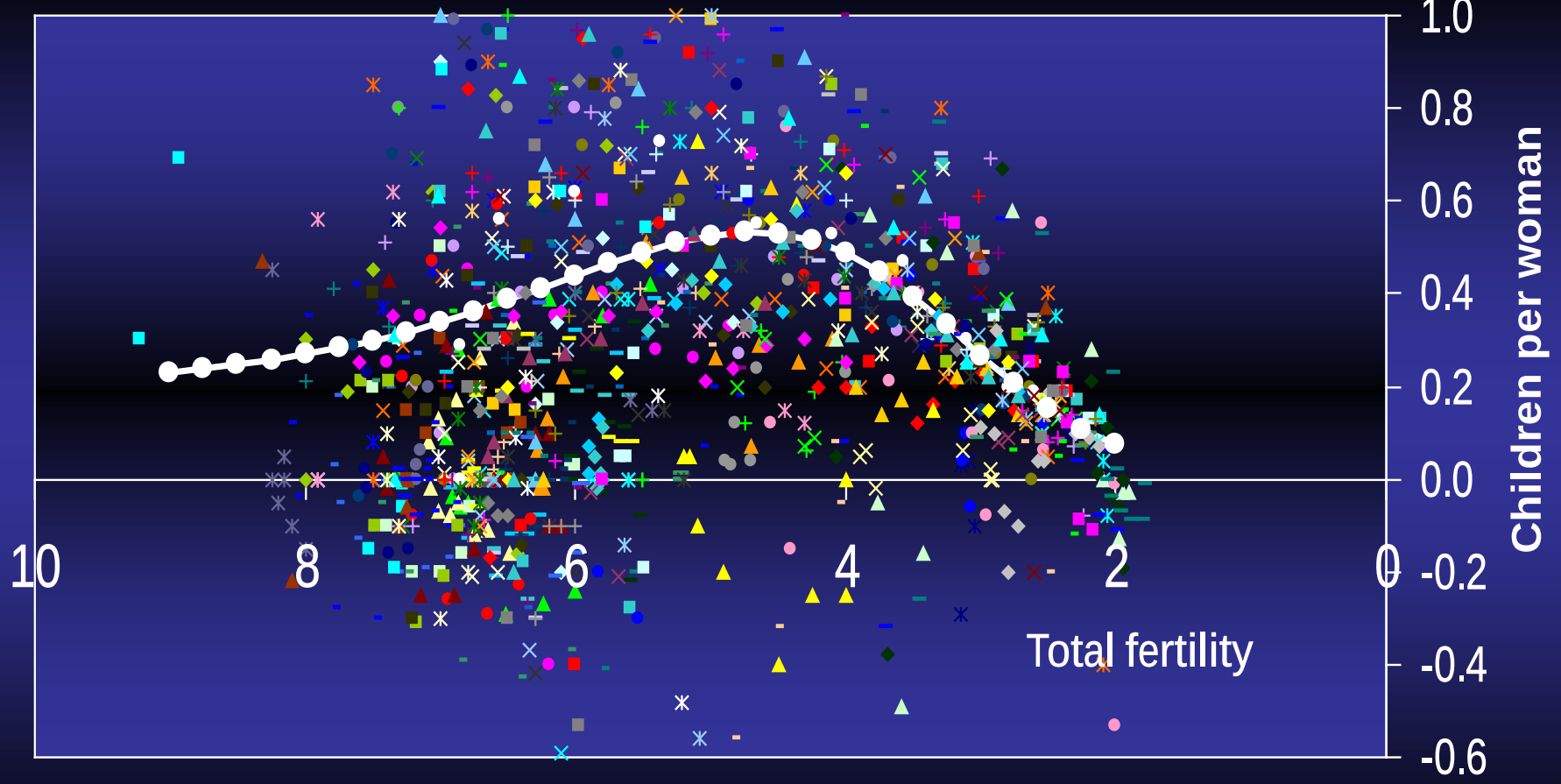
Fertility decrements during Phase II



Modeled fertility decrements, Phase II



Fertility decrements are modeled using a double logistic function with five parameters

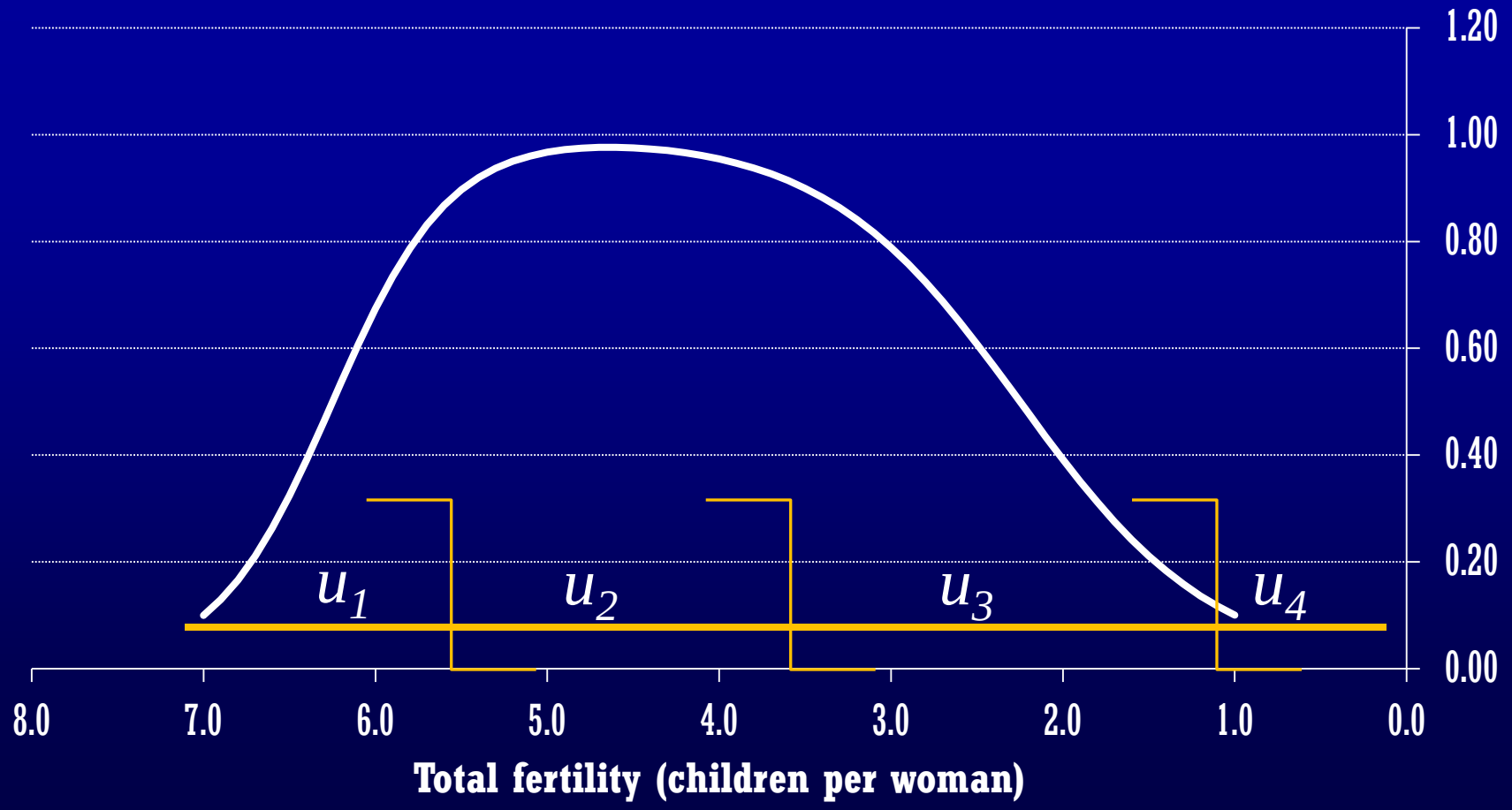
$$g(D, U, f_t) = \frac{-D}{1 + \exp\left[-2\ln(9) * \left[f_t - U + 0.5\, u_1\right]/u_1\right]}$$

$$+ \frac{D}{1 + exp\left[-2\ln(9) * \left[f_t - u_4 - 0.5u_3\right]/u_3\right]}$$

$$where \quad U = u_1 + u_2 + u_3 + u_4$$

and it represents the level at which fertility begins to decline.

Double logistic decrement function (D=1)



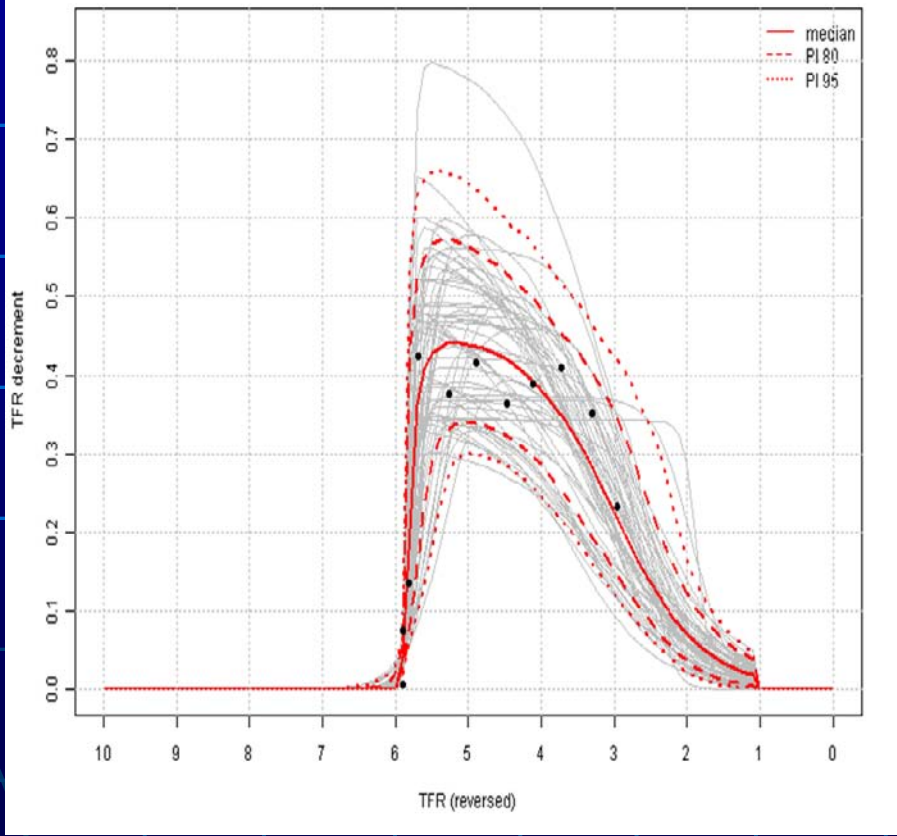
Fertility is projected by using the decrements yielded by the logistic model. Uncertainty is captured by a random distortion term

