Advances in population projection methods and their implications for the future

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Projecting the components of change

Fertility: Future trends in total fertility

Age distribution of fertility

Mortality: Future trends in life expectancy

Mortality rates by age and sex

Migration: Future net number of migrants

Migrants by age and sex

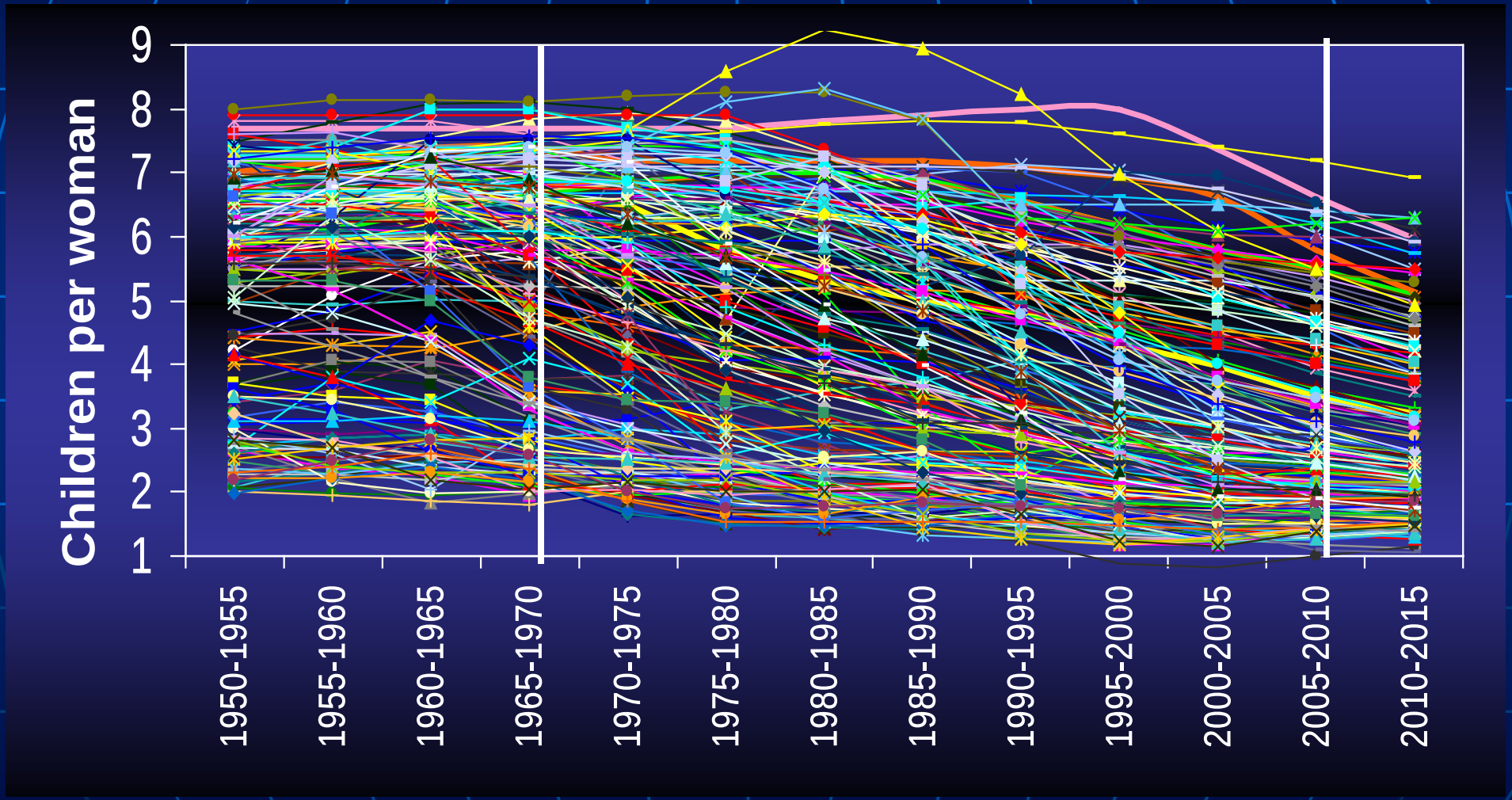
PROJECTING THE FIRST COMPONENT OF CHANGE:

FERTILITY

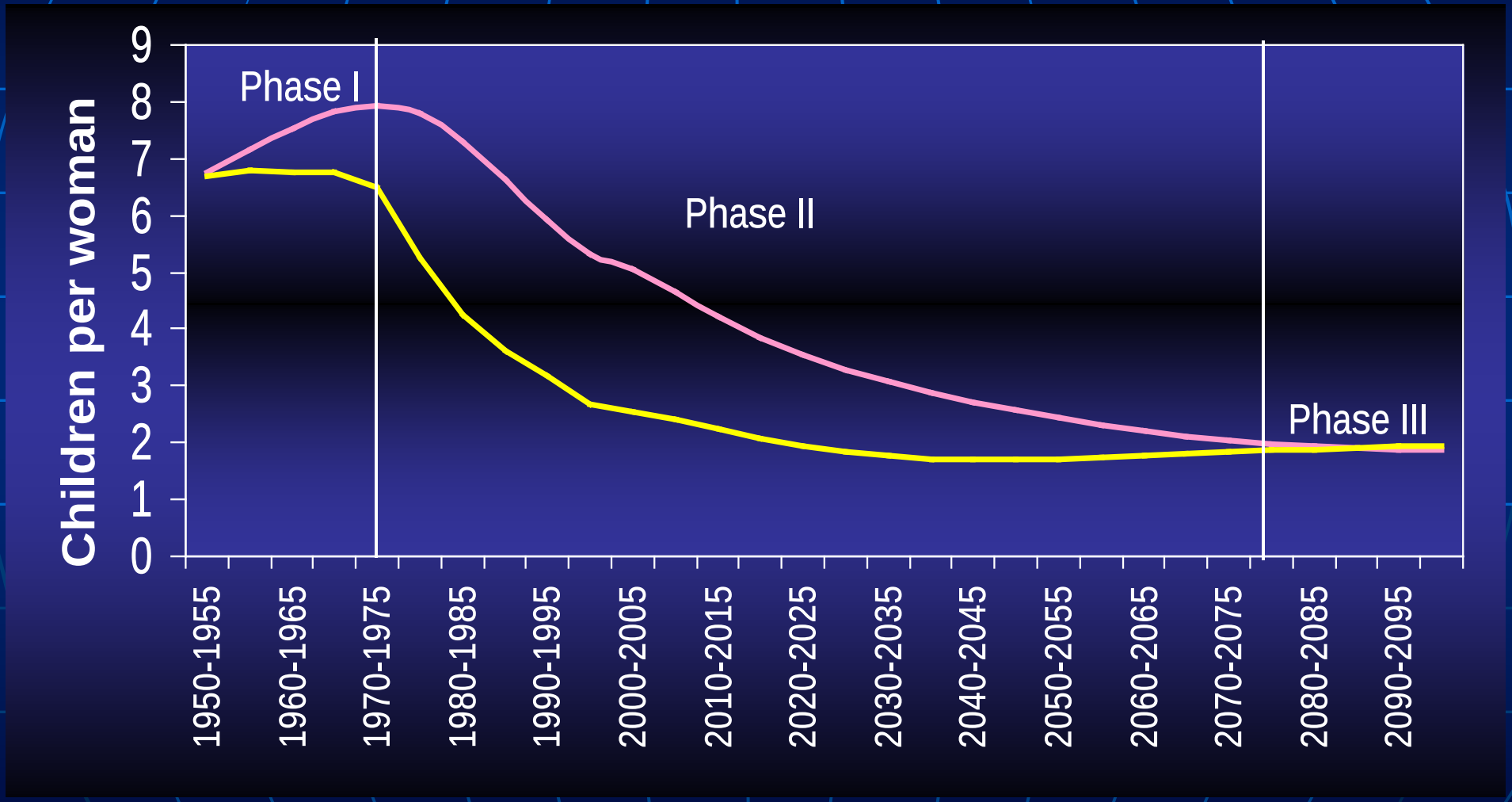
In projecting future fertility trends one can take advantage of two things:

