Fertility scenarios for high fertility countries in the IIASA/Oxford education projections

Regina Fuchs[1,2], Anne Goujon[2.3], Wolfgang Lutz[1.2.3]

[1] Wittgenstein Centre (IIASA, VID/ÖAW, WU), Vienna University of Economics and Business
[2] Wittgenstein Centre (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis
[3] Wittgenstein Centre (IIASA, VID/ÖAW, WU), Vienna Institute of Demography/Austrian Academy of Sciences

Fertility fundamentally shapes future population size. In the new round of IIASA/Oxford education projections, we develop new fertility scenarios; scenarios informed by past experience and international experts on fertility, demographic transition and development. Relating to historical data, a country's fertility decline depends on a multitude of factors. However, once demographic transition has started, fertility decline can, and in fact has been generalized by various authors in the field (Kirk, 1996; Mason Oppenheim, 1997; Dyson, 2010). Still, countries going through fertility transition experience distinct patterns in speed and pace of decreasing fertility, depending on country and region specific circumstances and it is not clear yet, whether today's high fertility countries will follow countries past demographic transition. Given current discussions of stalling fertility transition in Africa, it remains an open question of whether countries in Sub-Saharan Africa will follow the same speed and trends in fertility decline than their Asian, European or American counterparts (Bongaarts, 2003, 2006). In fact, recent evidence finds alternative, lengthening birth-spacing patterns in Sub-Saharan Africa as compared to historical fertility transition in other world regions (Moultrie et al., 2012). Nonetheless, fertility transition is underway in the majority of African countries; few of them lagging behind (Shapiro and Gebreselassie, 2008; Schoumaker, 2009)

Conventional methods of projecting future trajectories are often based upon informed expert judgments, at times supported by time-series models, logistic models, etc. Having considered all theoretical elements, building scenarios should logically depend on the one hand historical experience, and on the other hand country-specific expertise; expertise that can potentially improve any historical experience by taking country or region-specific circumstances into account. The IIASA/Oxford science based World Population Projections are an attempt to overcome limitations of regular assumption making by firstly including a large number of experts to feed into the scenario making process by answering a questionnaire to identify main drivers of fertility, and secondly having a group of meta-expert reflect on the questionnaire results. The resulting scenarios are based on a theoretical model, employing country-specific historical fertility declines, and in a second and third step, merged with expertise from experts and meta-experts. This paper discusses the assumption making process for countries in today's high fertility world and compares the differences in methods and results to the Bayesian projection methodology introduced by the United Nations (Alkema et al., 2011).

The construction of the scenarios consists of a three staged modeling approach. First, we estimate a model, using a country's level and decrease of fertility during the past five-year period and compare it to countries with similar characteristics since 1970. Second, we estimate expected decrease of fertility by employing information, gathered from the fertility questionnaire. And third, numerical point estimates, supplied by the meta-experts, are utilized to estimate future fertility decline. Combining the information from three different sources - from qualitatively very different sets of data - we are able to provide a new set of fertility assumptions to feed into the IIASA/Oxford education projections.