$$f_{t+1} = f_t + g(D, U, f_t) + \varepsilon_t$$

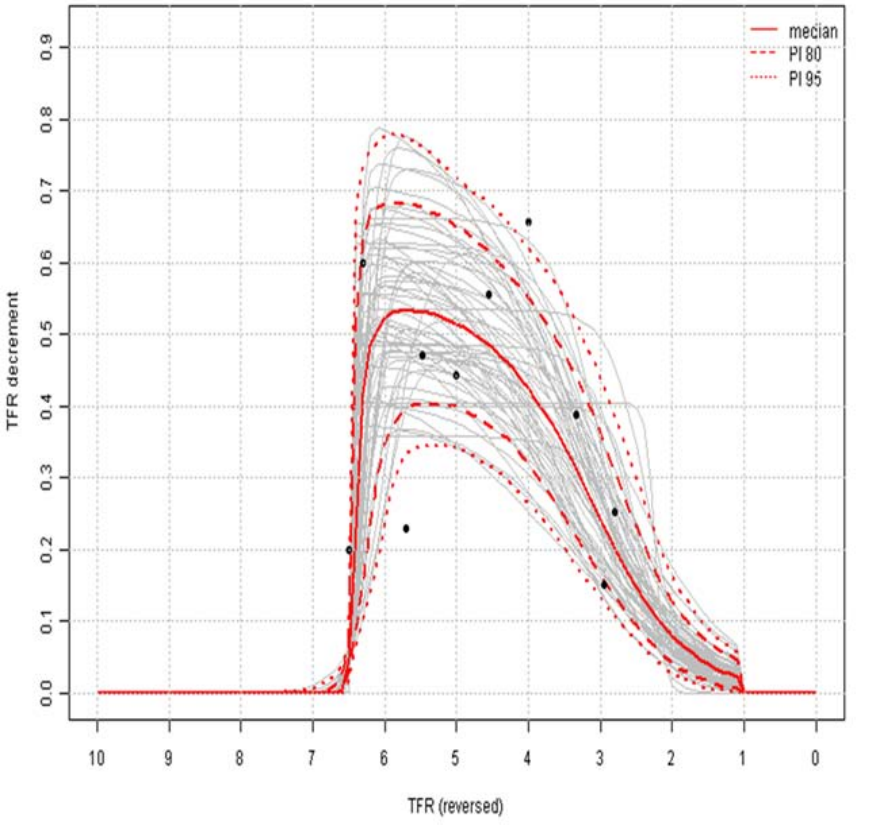
where ε_t *is normally distributed and the parameters* (D, U) *are estimated by using a Bayesian hierarchical framework with prior distributions based on world experience or guessed and posterior distributions derived using Monte Carlo Markov chain simulation incorporating country-specific data.*