- 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

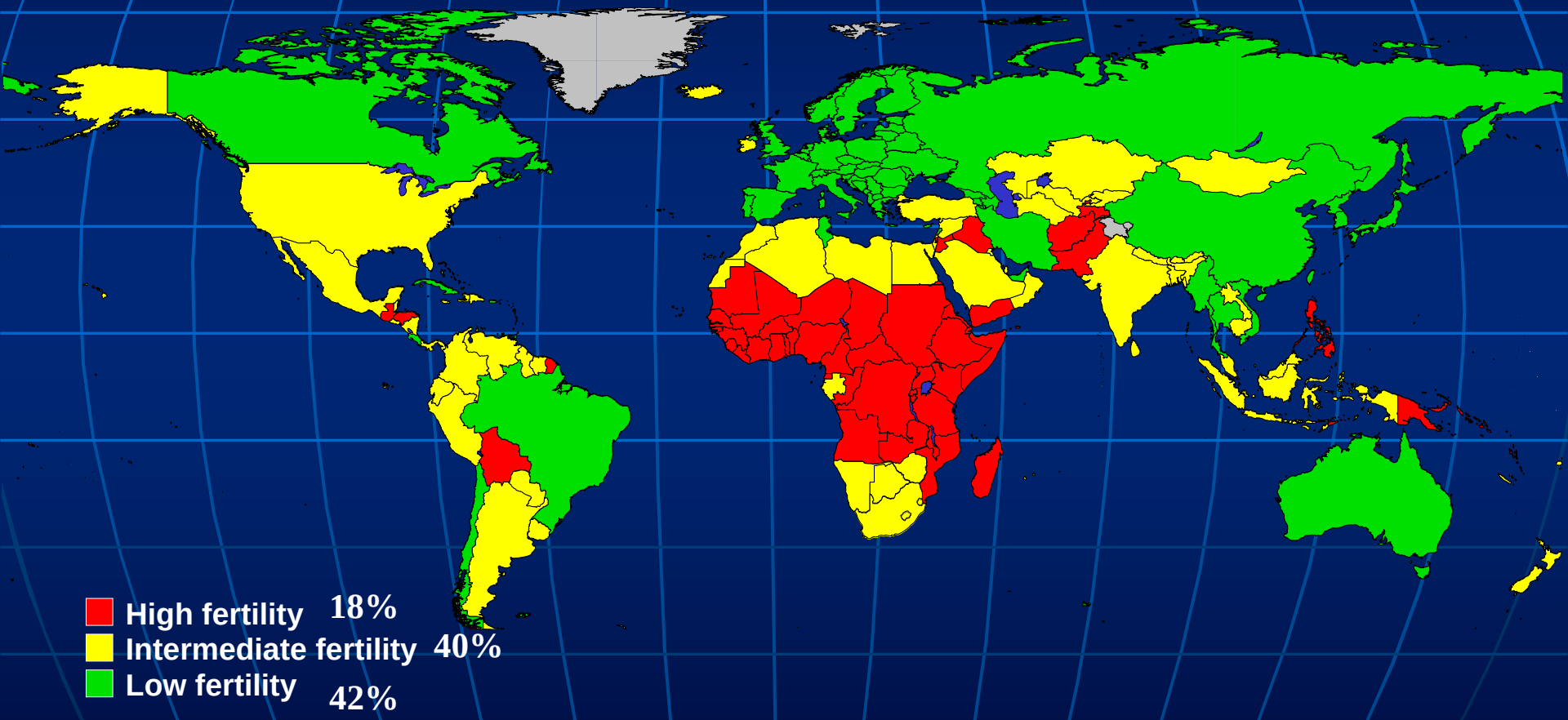
Fertility estimates from 1950 to 2015



Typical fertility trend from high to low



Countries classified by fertility level



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

PROJECTING FERTILITY FOR COUNTRIES IN PHASE II

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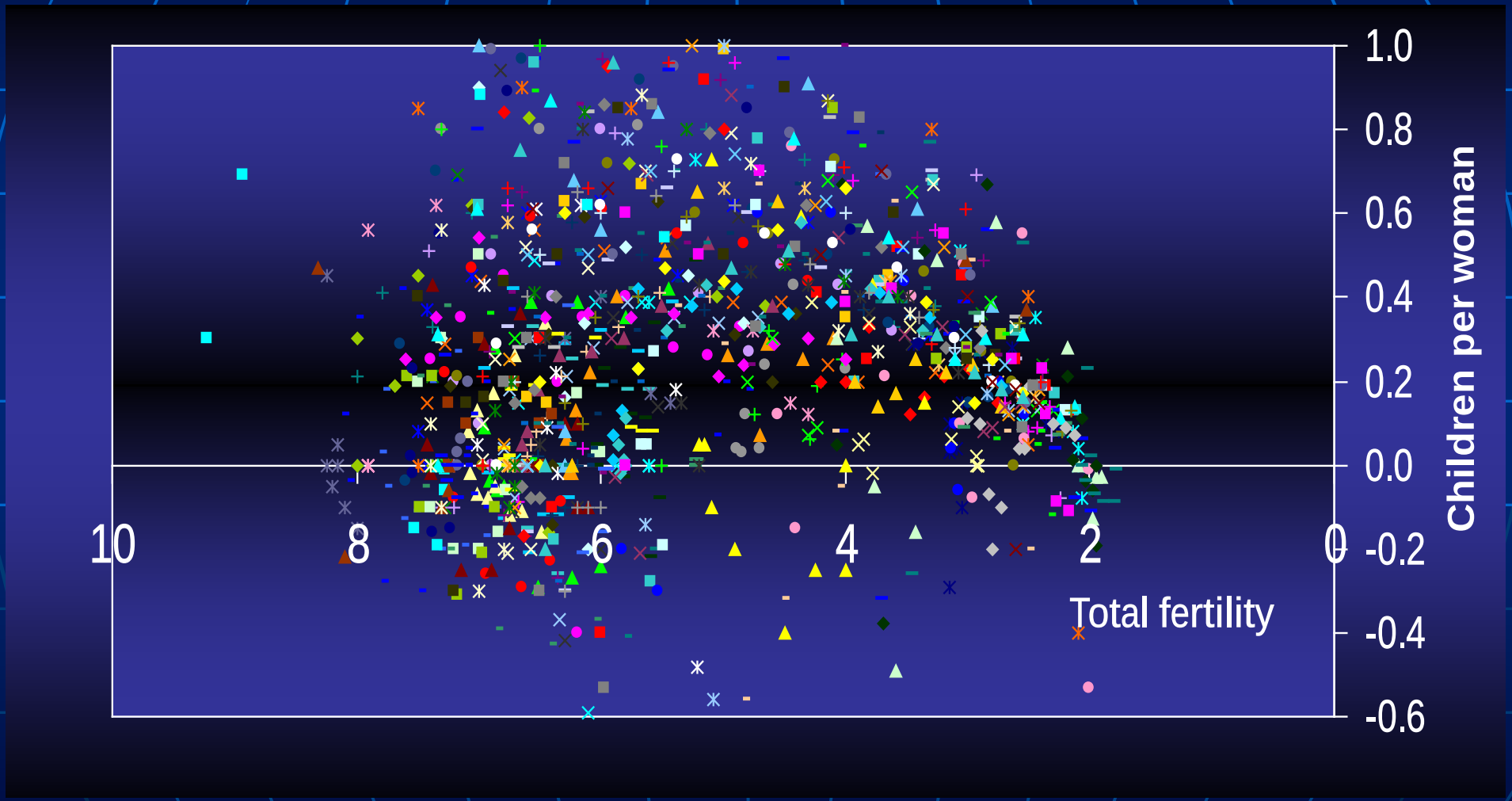
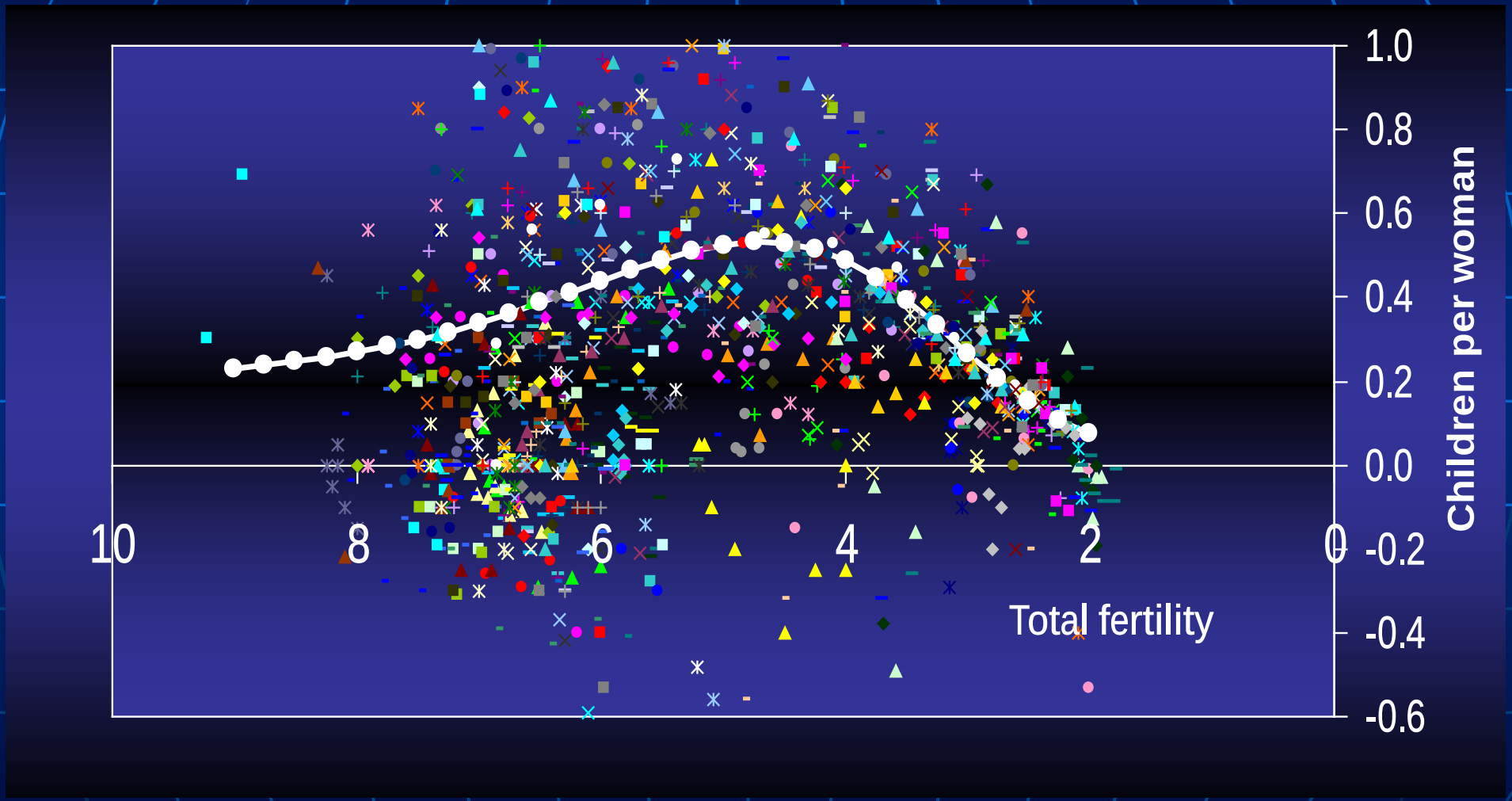
Fertility decrements during Phase II



Modeled fertility decrements, Phase II



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

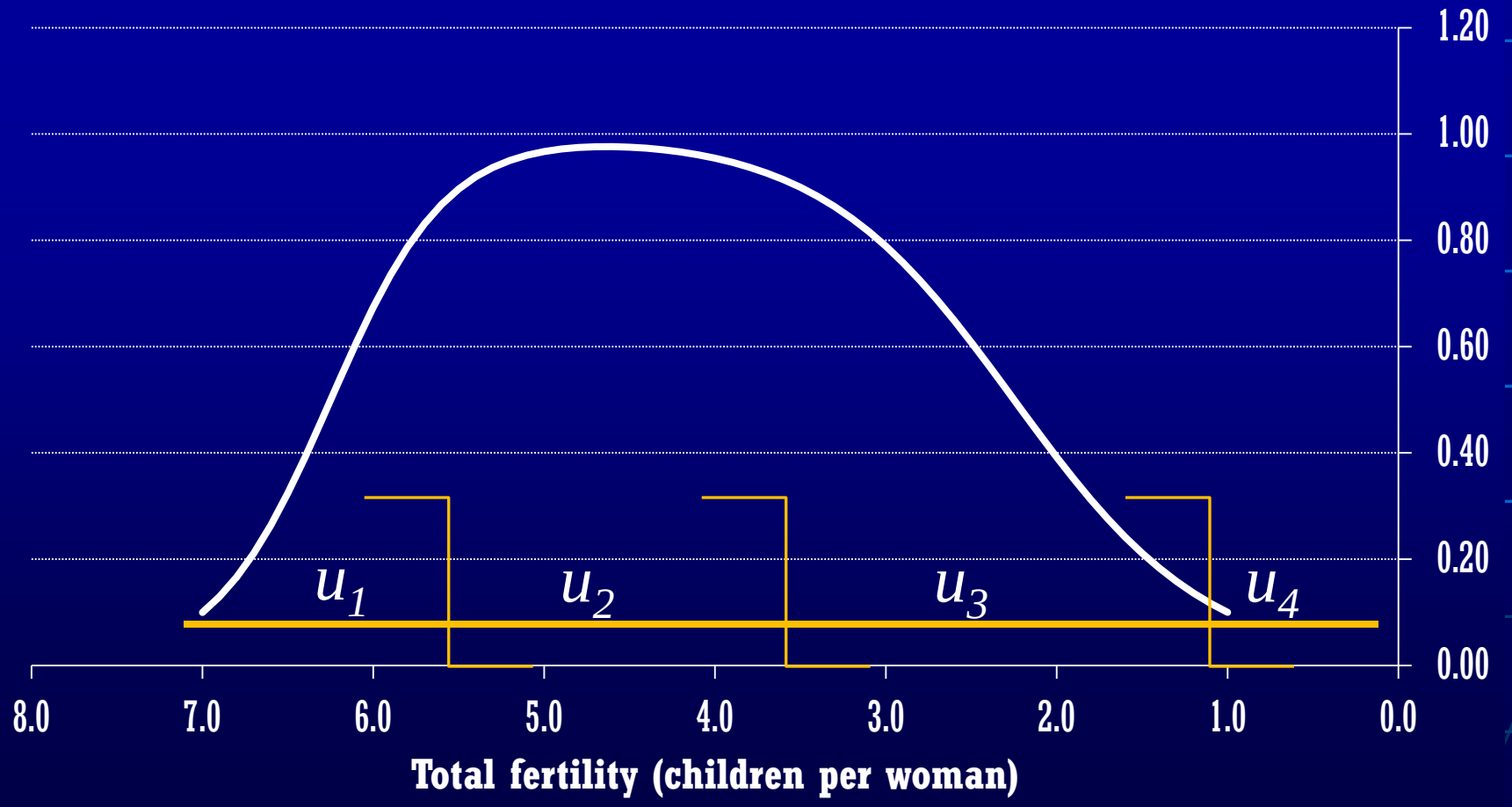
$$g(D,U,f_t) = \frac{-D}{1+\exp[-2\ln(9) * [f_t - U + 0.5\,u_1]/u_1]}$$

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

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

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

Double logistic decrement function (D=1)