Examples of decrement paths

India

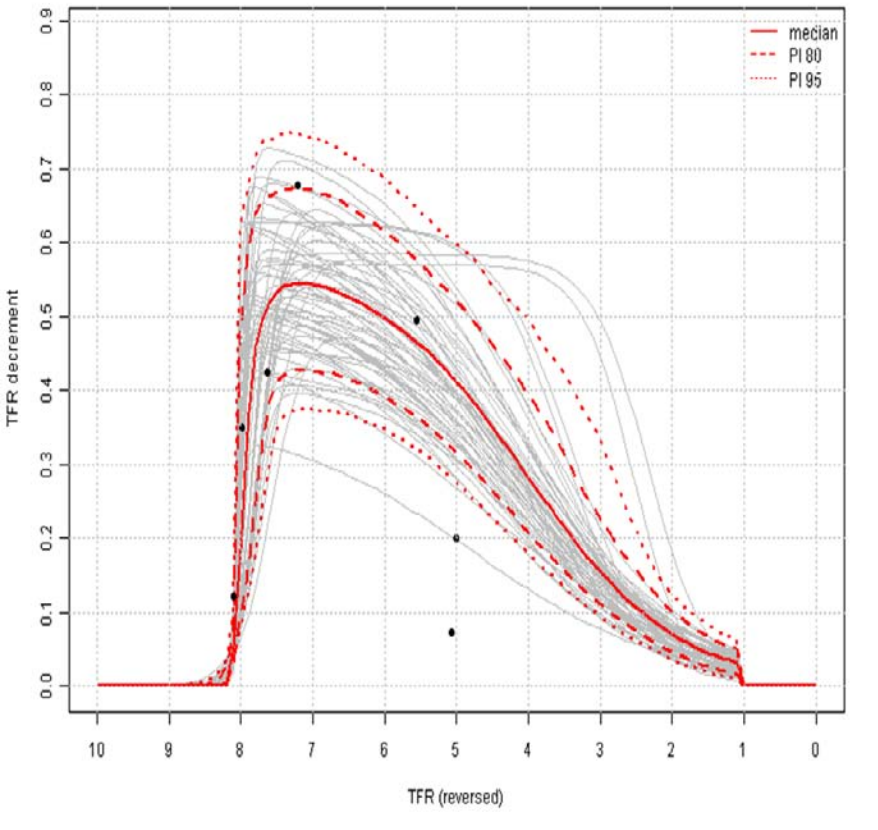


South Africa

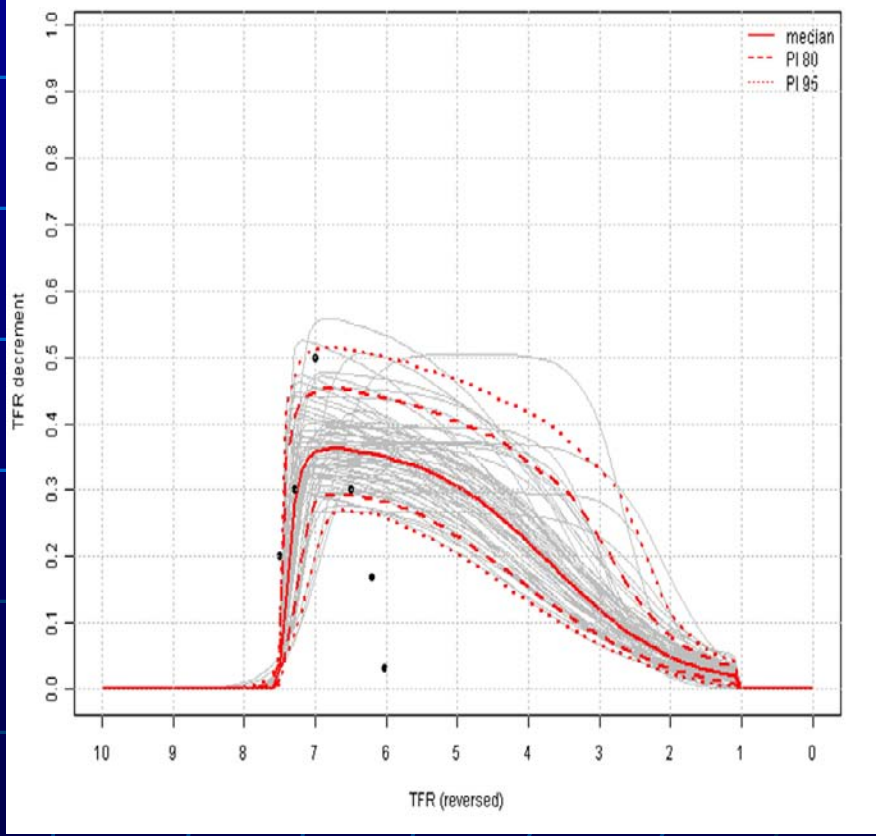


Stalling fertility has been common in Africa

Kenya

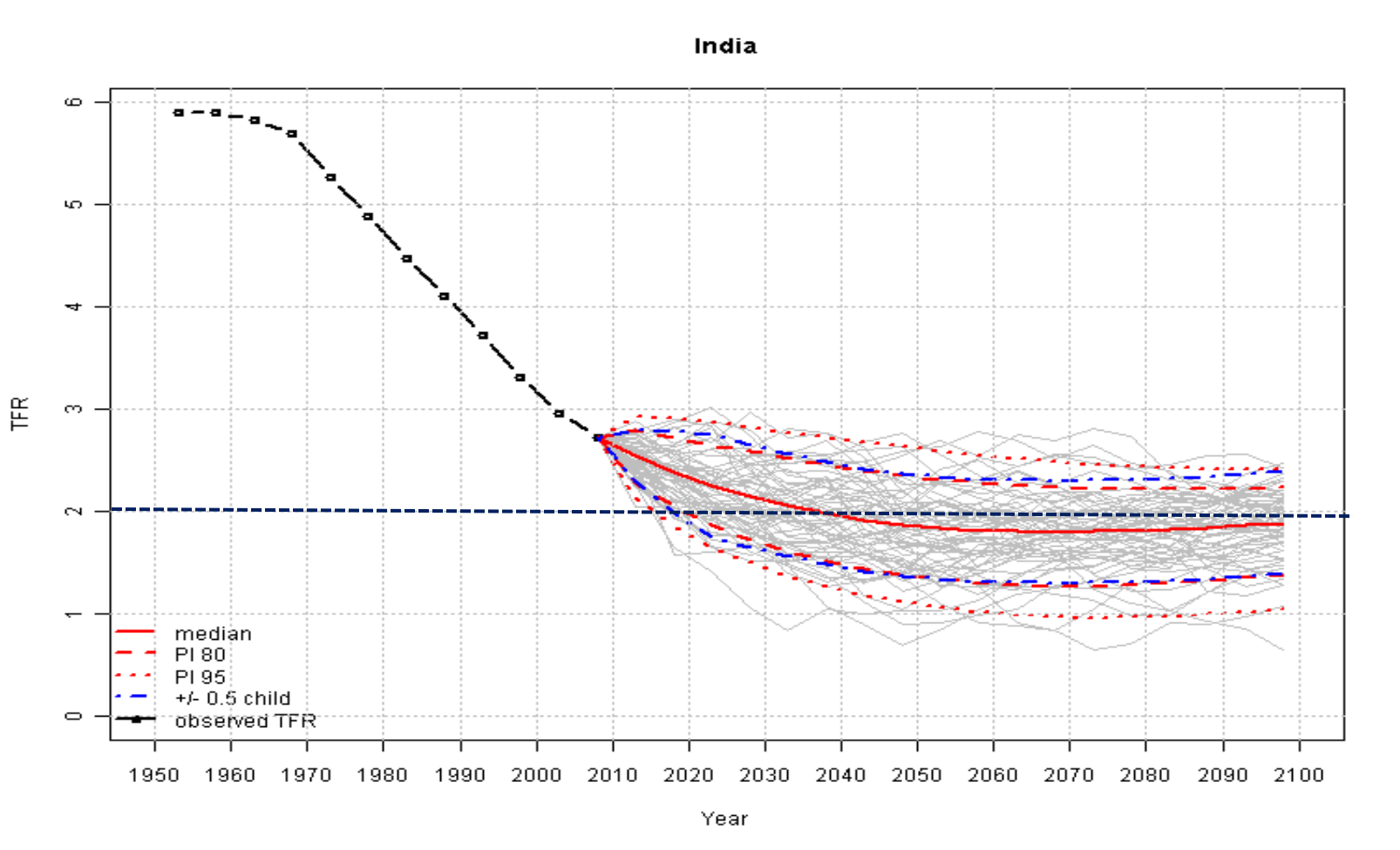


Malawi

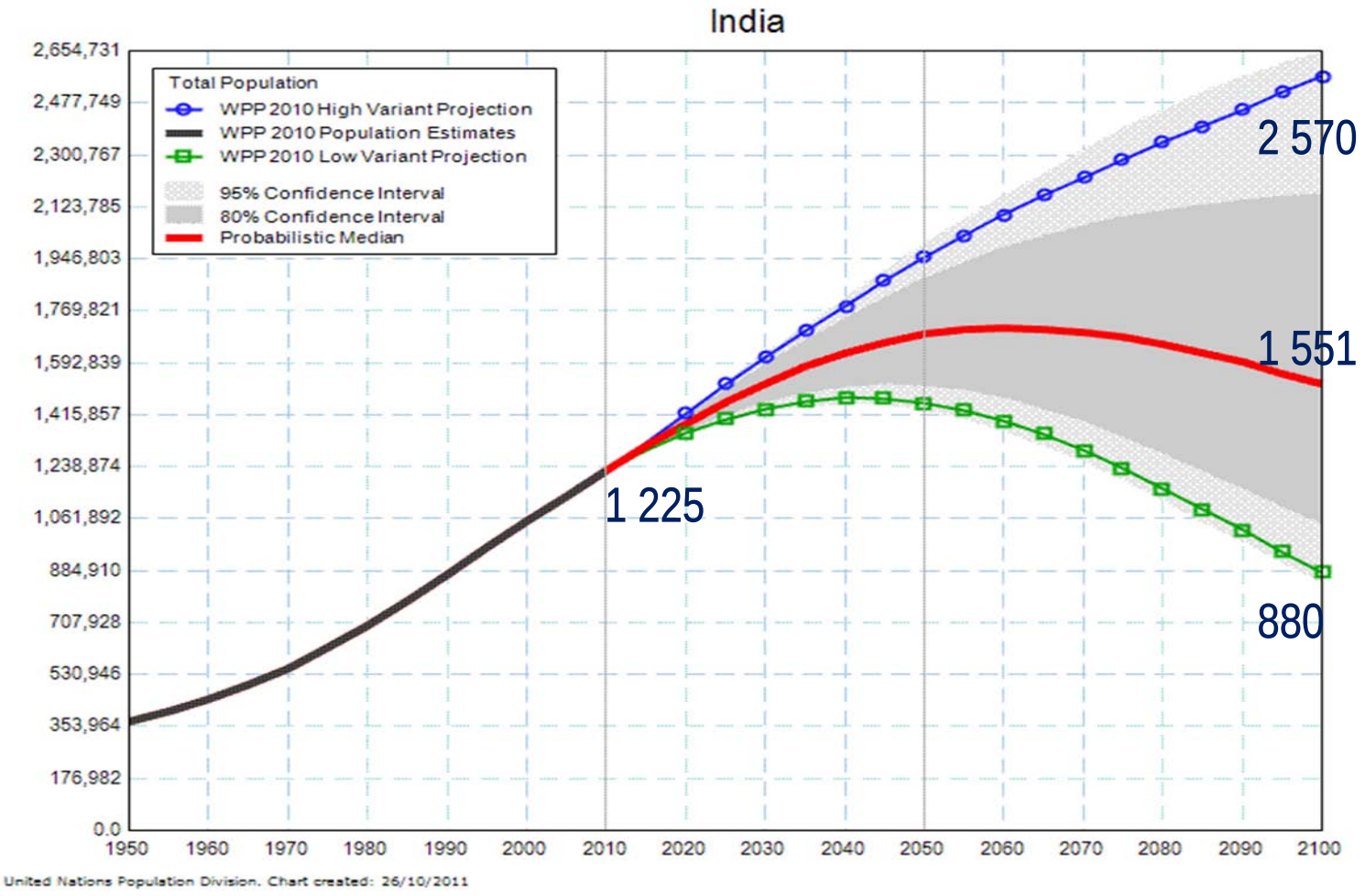


THE RESULTS OF USING THE PROBABILISTIC DECREMENT PATHS

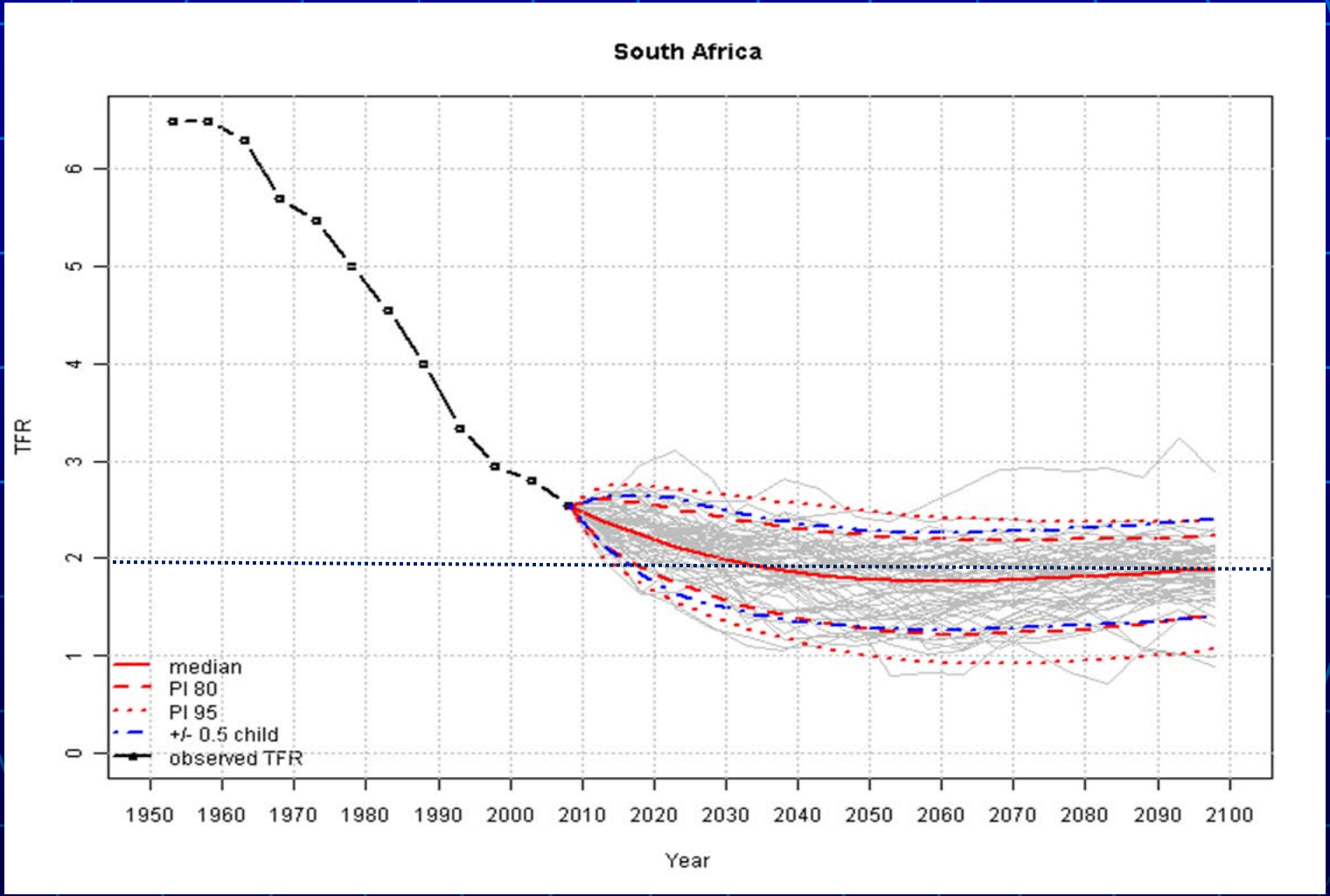