ADDING UNCERTAINTY

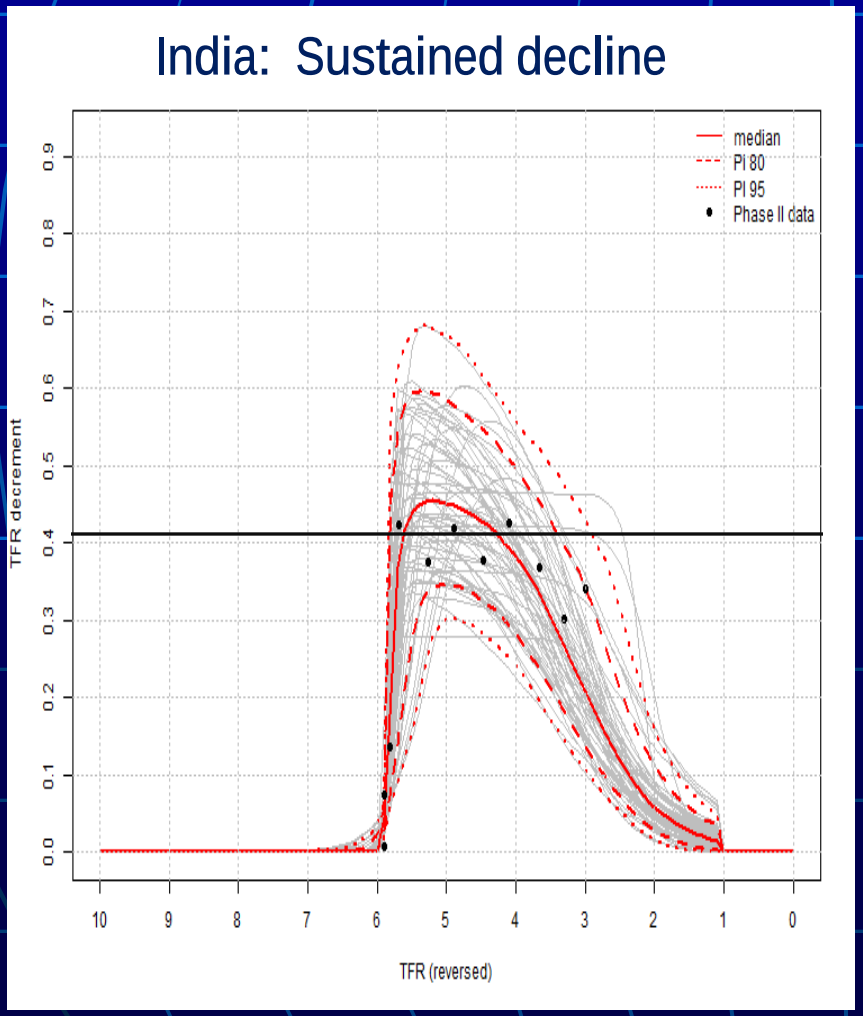
Fertility is projected by using the decrements yielded by the logistic model. Uncertainty is captured by a random distortion term

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

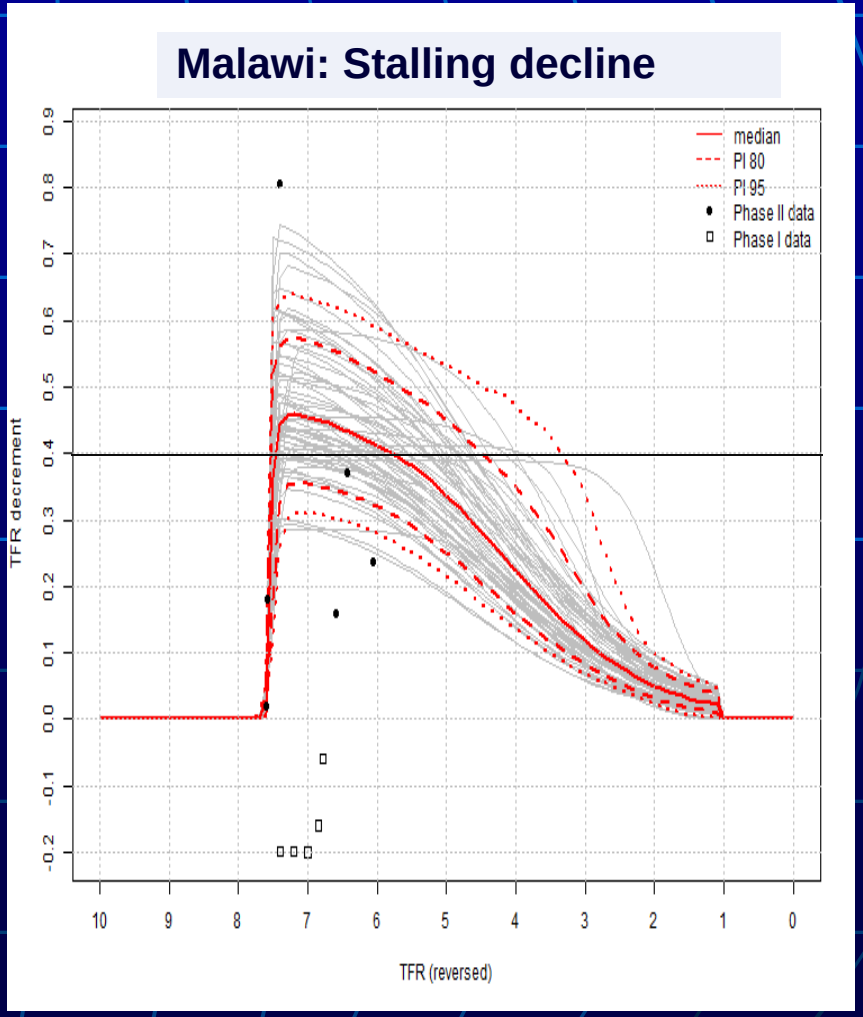
where ε_t is normally distributed and the parameters (D, U) are estimated by using a Bayesian hierarchical framework with prior distributions based on world experience or guessed and posterior distributions derived using Monte Carlo Markov chain simulation incorporating country-specific data.