India: Projection of fertility



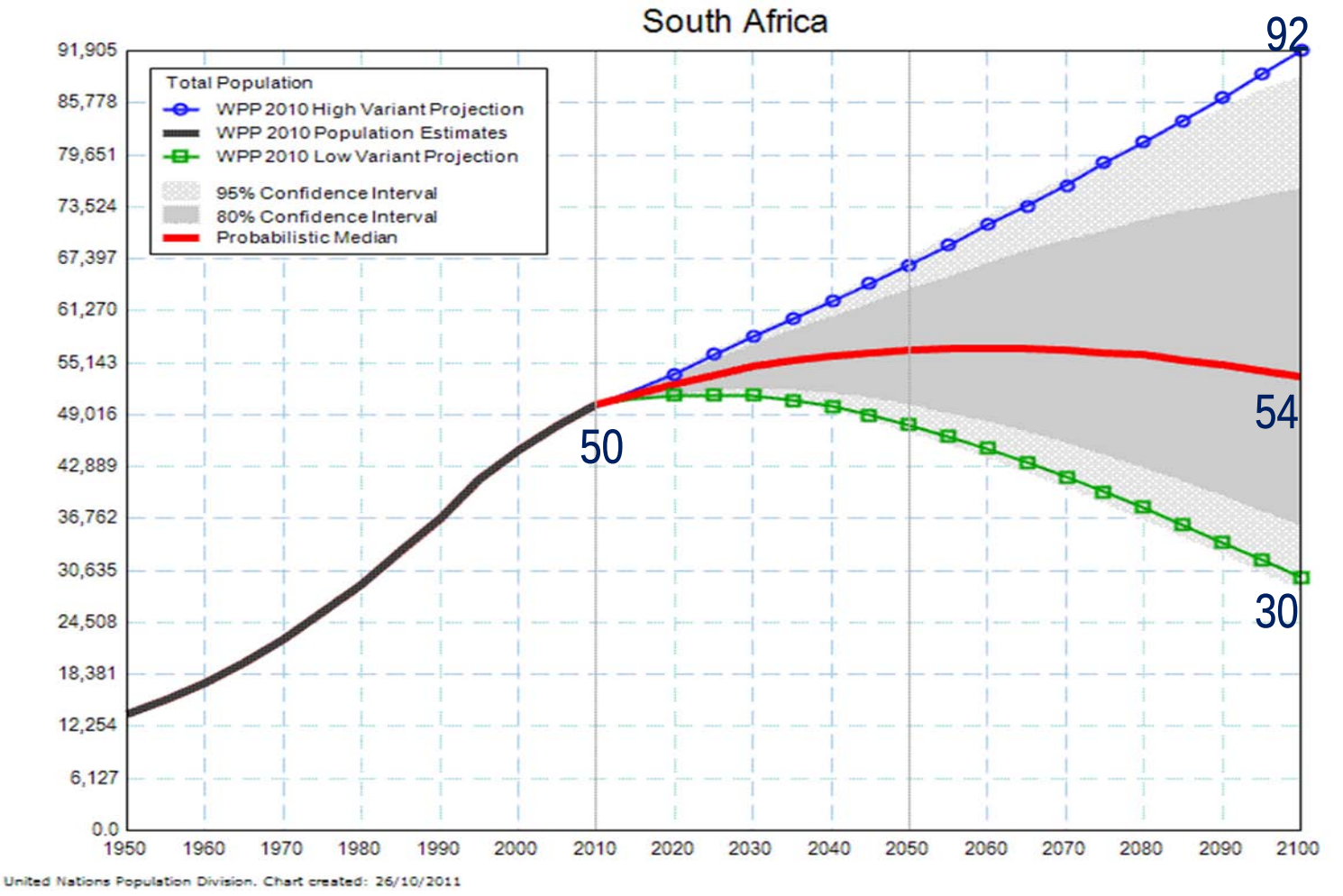
India: Projected population



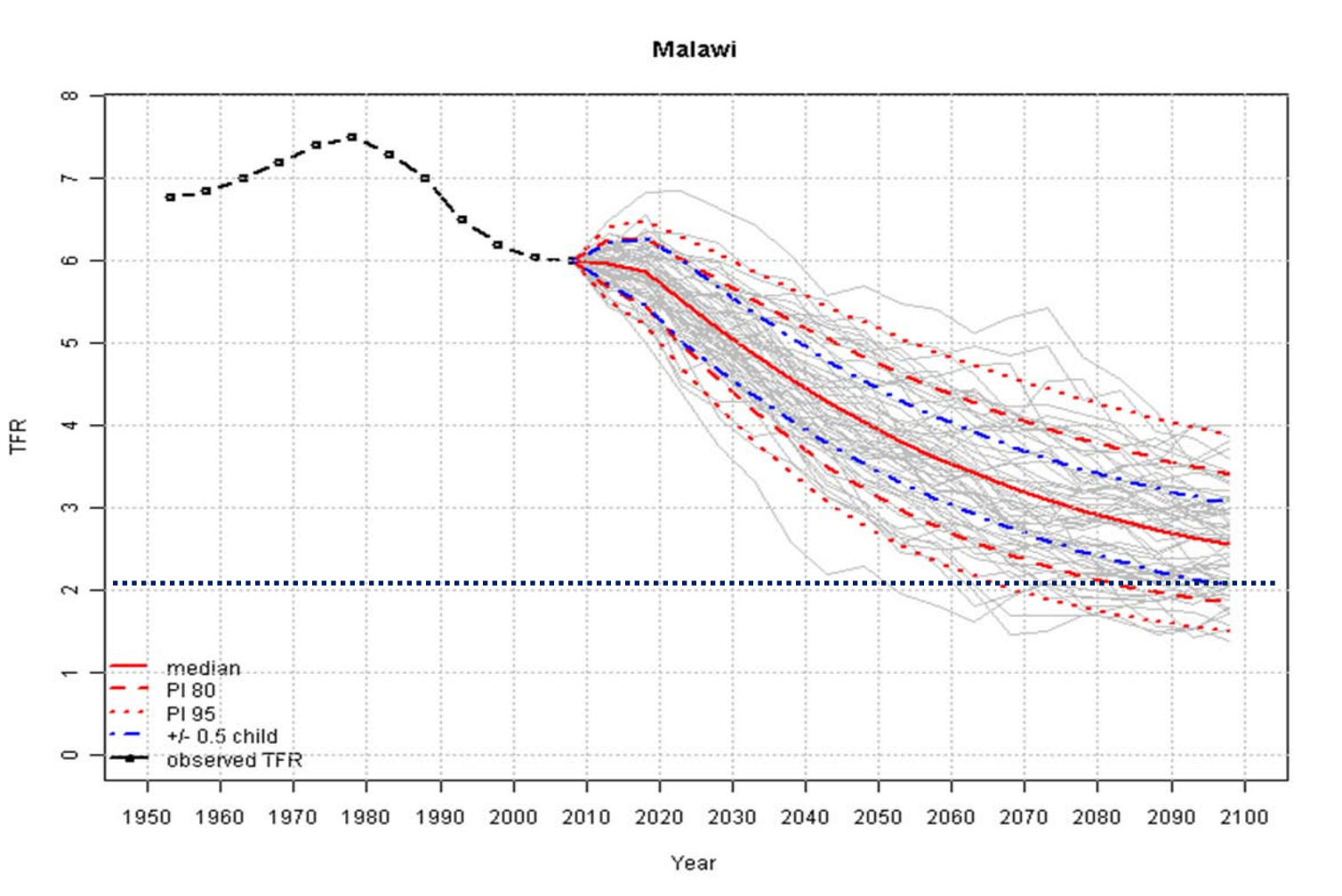
South Africa: Projection of fertility



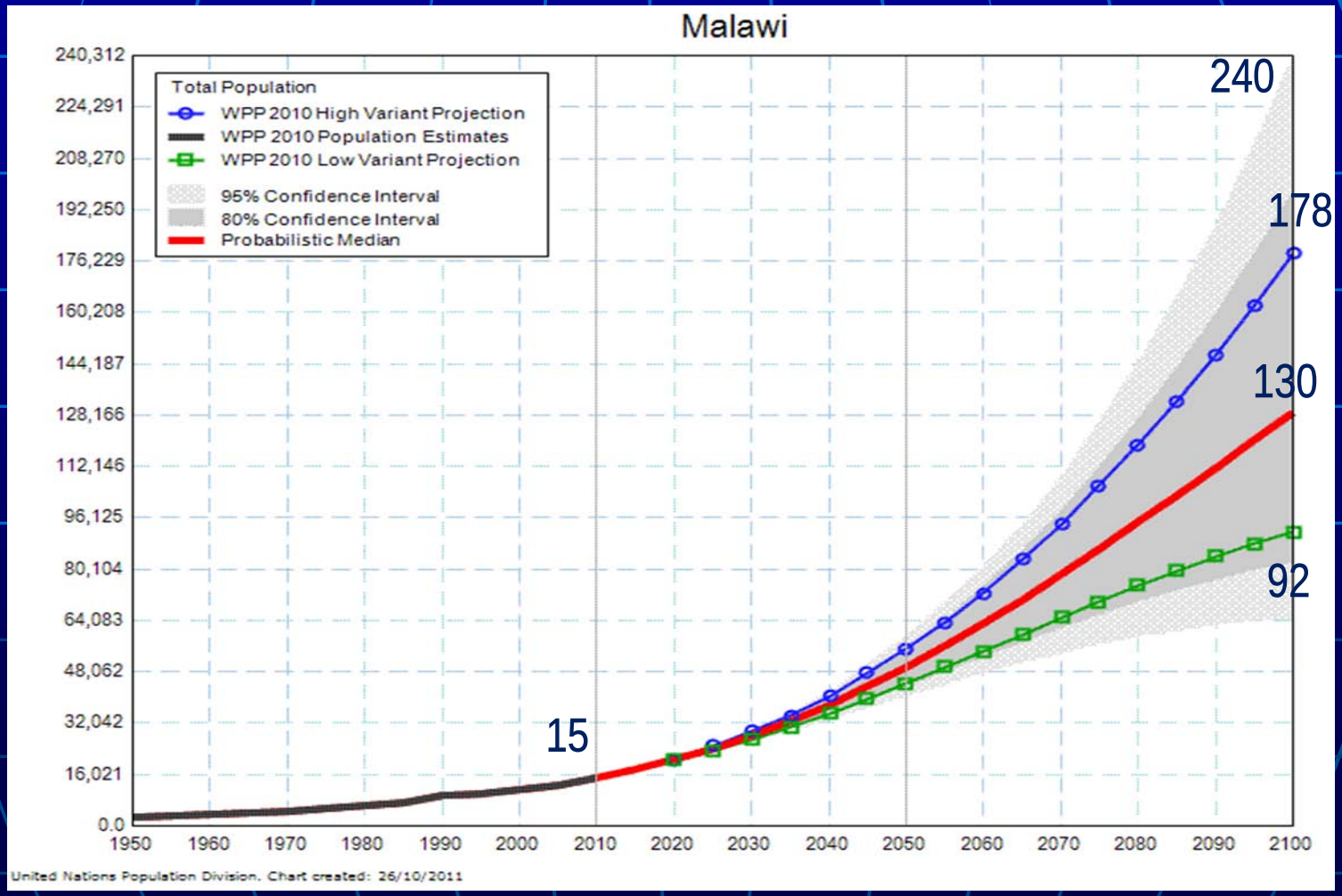
South Africa: Projected population



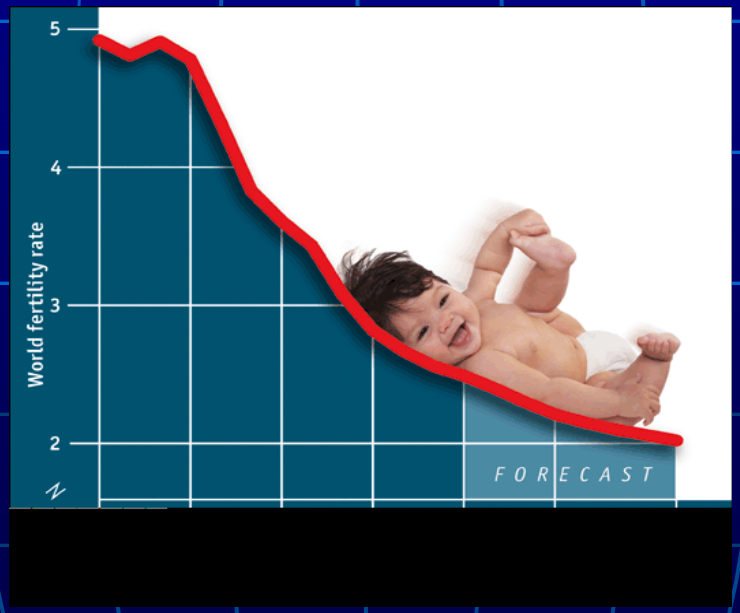
Malawi: Projection of fertility



Malawi: Projected population