Examples of decrement paths

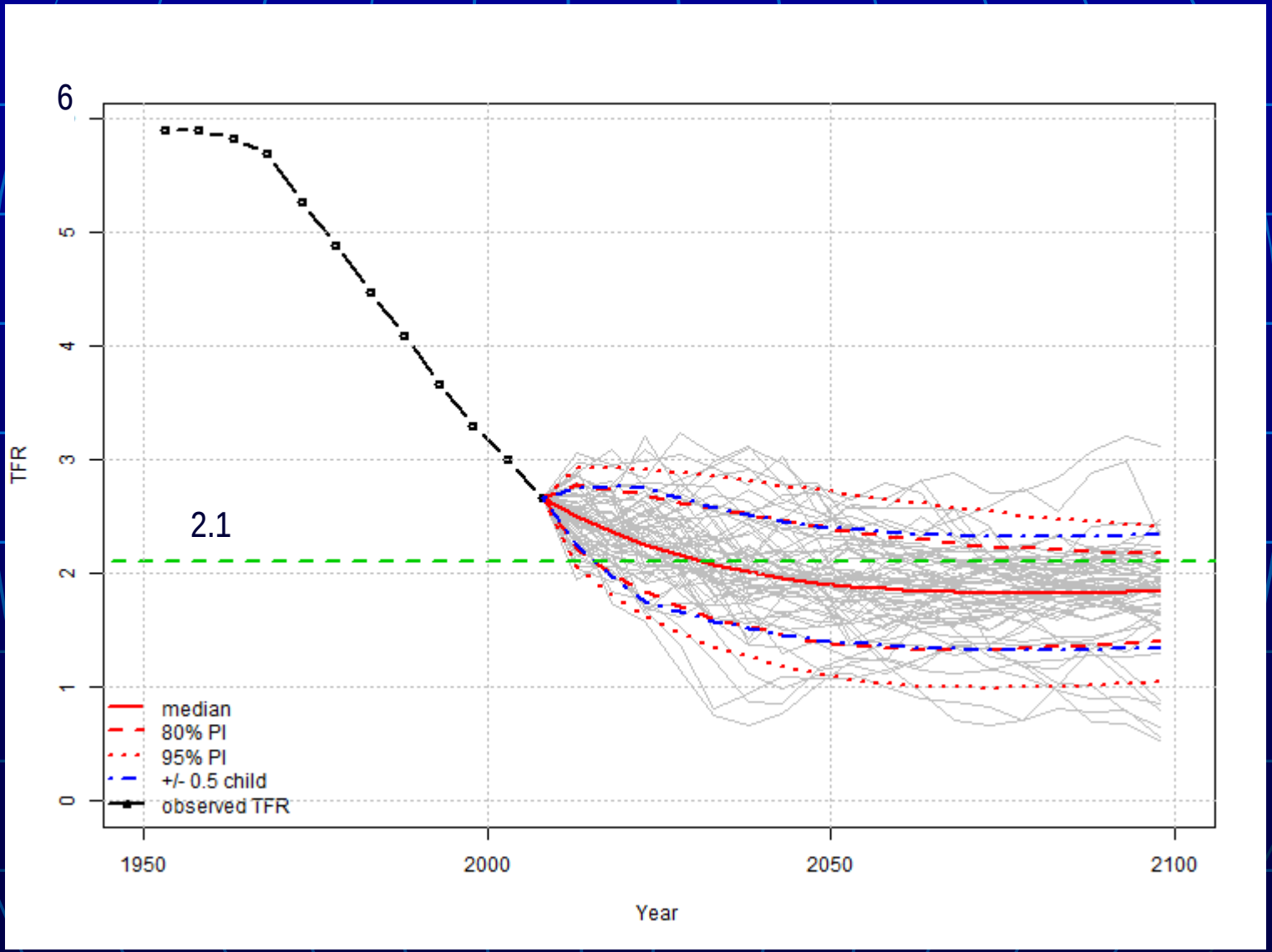
India: Sustained decline



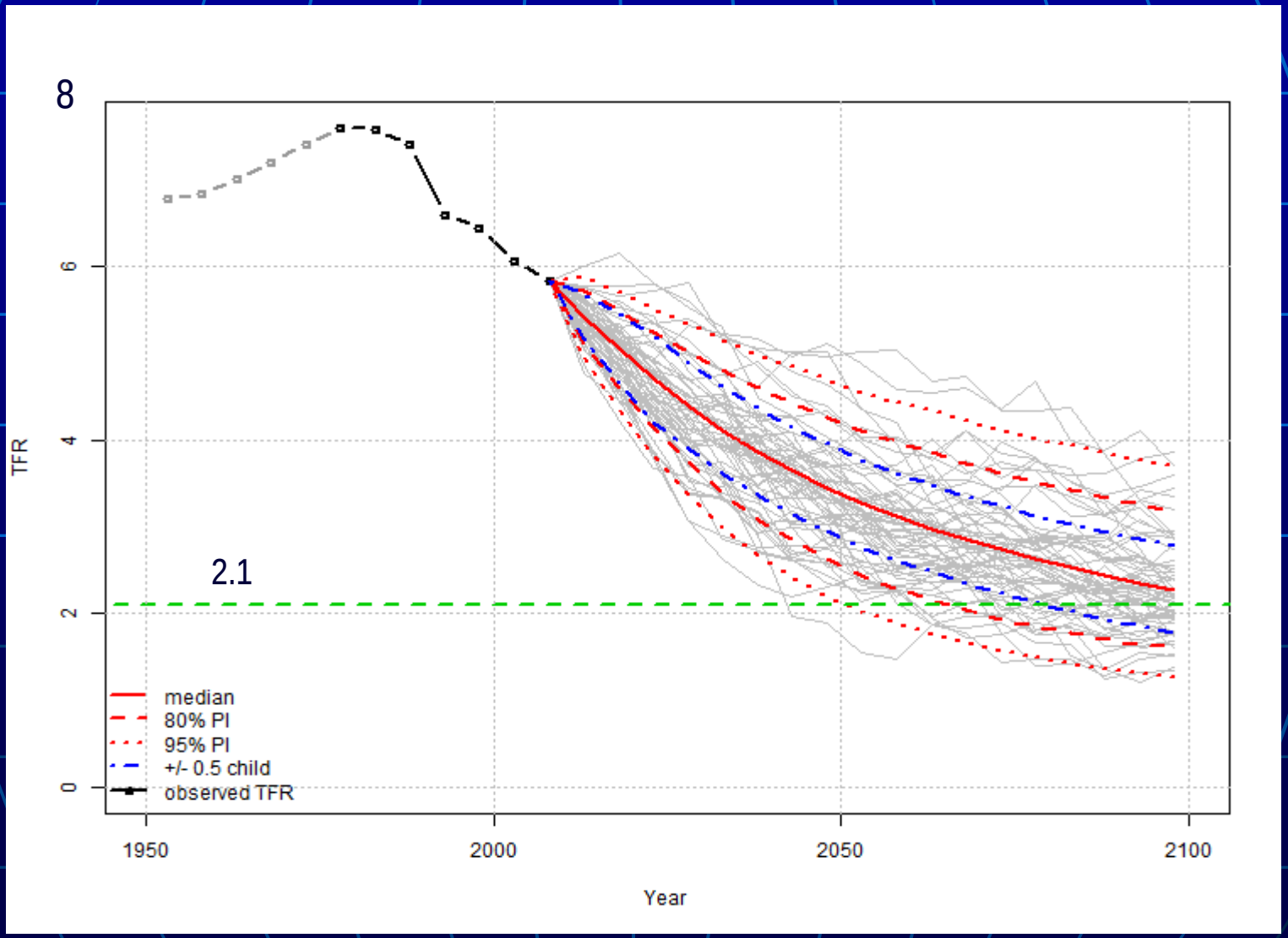
Malawi: Stalling decline



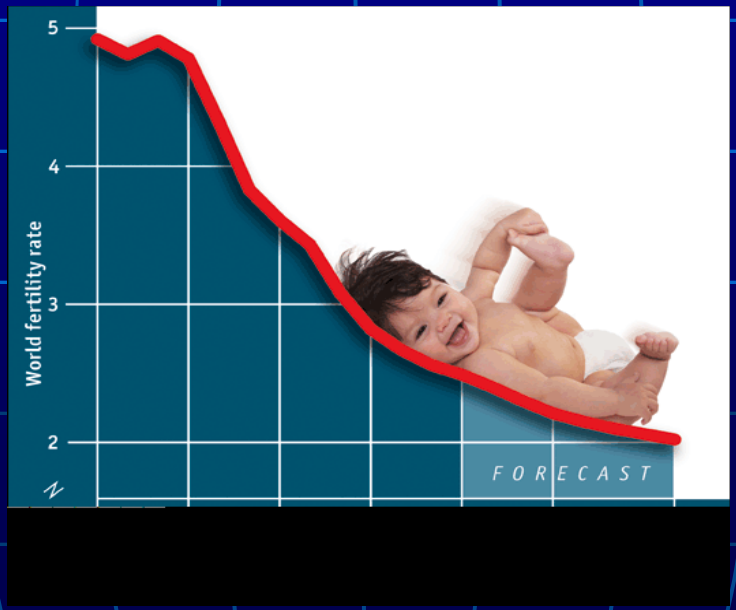
India: Projection of fertility



Malawi: Projection of fertility



PROJECTING FERTILITY FOR COUNTRIES IN PHASE III



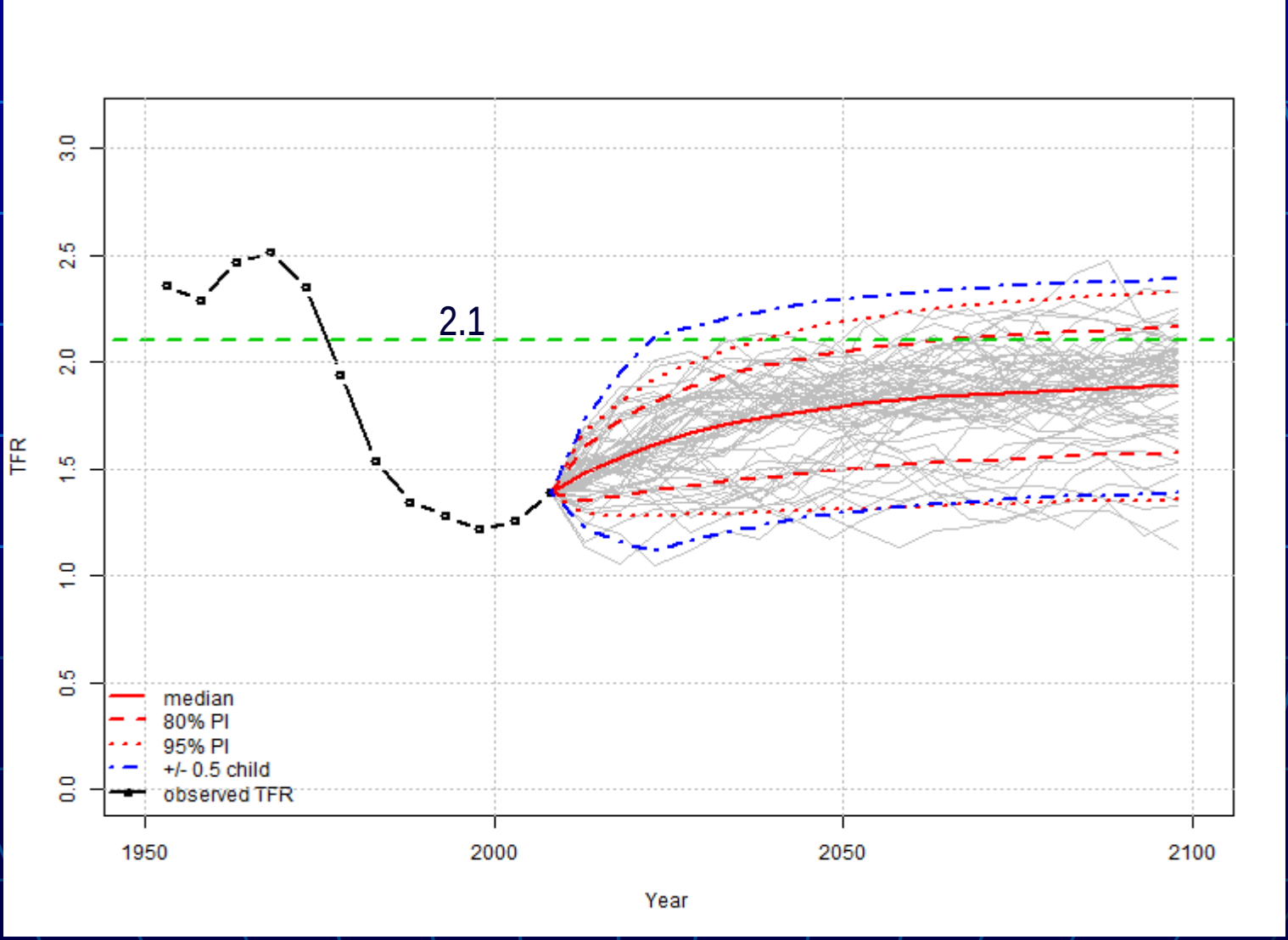
Projection for countries in Phase III

- 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

Italy: Projected fertility



PROJECTING THE SECOND COMPONENT OF CHANGE:

MORTALITY

Probabilistic projection of life expectancy

Raftery et al. assume that life expectancy follows 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.*

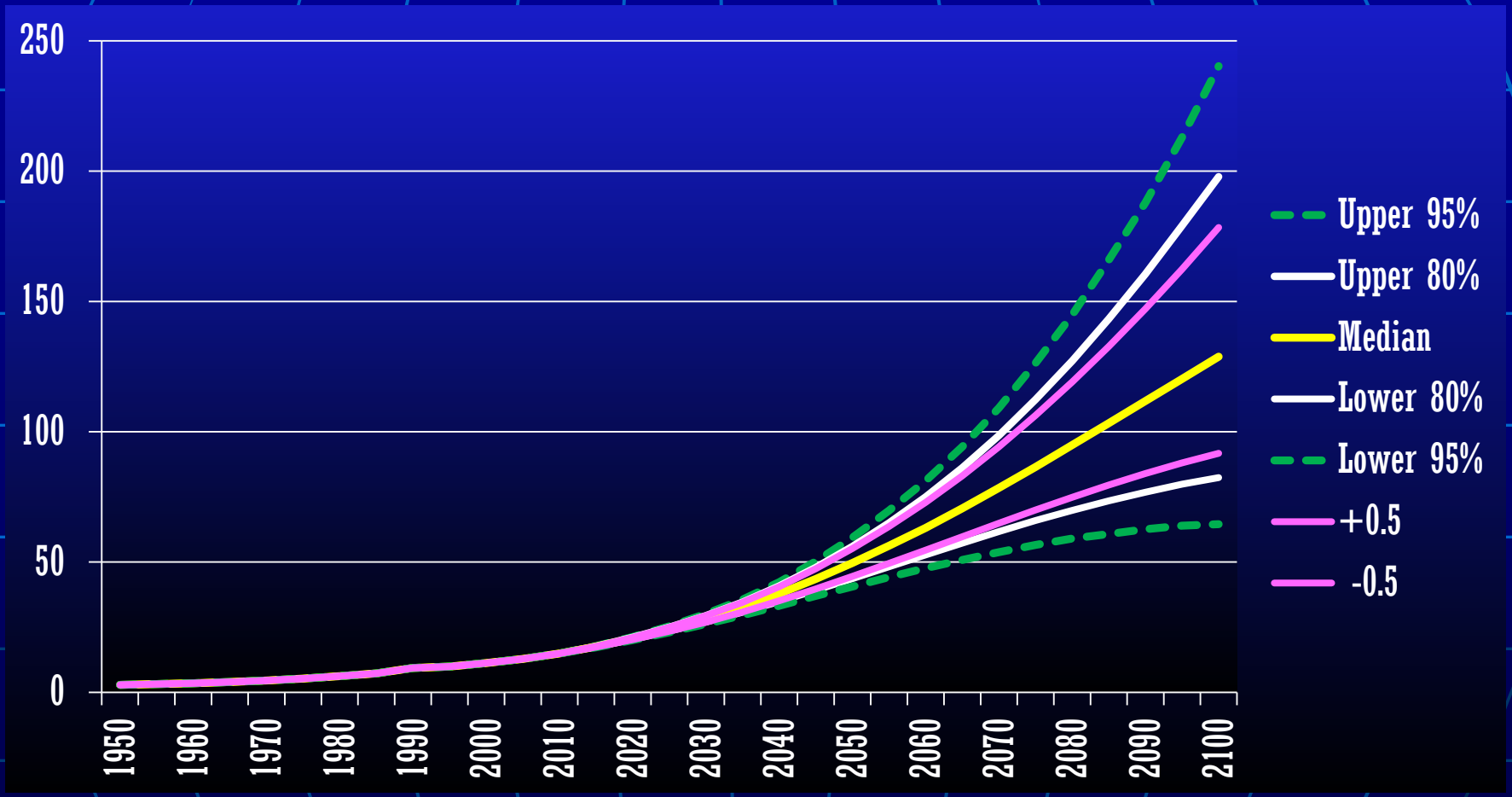
Probabilistic projection of life expectancy

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

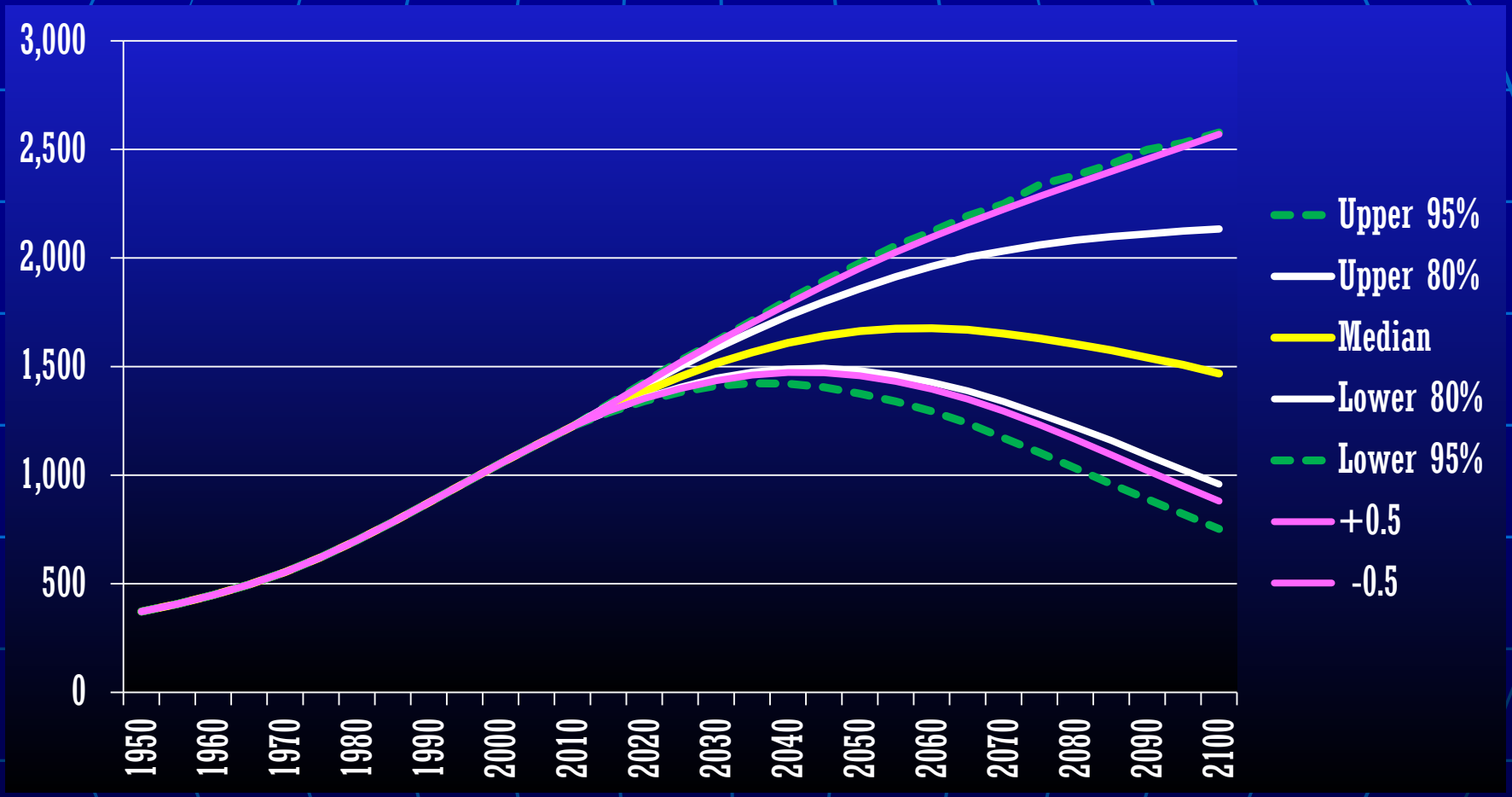
Male life expectancy is derived from a regression model for the female to male gap in life expectancy

Putting it together

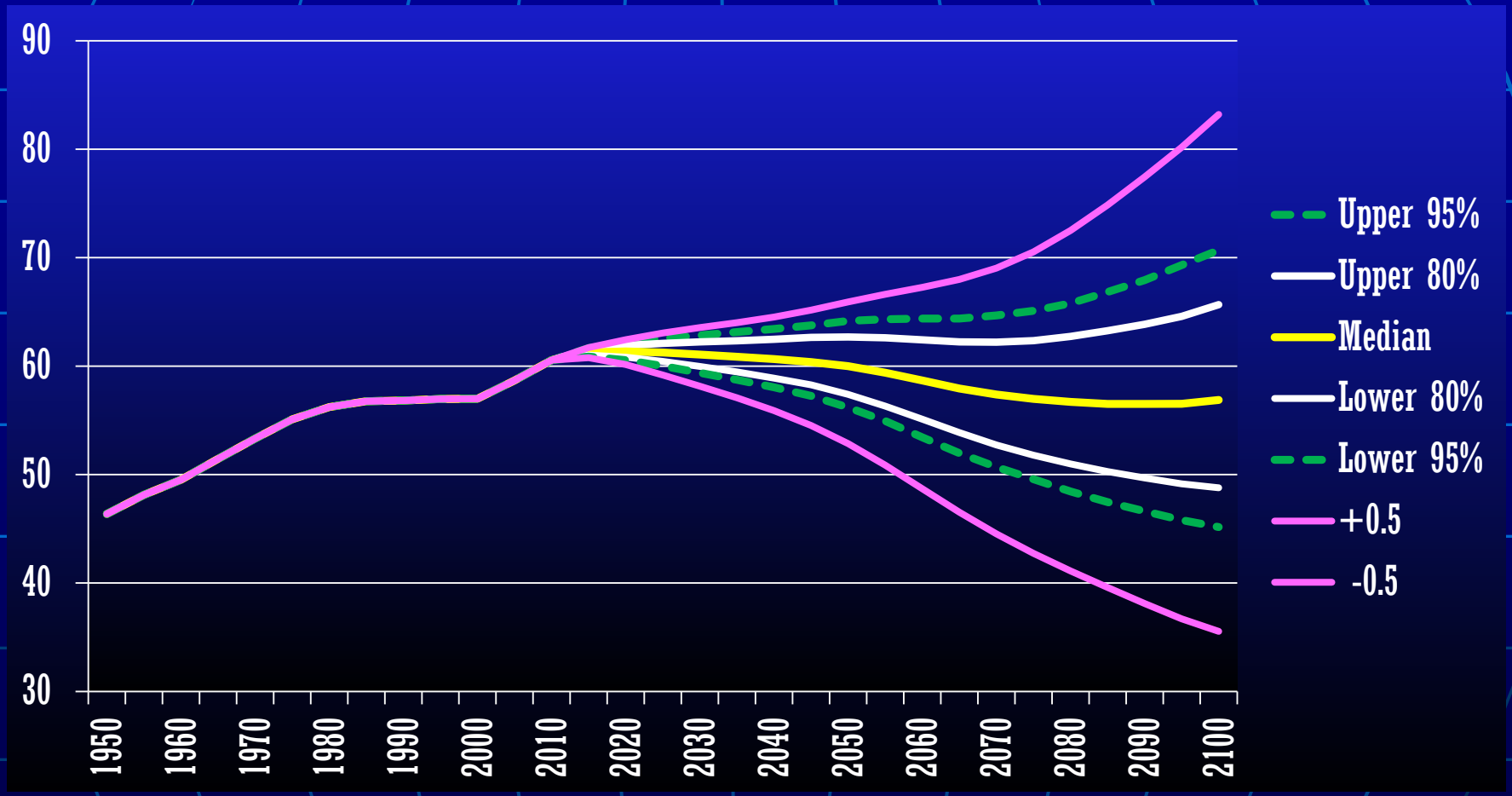
Malawi: Projected population in millions



India: Projected population in millions



Italy: Projected population in millions



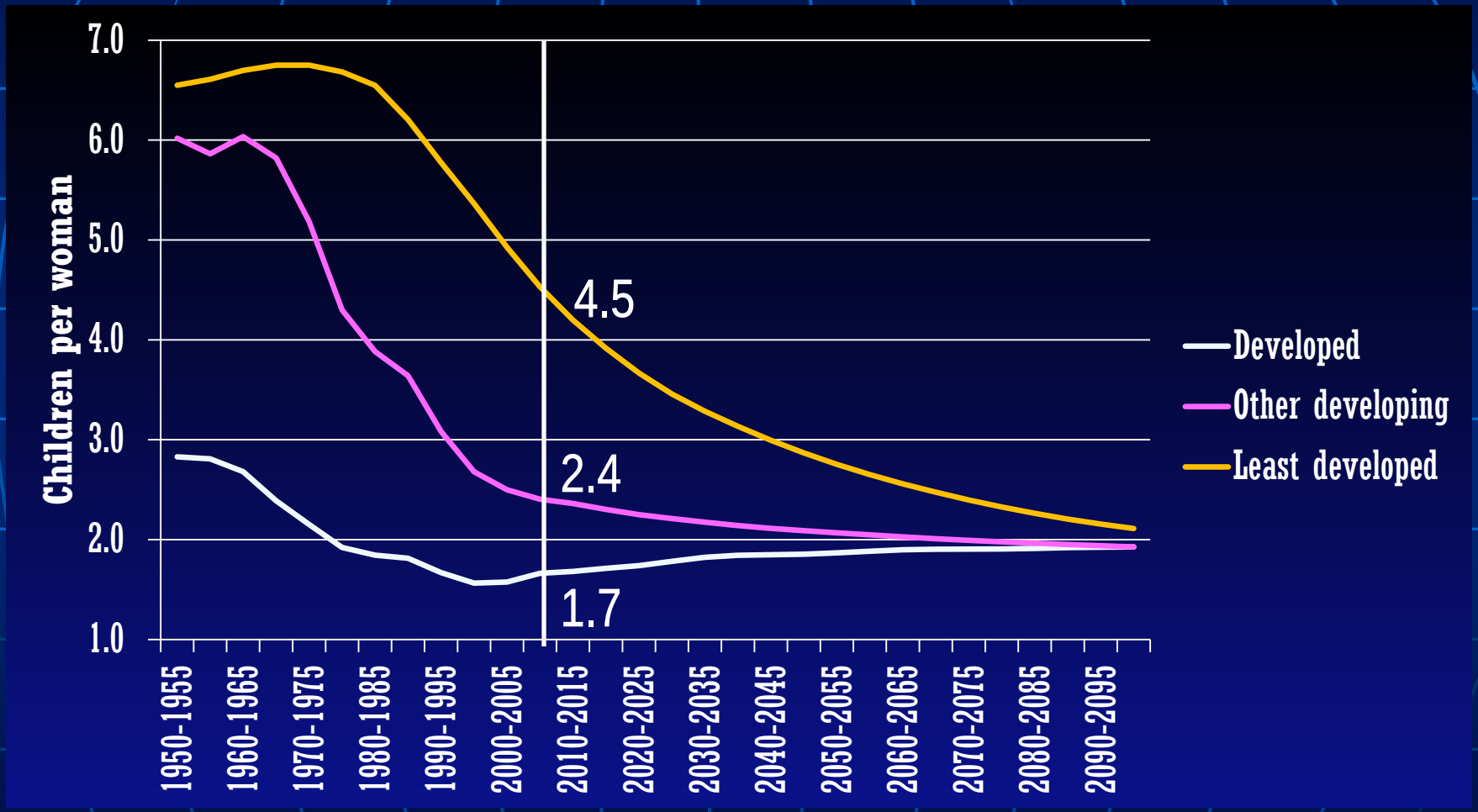
Some patterns emerge:

For high-fertility countries, the intervals between the high and low variants are too narrow compared to those yielded by the probabilistic projections

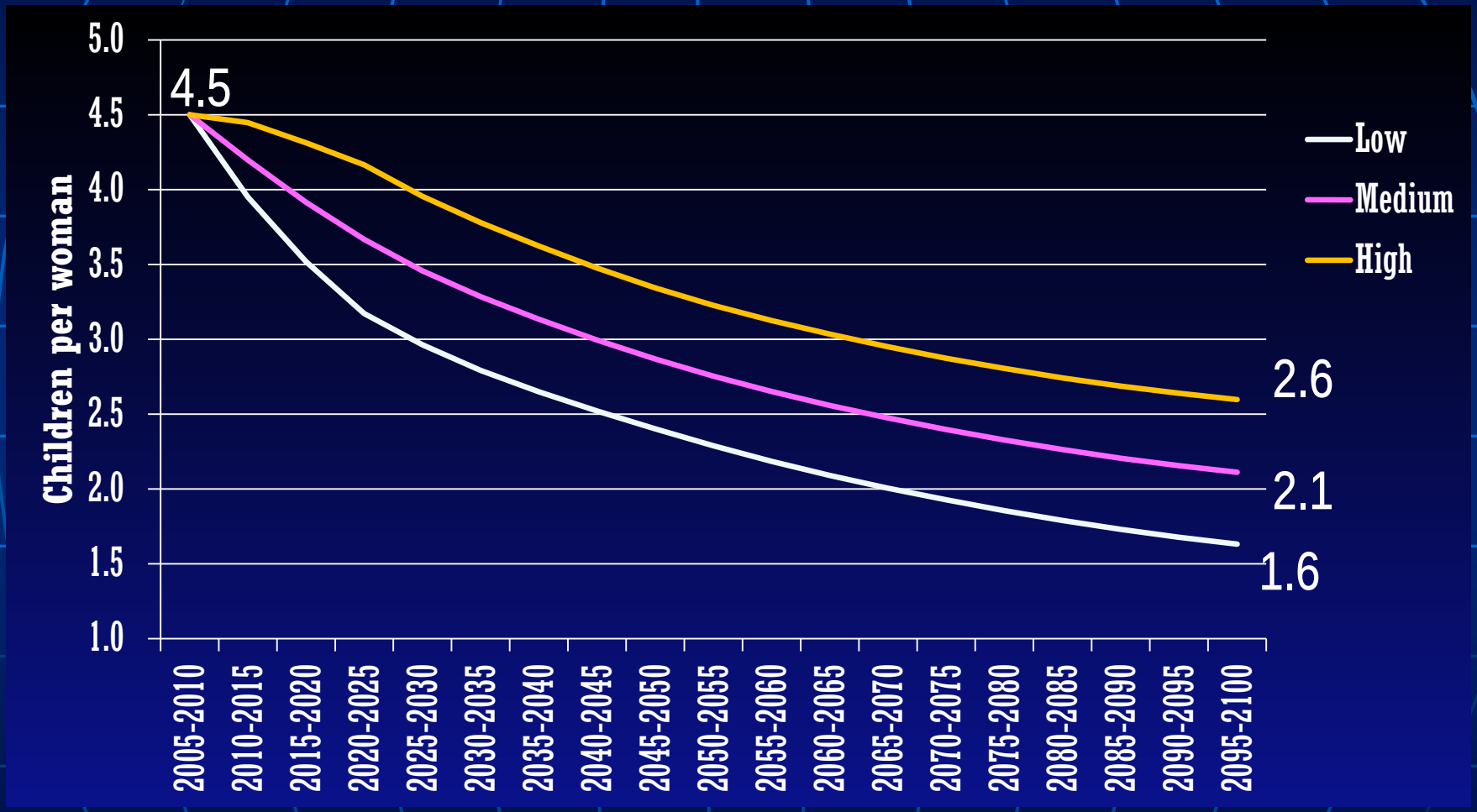
For low-fertility countries, the high-low intervals are too wide