PROJECTING FERTILITY FOR COUNTRIES IN PHASE III



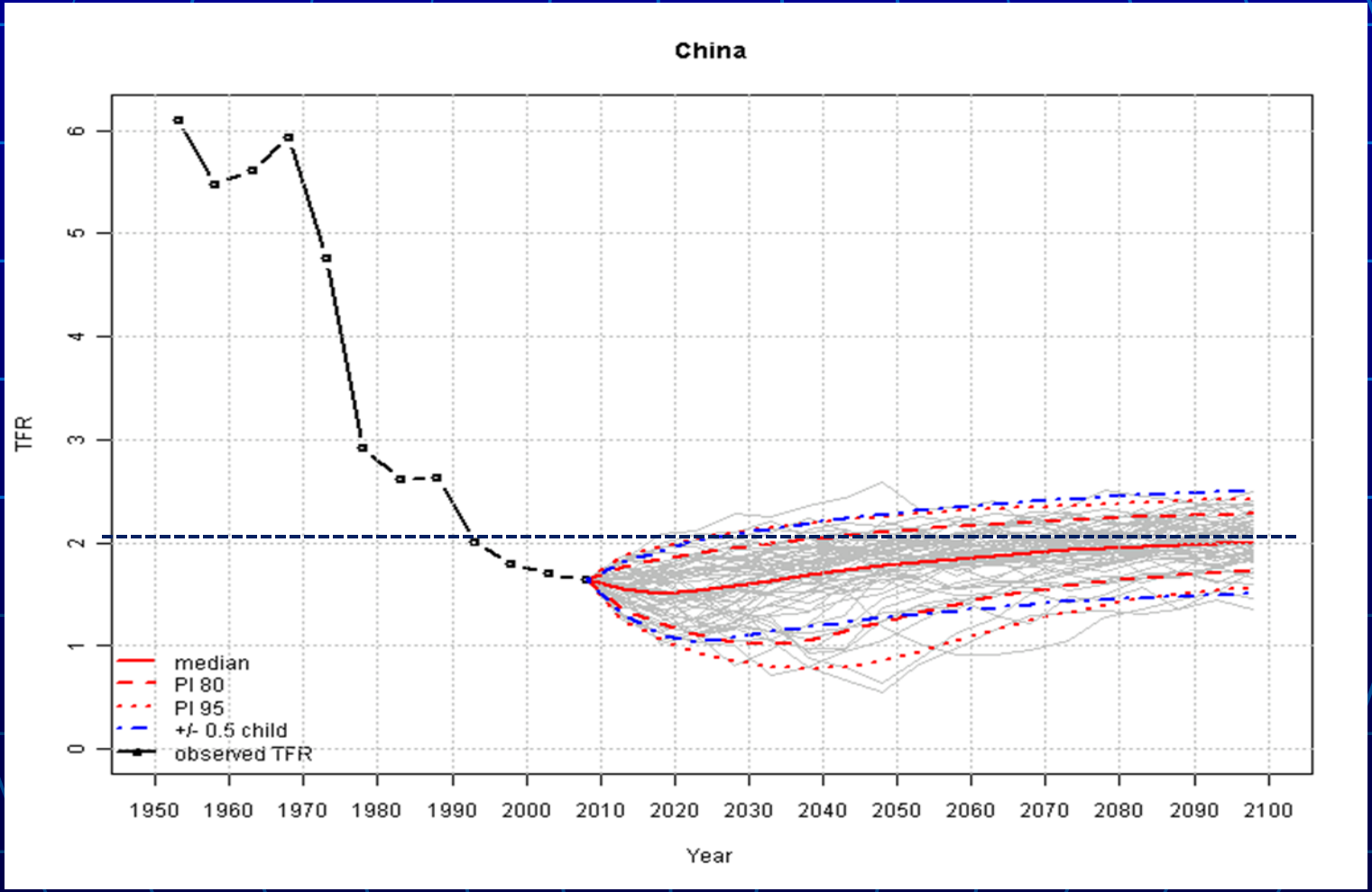
Projection for countries in Phase III

- Assume TFR will fluctuate around 2.1, use an AR(1) model:

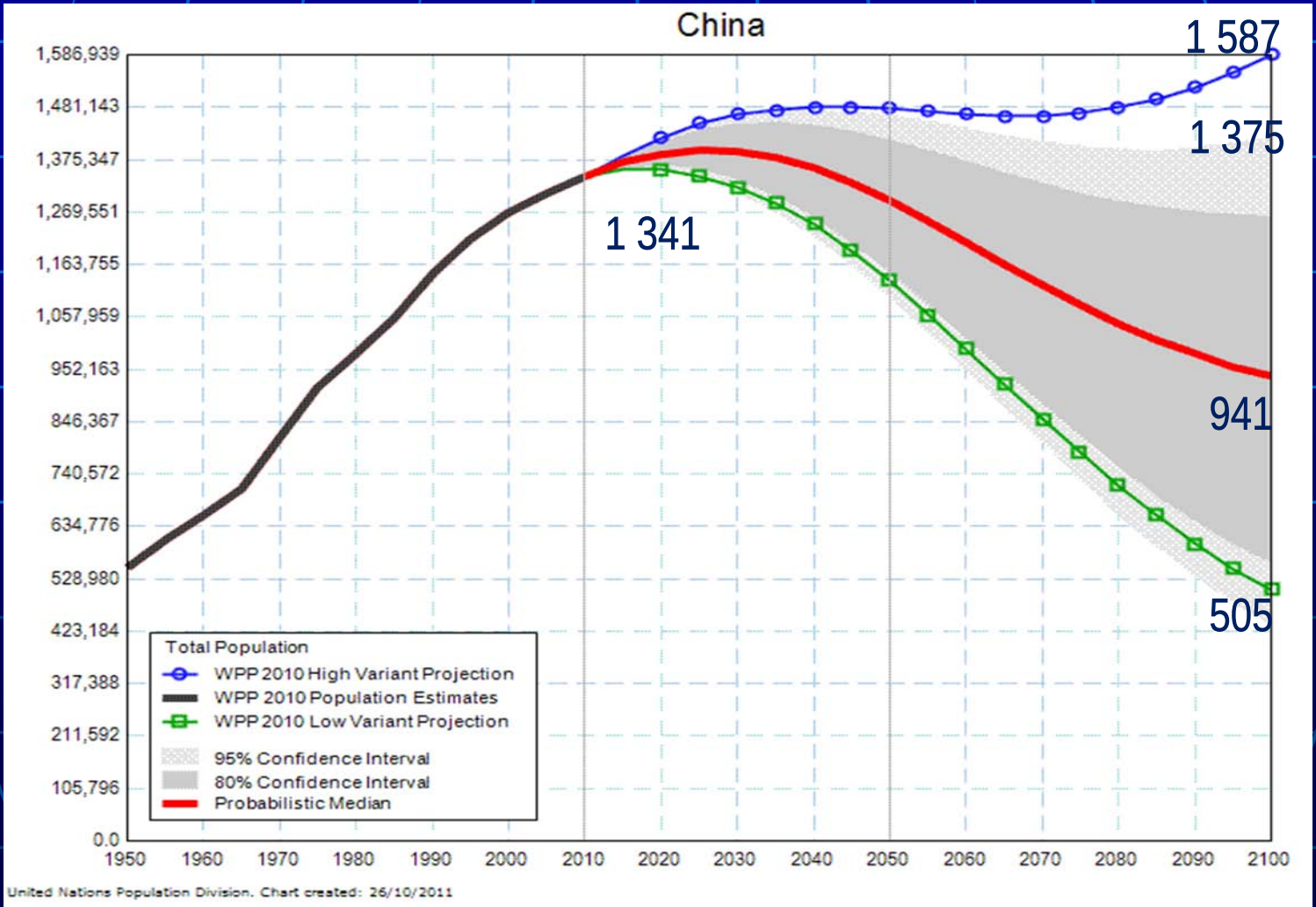
$$f_t = f_{t-1} + (1-\rho)(2.1 - f_{t-1}) + e_t$$
$$e_t \sim N(0, s^2)$$

with ρ = autoregressive parameter with $|\rho| < 1$ and s = standard deviation of the random errors

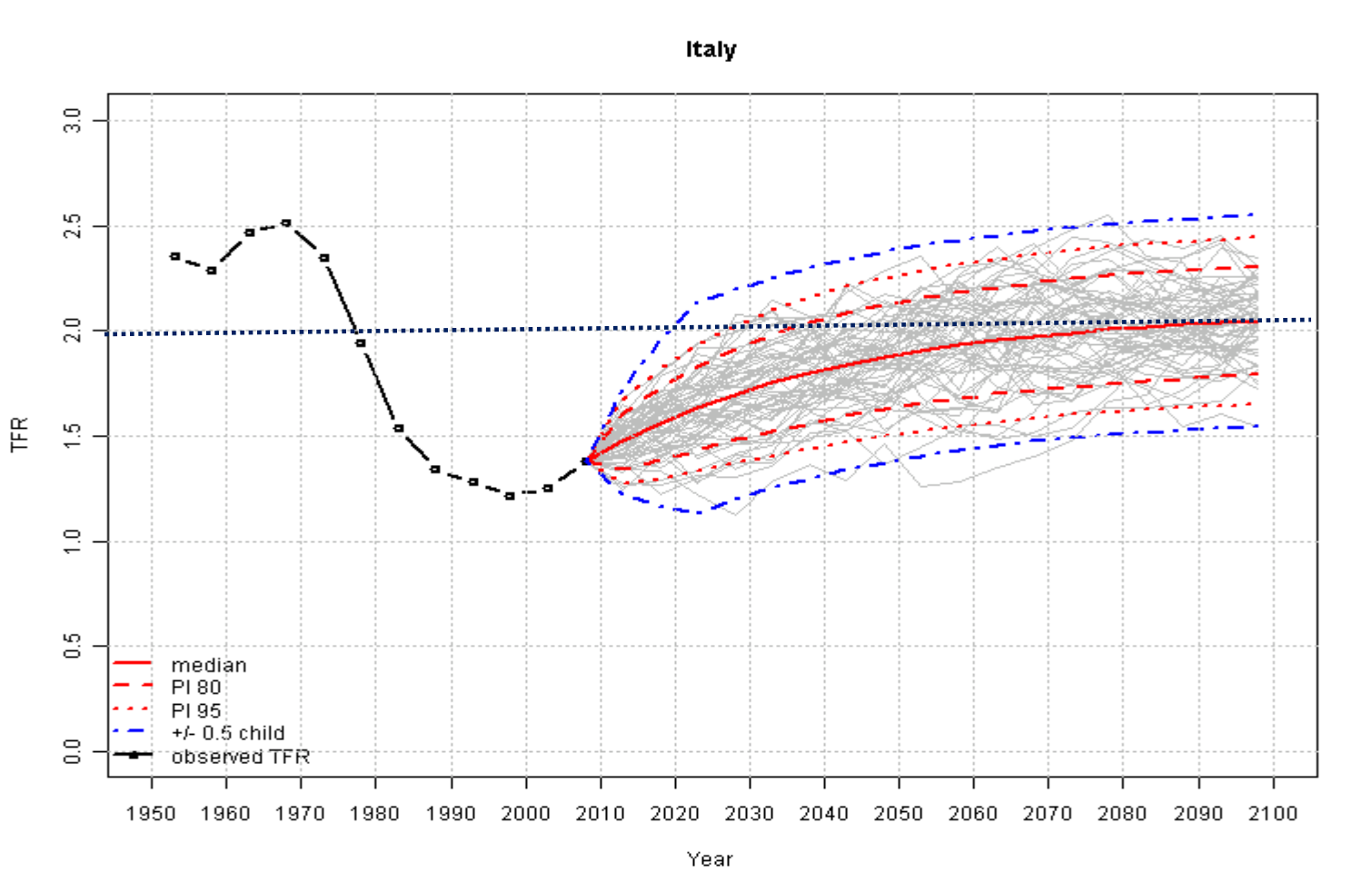
China: Projected fertility



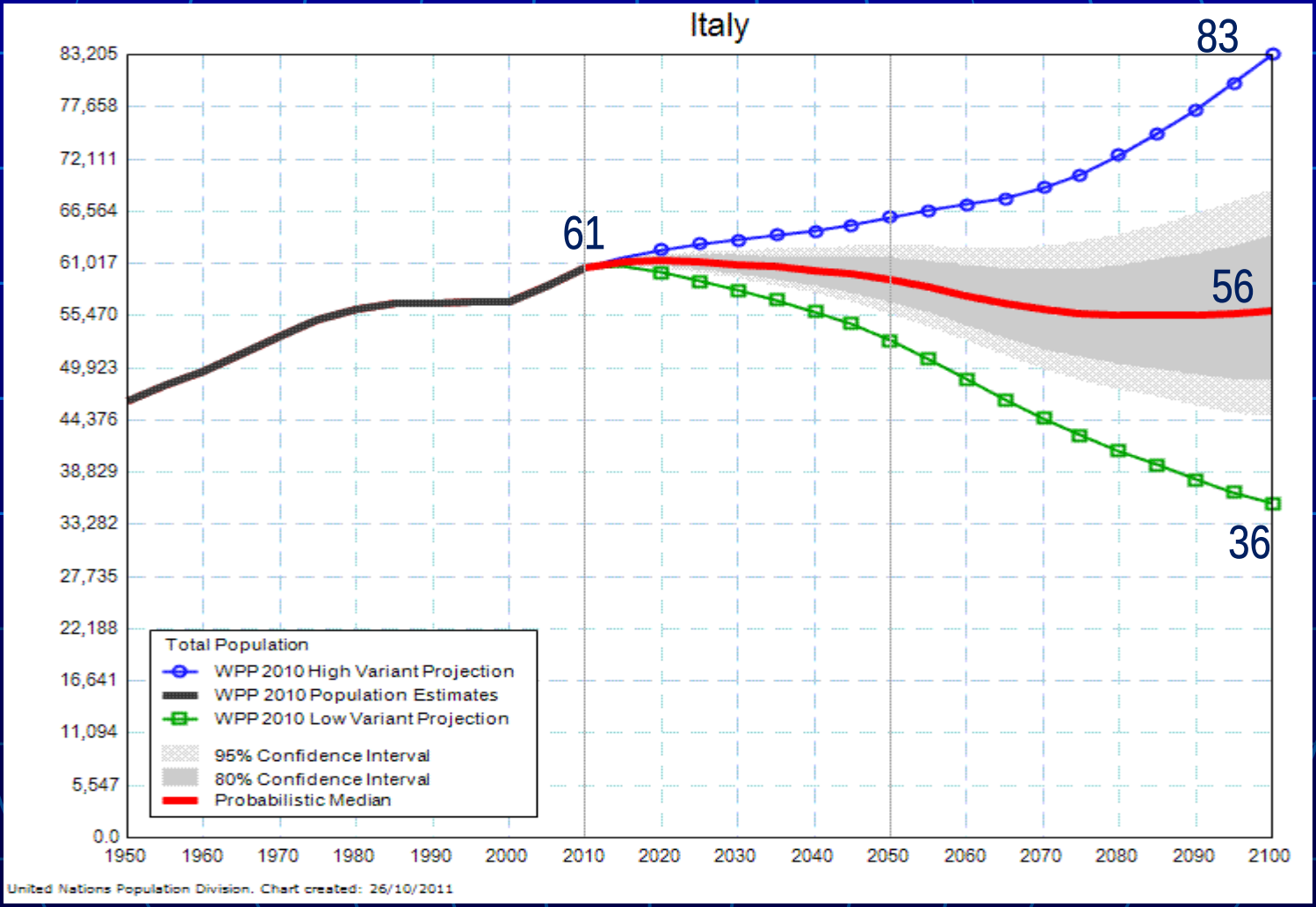
China: Projected population



Italy: Projected fertility



Italy: Projected population



PROJECTING THE SECOND COMPONENT OF CHANGE:

MORTALITY

Probabilistic projection of life expectancy

Raftery et al. assume that life expectancy is assumed to follow a random walk with drift:

$$e_{t+1} = e_t + g(e_t, \theta) + \varepsilon_{t+1}$$

where $g(e_t, \theta)$ is a double logistic similar to that used in modeling fertility change and ε_{t+1} is a random error with a normal distribution