For intermediate-fertility countries they are about right

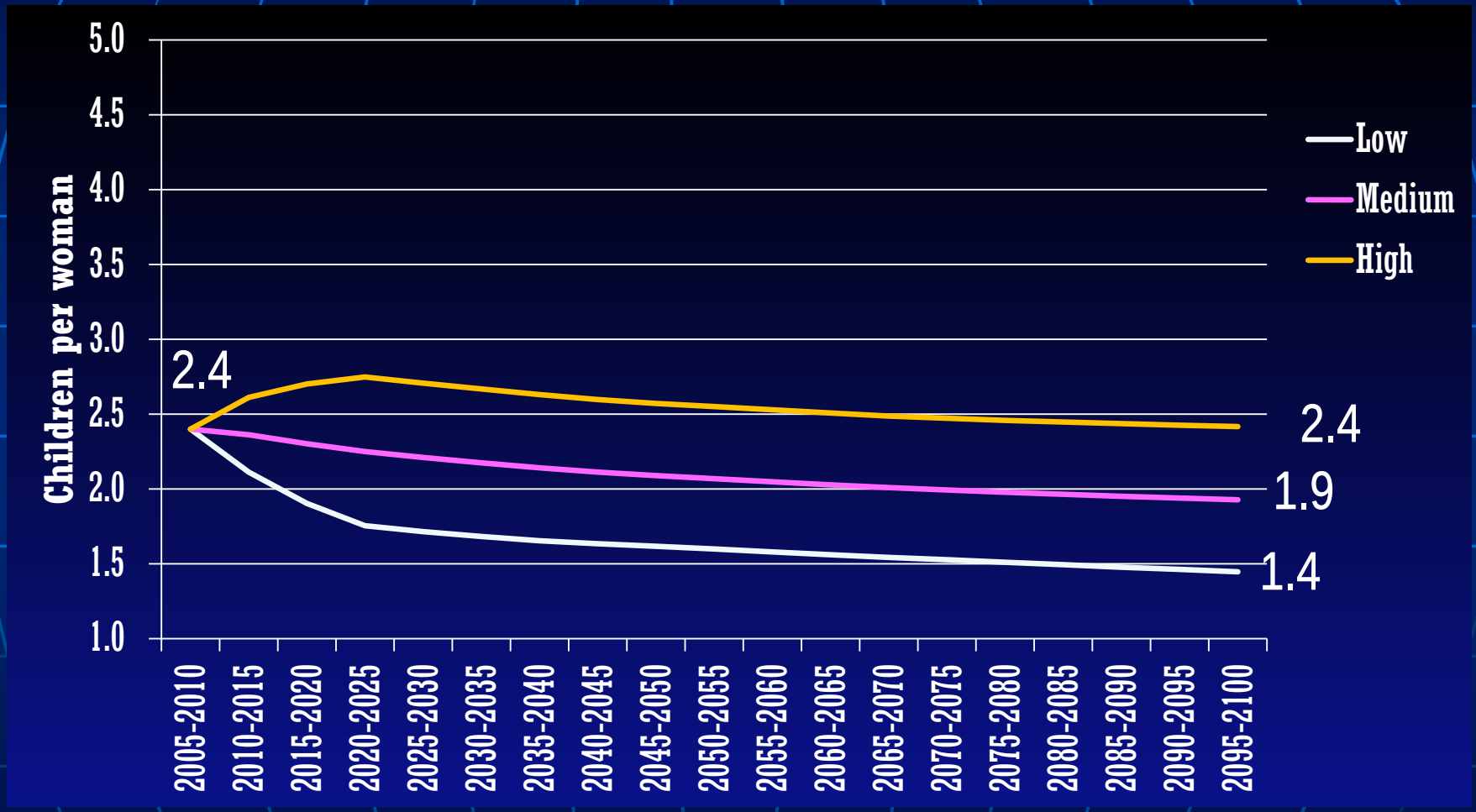
Fertility trends, 1950-2100



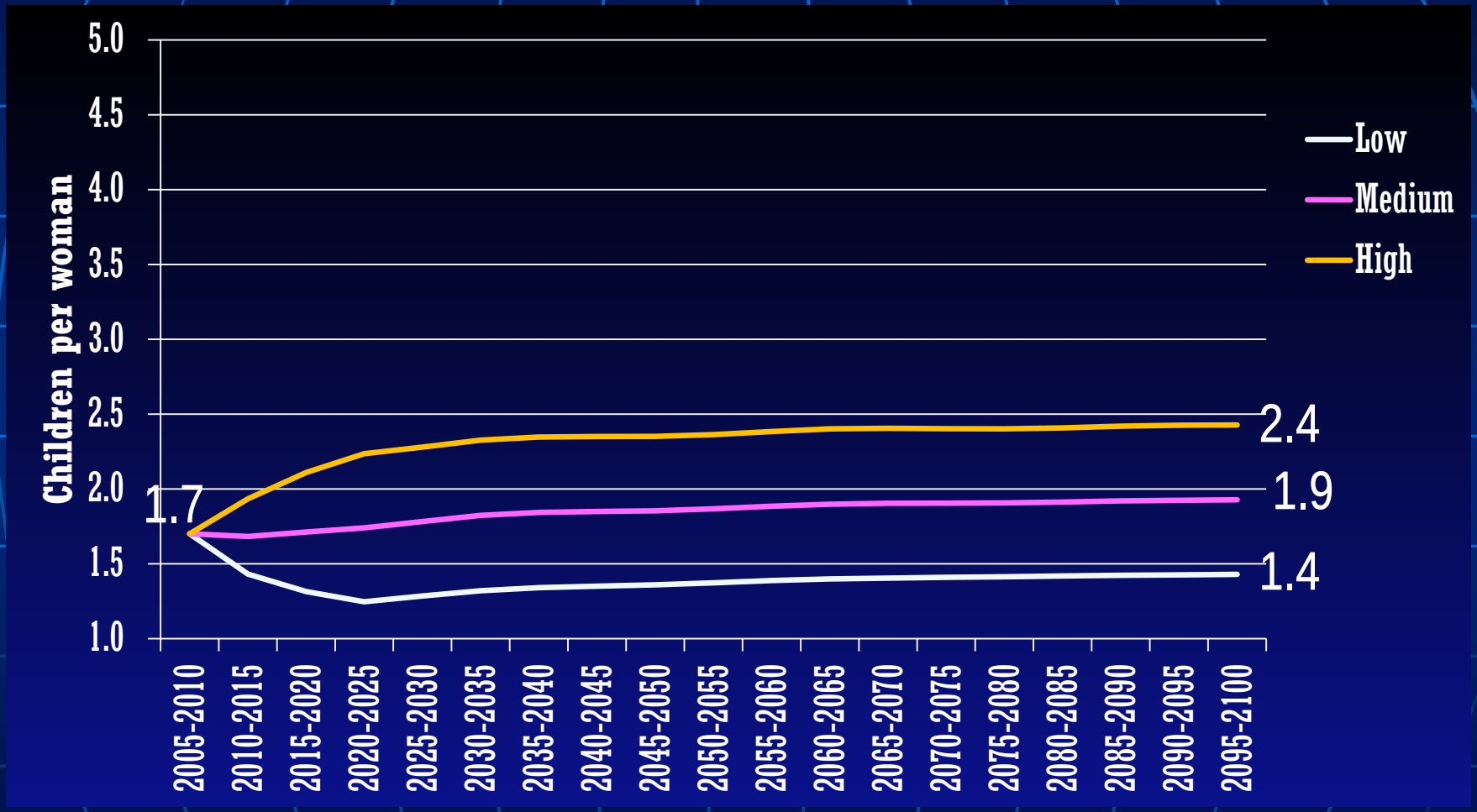
Least developed countries: projected fertility



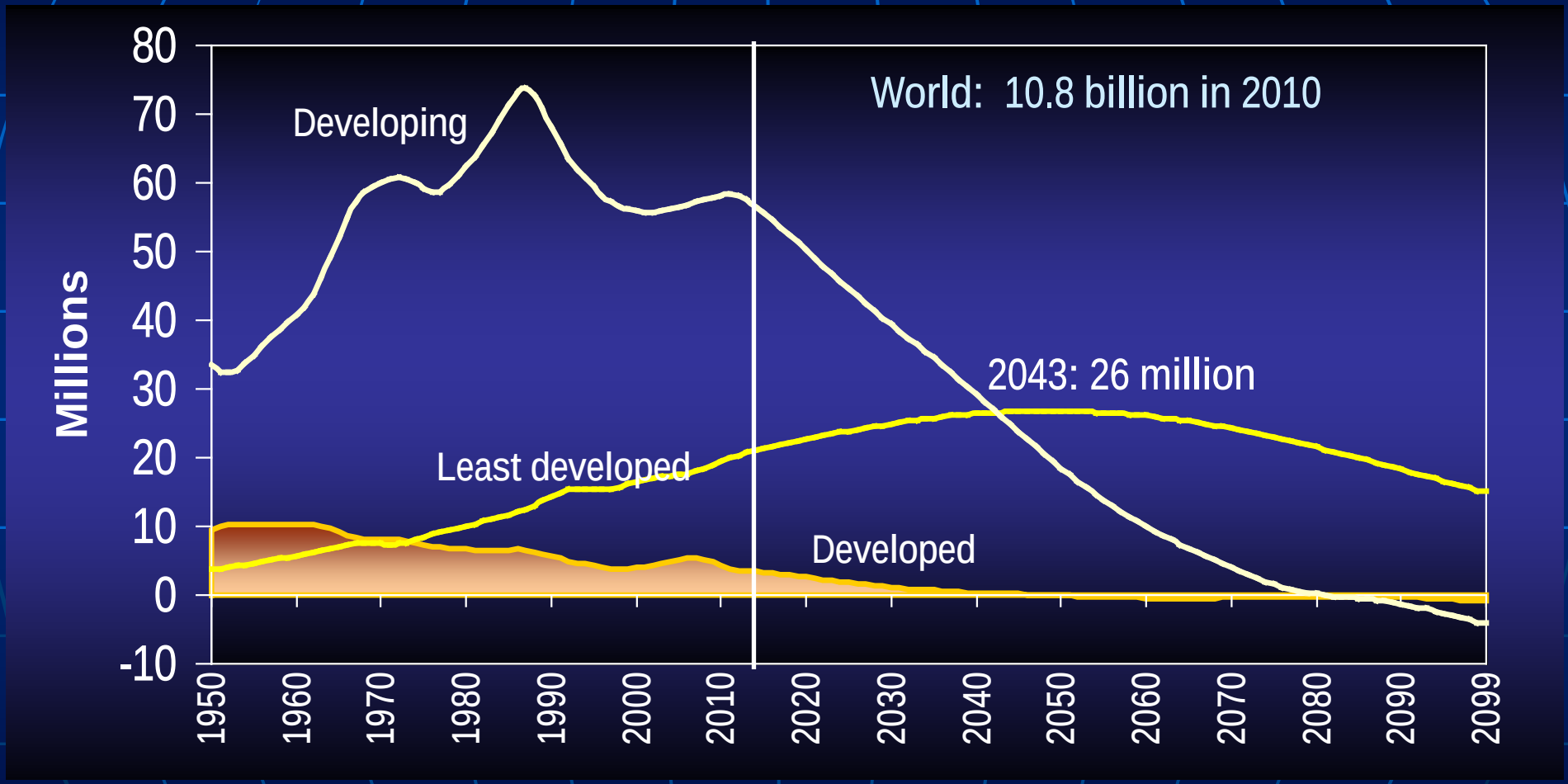
Developing countries: projected fertility