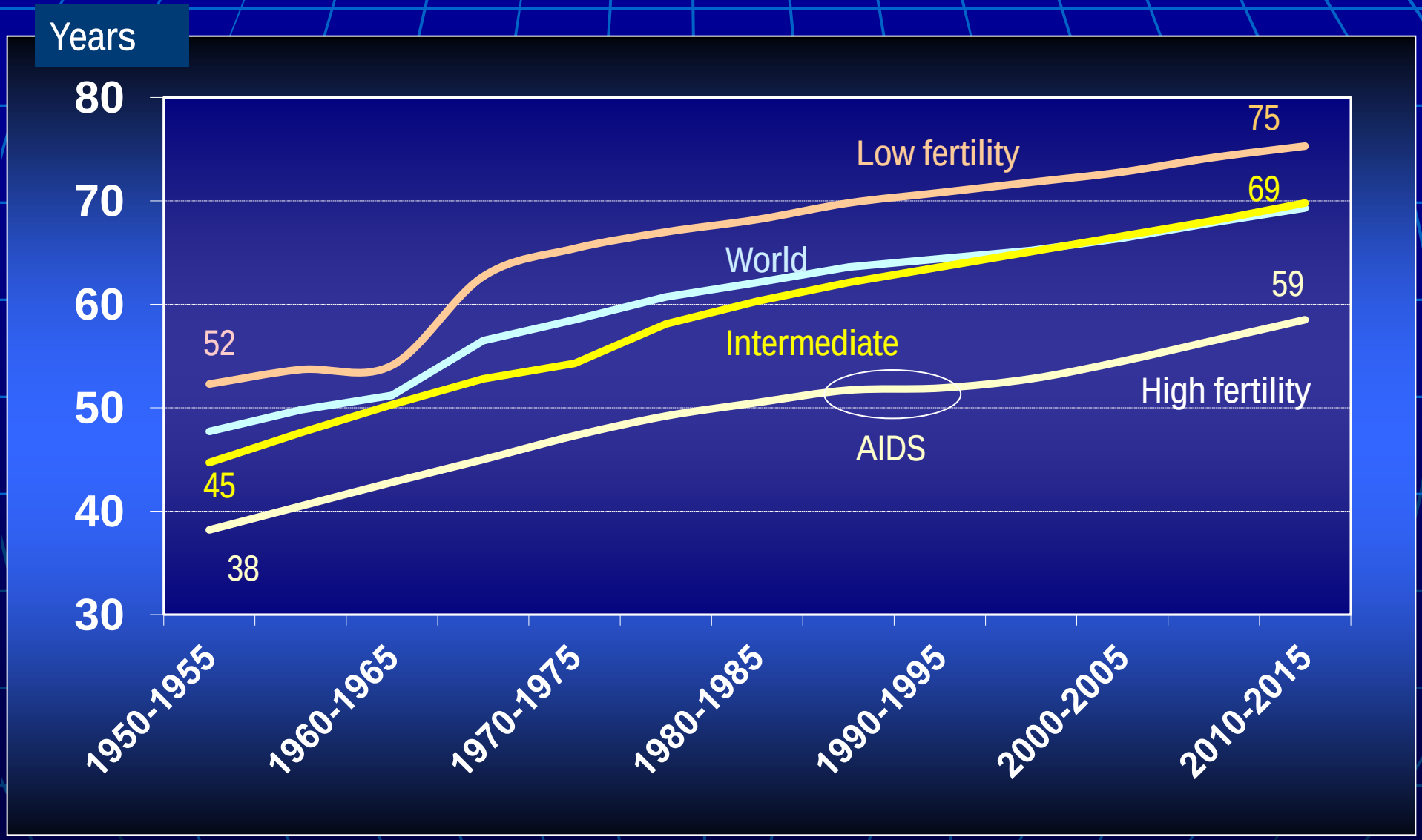
Probabilistic projection of life expectancy

A Bayesian hierarchical approach is used to estimate the model's parameters. This approach is used to project female life expectancy.

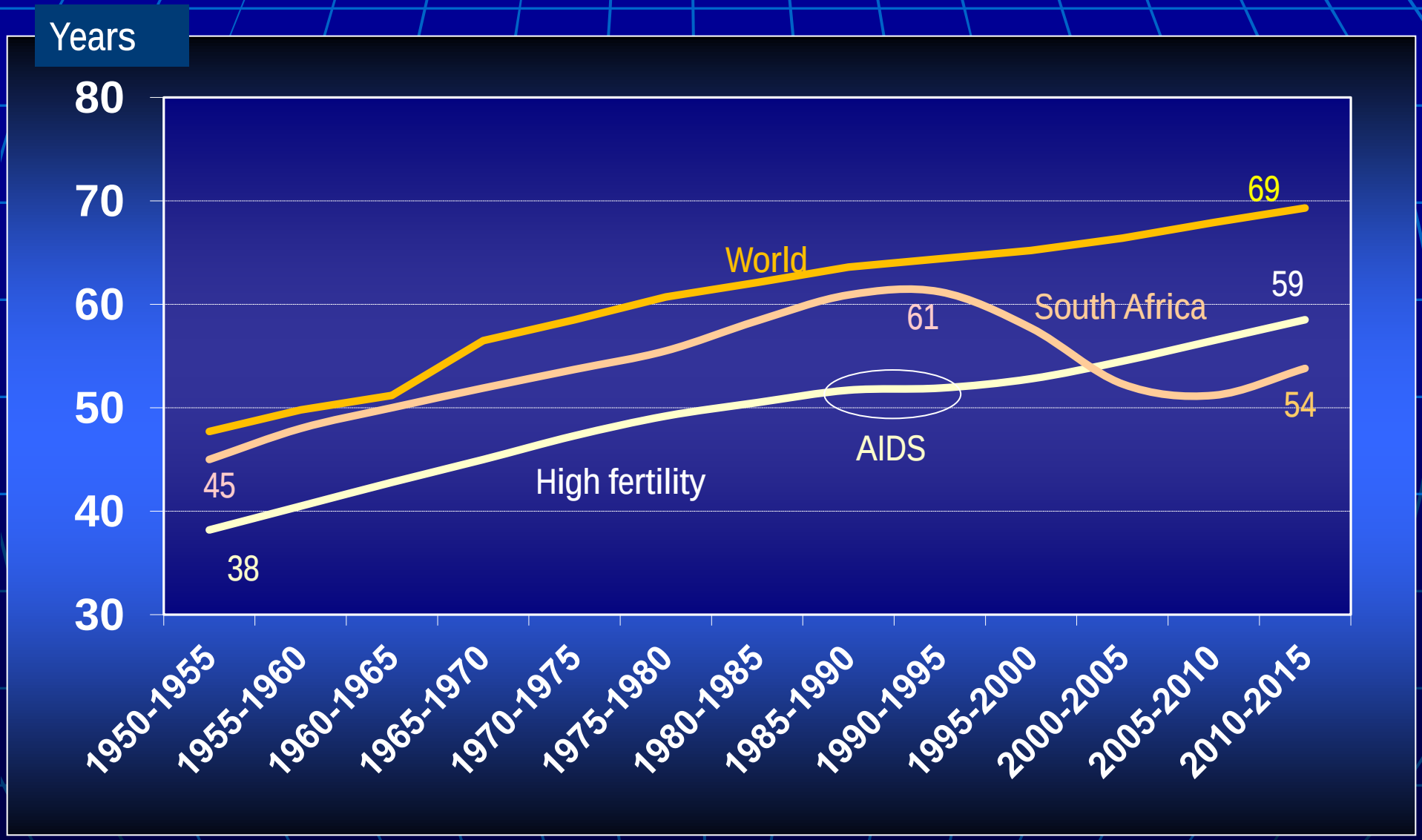
Male life expectancy is derived from a regression model for the female to male gap in life expectancy

However, this approach was not used in the 2010 Revision produced by the UN.

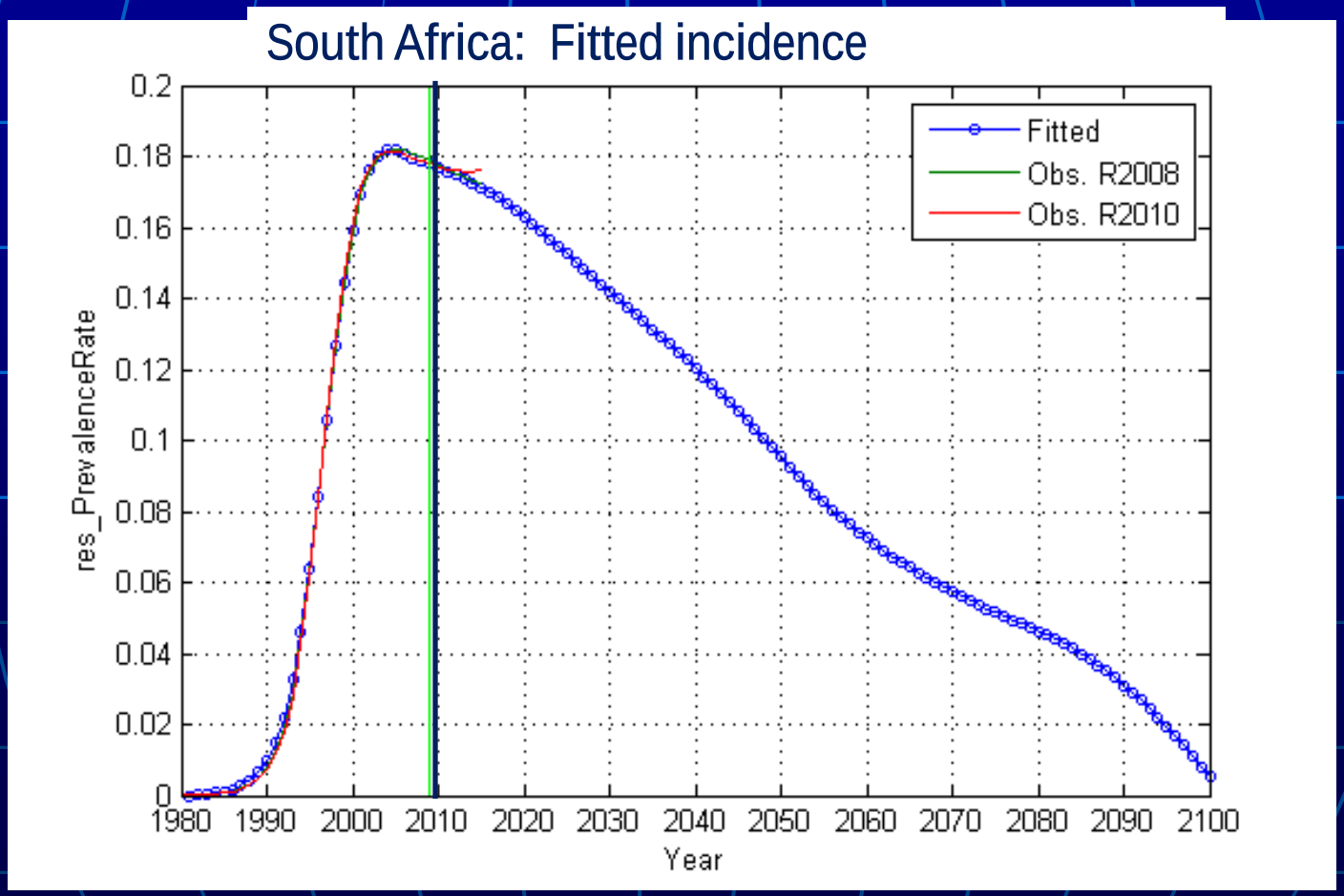
Life expectancy trends from 1950 to 2015



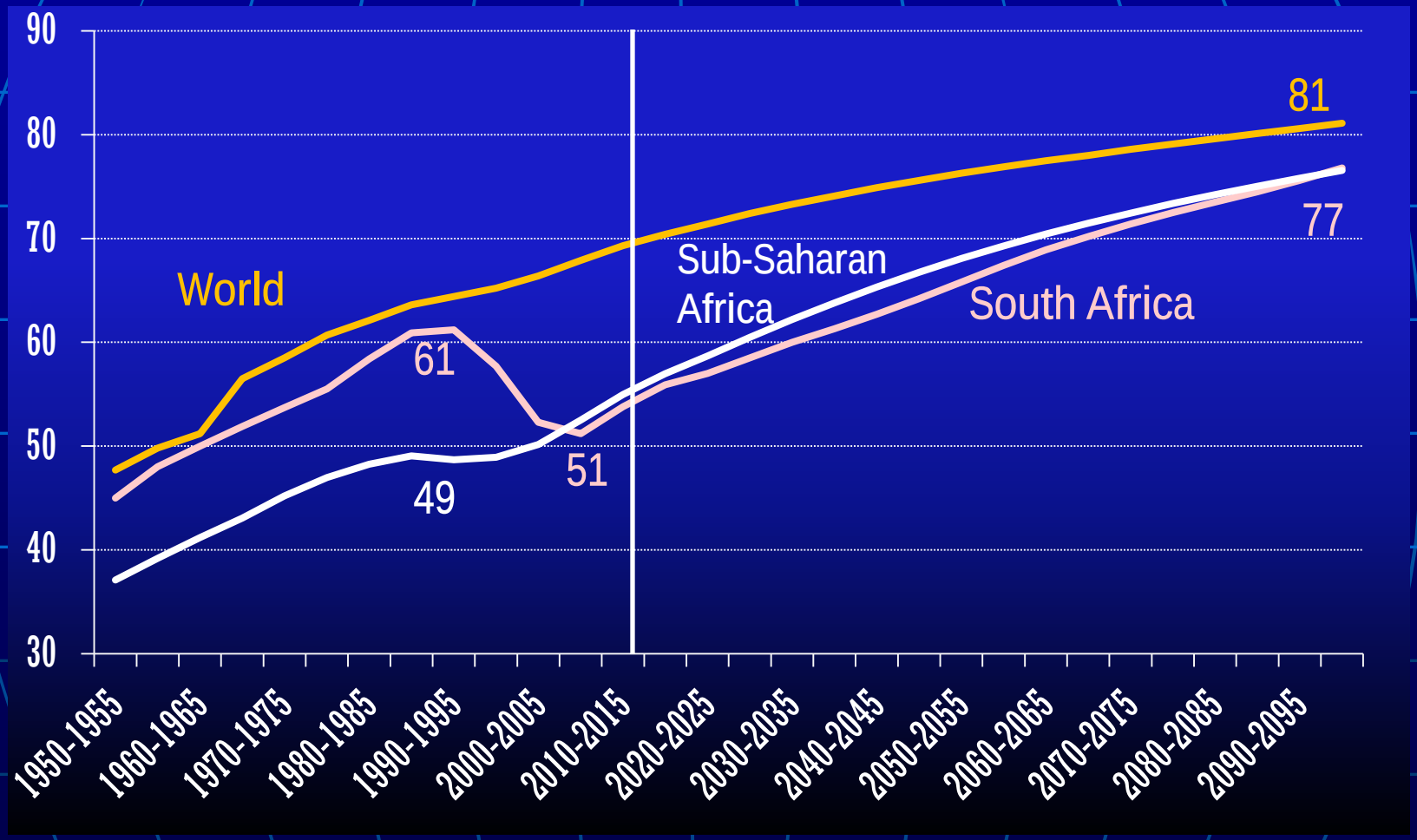
Life expectancy trends from 1950 to 2015



South Africa: Estimated HIV incidence



South Africa: Projected life expectancy



PROJECTING THE THIRD COMPONENT OF CHANGE:

INTERNATIONAL MIGRATION

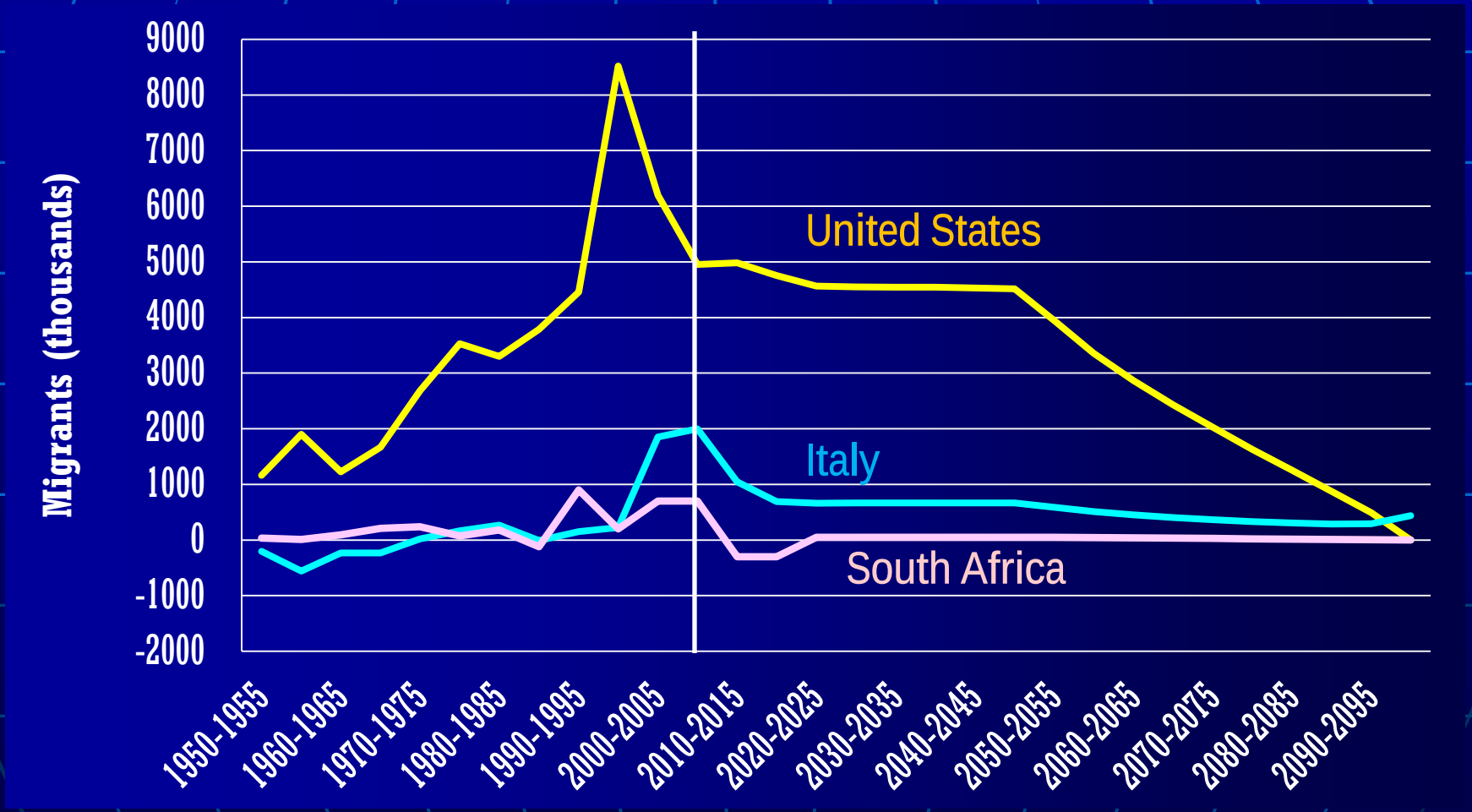
Projecting international migration

The methodology to project international migration remains the least developed

A major constraint is the lack of an adequate database on migration flows

A second constraint is the volatility of migration flows

Projected net migration for selected countries



CONCLUSION:
COPING WITH UNCERTAINTY

Advances made

Probabilistic methods are clearly useful in preparing population projections but they demand the existence of a reliable set of past estimates and adequate models for future change

The UN approach borrows strength from the wealth of data on fertility trends available

Challenges

- To improve the data on mortality trends and, especially, on mortality by age and sex
- For the majority of developing countries, reliable time series estimates of adult mortality are scarce
- Taking account of discontinuities, such as those generated by AIDS

Do probabilistic population projections aid in planning the future?

Doubts are in order

- People have difficulty understanding and using probabilistic concepts
- The implications of the measures of uncertainty yielded by probabilistic projections are not easy to grasp
- Probabilistic projections are not "transparent" regarding cause and effect

Time to thank:

The developers of the UN methodology

***University of Singapore*:**

Leontine Alkema

***University of Washington*:**

Adrian Raftery and Samuel Clark

***UN Population Division*:**

Patrick Gerland, Francois Pelletier, Nan Li, Gerhard Heilig, Thomas Buettner

THE END!