Developed countries: projected fertility

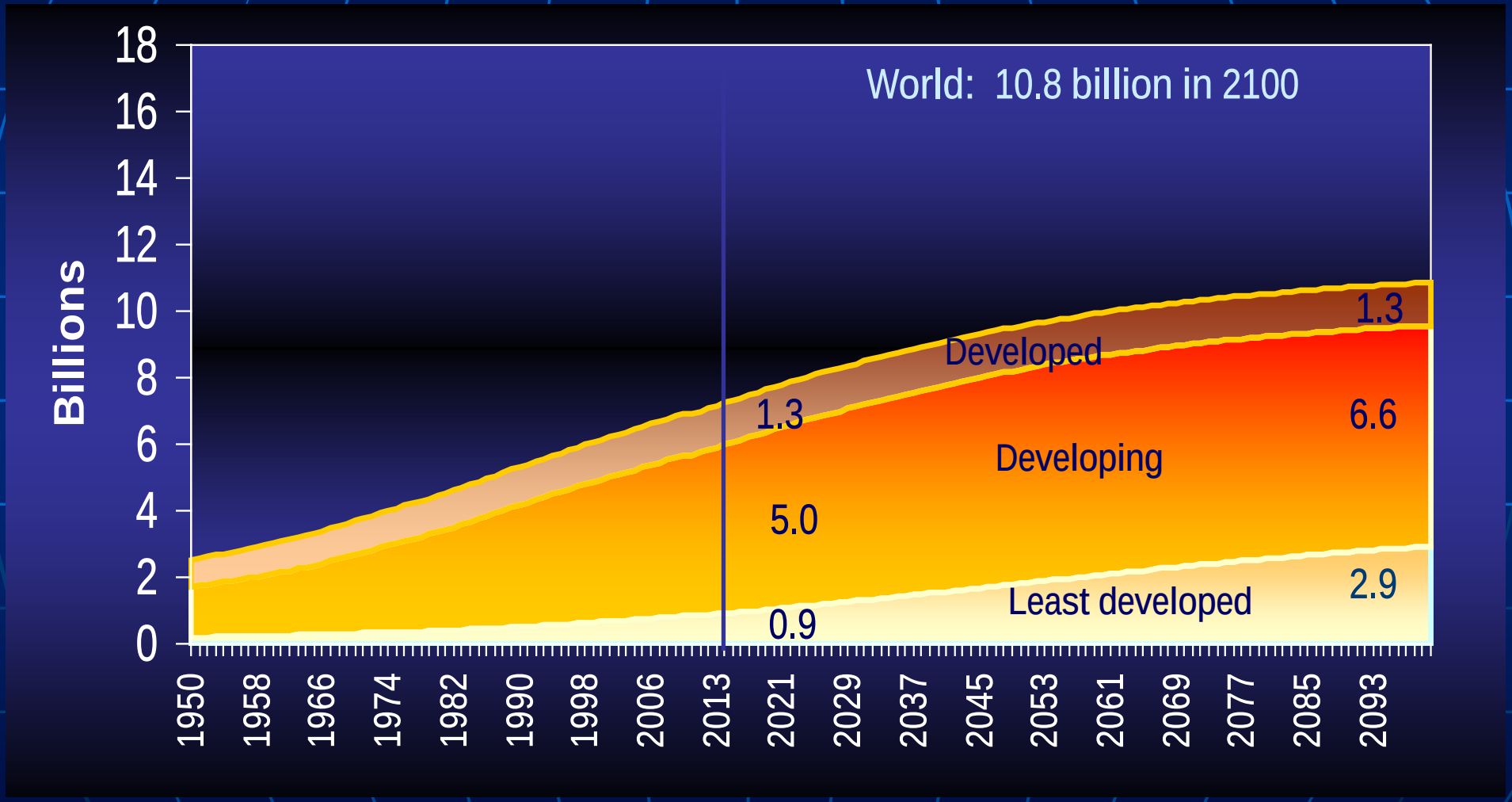


Annual population increments, medium variant



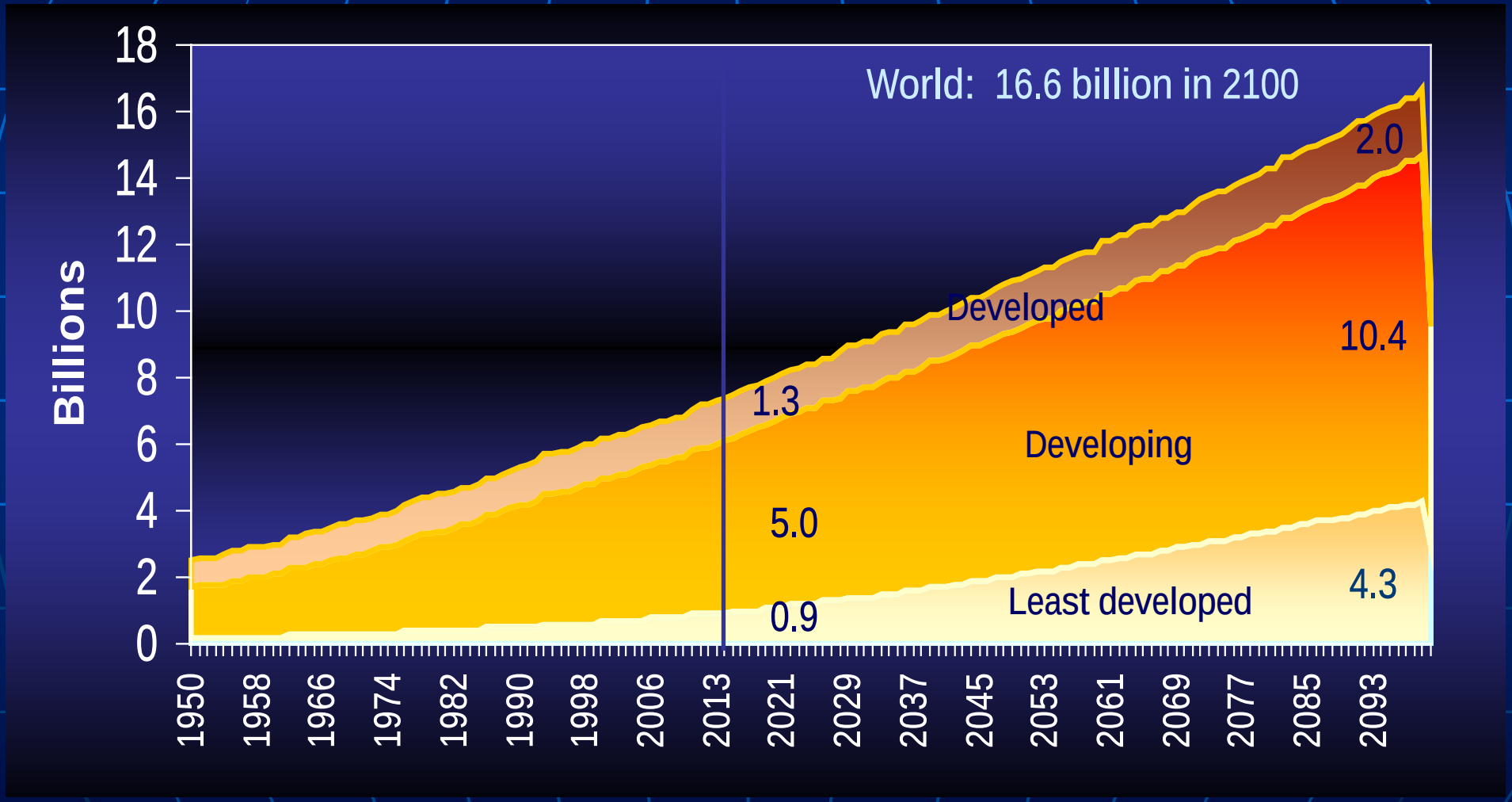
United Nations , 2012 Revision, WPP

Projected population, medium variant



United Nations , 2012 Revision, WPP

Projected population, high variant



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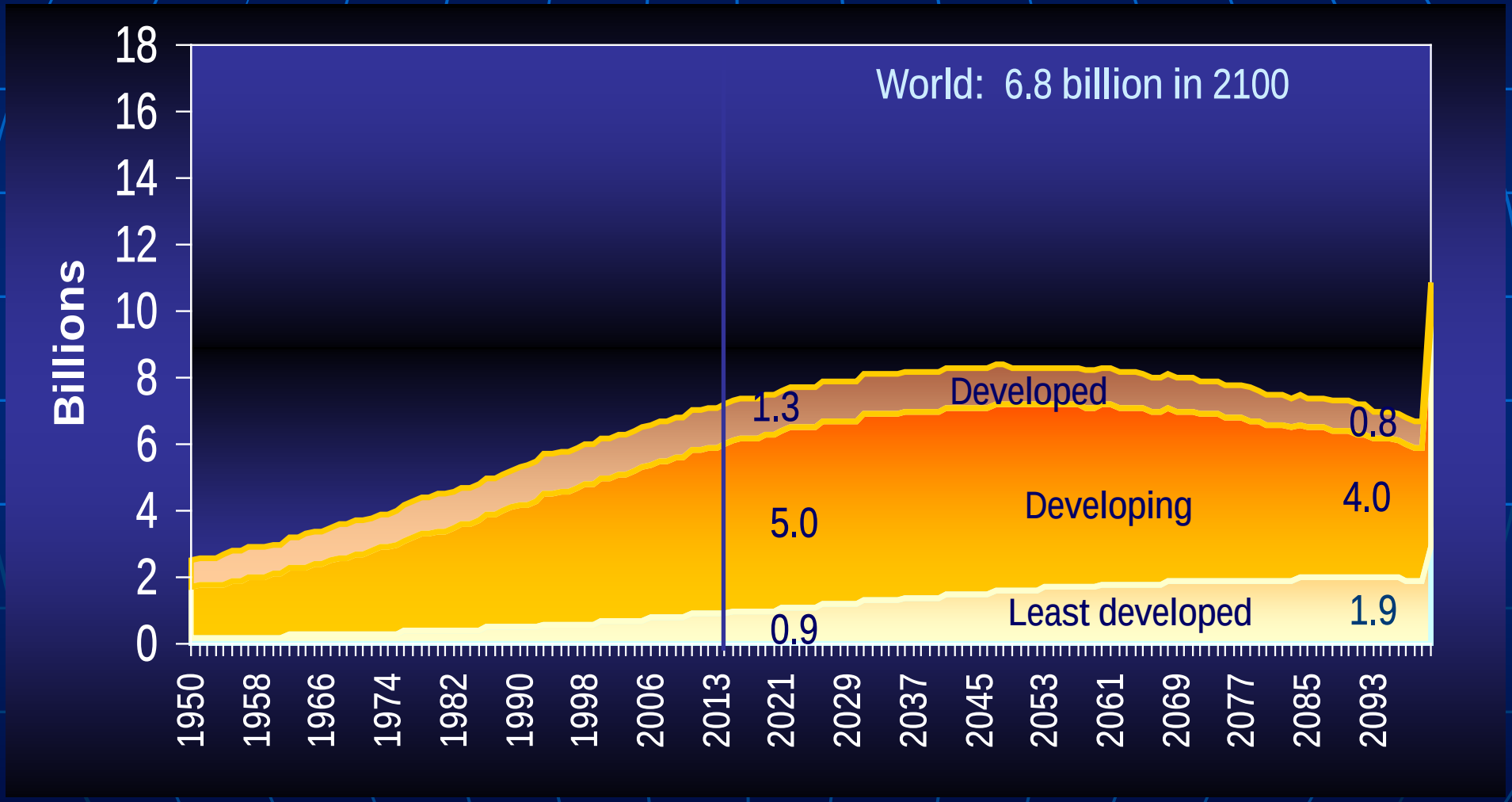
Projected population, low variant



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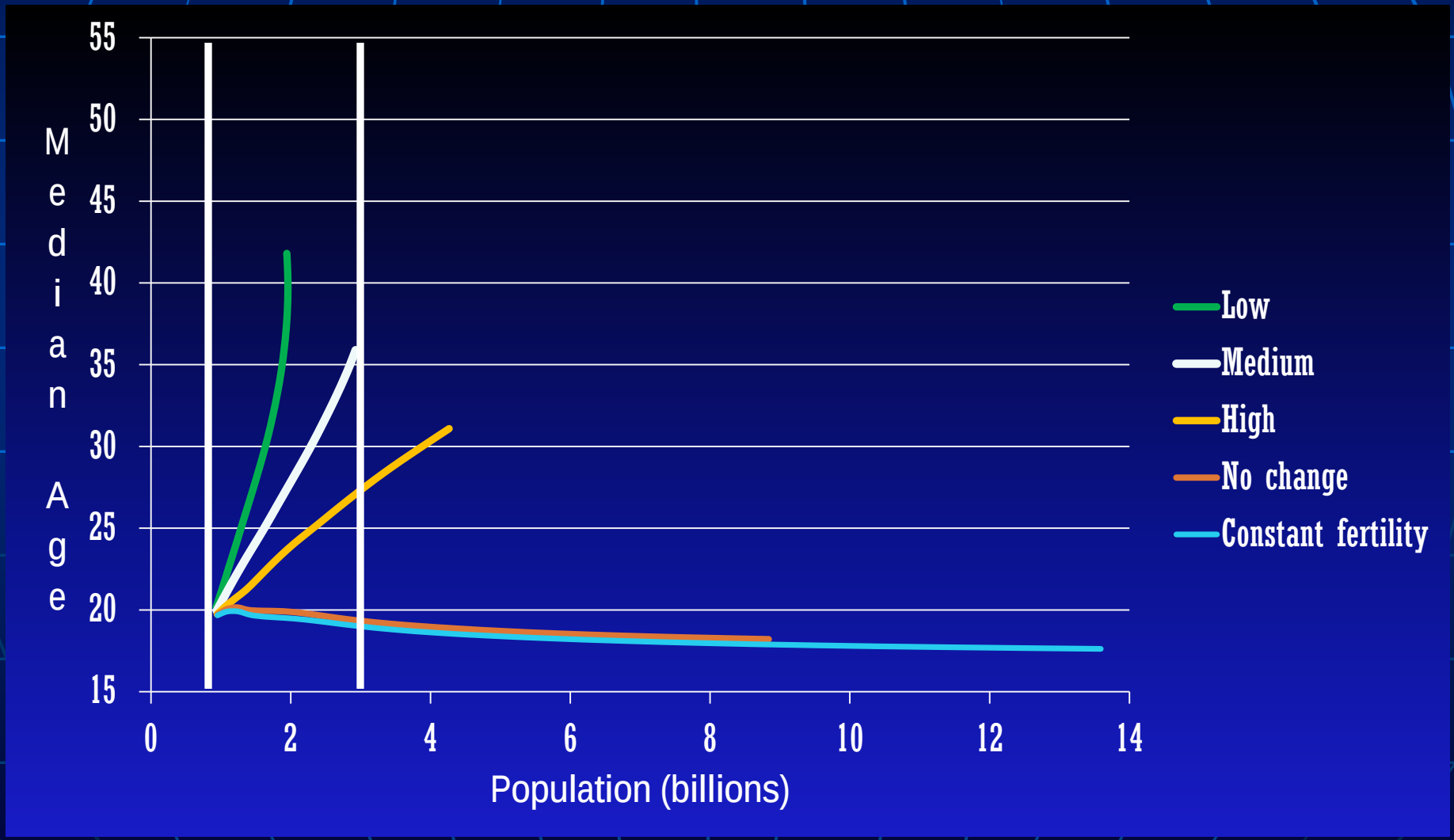
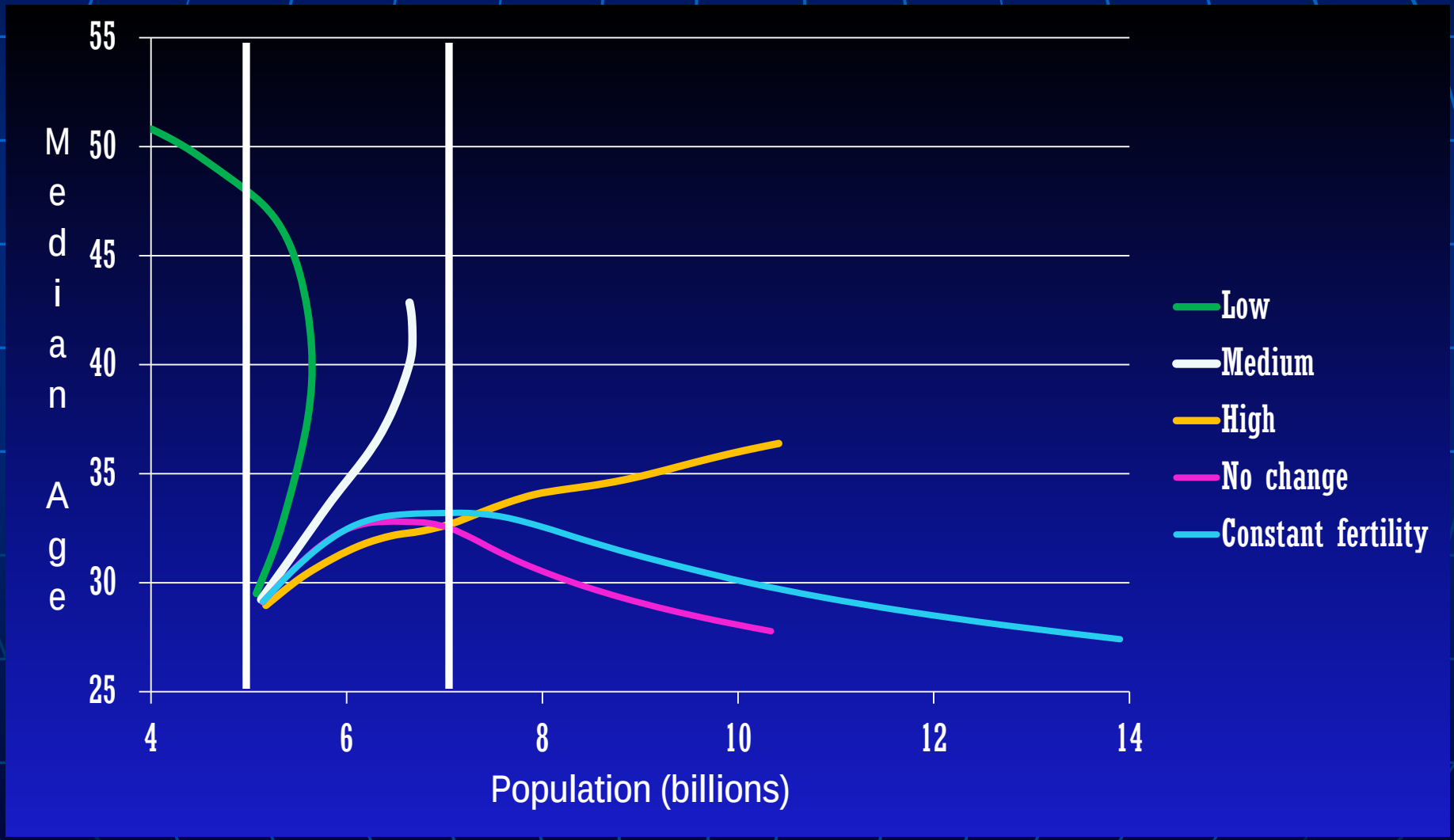
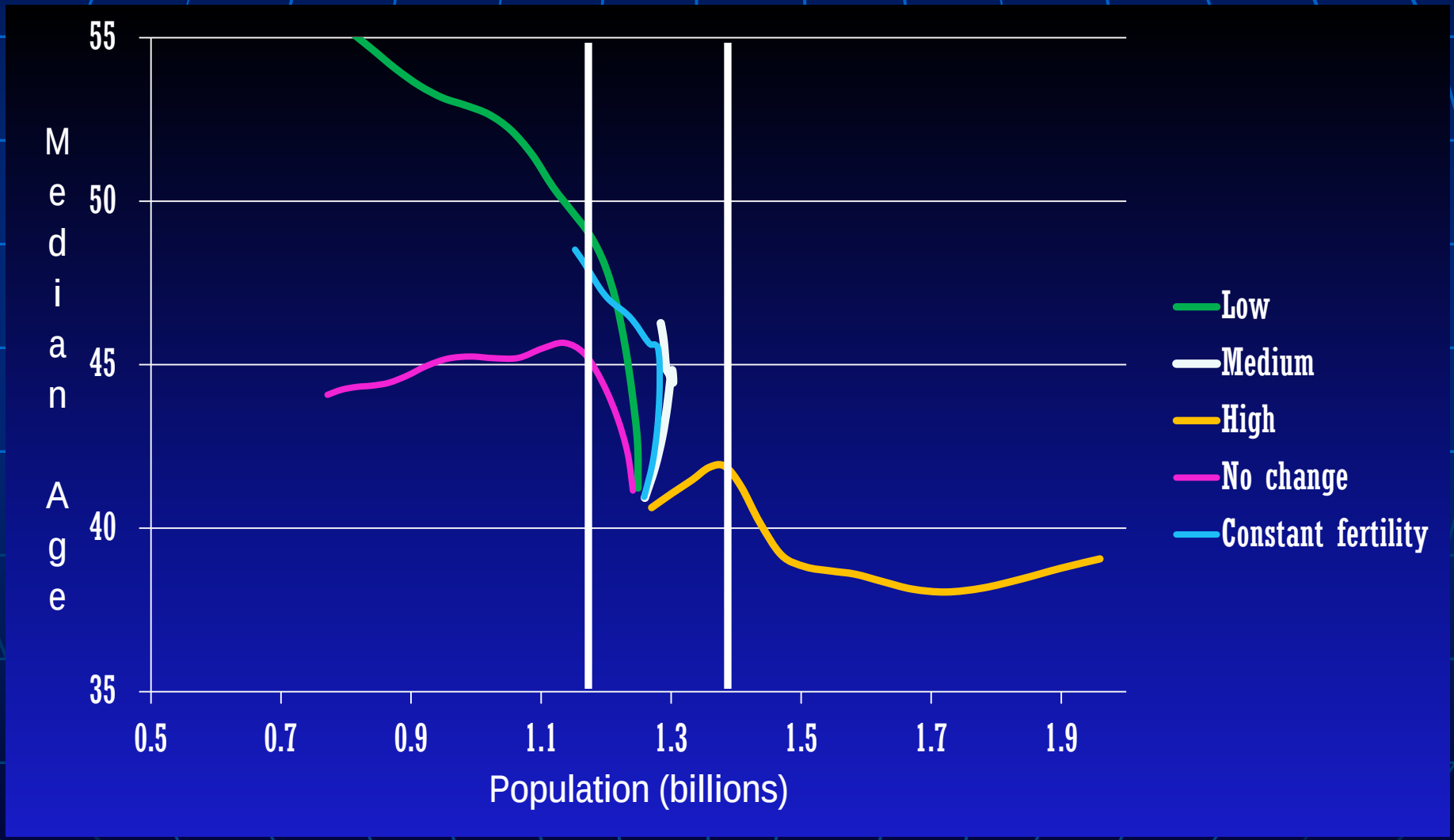
Median age vs. population size in different projections: least developing countries



Median age vs. population size in different projections: other developing countries



Median age vs. population size in different population projections: developed countries



Conclusions

1. Curbing population growth in developing countries is still a challenge
2. Least developed countries have the highest potential for growth
3. Achieving the high variant is well within the realm of possibility for the least developed countries
4. Even the contraction or slow growth of the rest of the world might not counterbalance that growth.

Conclusions

1. Population ageing is inevitable if the world population is not to grow excessively
2. The medium variant offers a path where population ageing occurs at acceptable levels while population growth remains moderate
3. The low variant would produce faster and more profound ageing.

For more information, consult:

www.unpopulation.org