1. Model of historical analogy

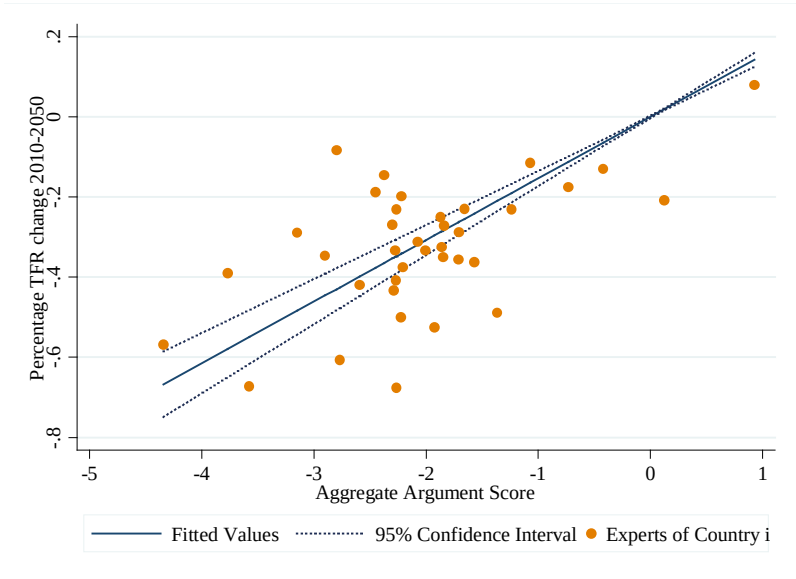
Employing past levels and decreases of fertility across countries, we develop a model of historical analogy. The overarching idea can be summarized as follows: Take a country's level and decrease of fertility in the past 5-year interval and compare it to all countries, which have undergone similar levels and decreases of fertility in the period since 1970. Historical time-series were taken from United Nations World Population Prospects, 2010 (United Nations, 2011). Employing total fertility estimates for 5-year intervals, we generate percentage changes in fertility decline for adjacent periods. The predicted percentage change of fertility for country $i1$ in projection period $t1$ can be described as the median percentage decrease of all countries j, in any period s.

2. Results from a global survey of experts[1]

Having received 140 responses from the expert questionnaire sent to member of population associations, we develop a model that translates responses from arguments to respective changes in fertility. Respondents were invited to evaluate the arguments towards 2050. Responses from the experts are weighted by their validity and summed up to an aggregate argument score for each expert. Also, experts were asked to provide numerical estimates for their country of choice in 2030 and 2050. The construction of the arguments allows drawing a positive association between the expected decrease in fertility and the value of the aggregate argument score. In other words, the lower the aggregate argument score (AGGSCORE), the stronger the expected decrease in fertility.

[1] Please find an archived version of the questionnaire here: http://webarchive.iiasa.ac.at/Research/POP/ExpertSurveySandbox/

Figure 1: Predicted percentage change in TFR, 2010-2050 by the experts of country i



3. Input from Meta-Experts

During the meeting of meta-experts evaluating the results from the questionnaire, we did not only gain further insight into the most important drivers of fertility across world regions from the meta-experts, but after intensive discussion, also formulated numerical estimates of fertility for 14 countries in 2030 and 2050 (Bangladesh, Egypt Ethiopia, Ghana, India, Indonesia, Nepal, Niger, Nigeria, Pakistan, Philippines, South Africa, Uganda and Yemen). We calculate two rates of decrease, one from 2010 to 2030 (r_1) and the second one from 2030 to 2050 (r_2).

4. Combining the Models

In a final step, we develop a method of combining estimated fertility decrease of all three models, described above. While the model of historical analogy can be implemented to all countries in the cluster of high-fertility countries, we estimated rates of fertility change for 37 countries from the expert questionnaire model, and another 14 trajectories from the meta-expert model, which partially overlap. Thus, for countries where we do not dispose of any type of expert model, we only apply the model of historical analogy. Using the following weighting scheme, we yield a percentage change in fertility for 5-year periods from 2010 to 2050, respectively.

	Historical Analogy %ΔTFR_1	Expert Model %ΔTFR_2	Meta-Expert Model %ΔTFR_3
	α_1	α_2	α_3
Relative Weight	1	1	0.2 x # of experts

For each projection period, we first calculate model 1, weight the percentage decline with results from models 2 and 3, and then, deduct the weighted percentage change from TFR_{t-1}.This process is repeated for all t until 2045-2050, after 2050, only model 1 applies. If a country's fertility reaches 1.6 or below in the period from 2010 to 2100, the model estimates are replaced by linear convergence towards 1.75 in 2200.

5. Results

Figure 2 displays fertility scenarios for Ethiopia and Kenya, two countries in East Africa. Compared to UNs fertility scenarios, our joint models produce fertility, higher than the historical model and the UN estimates. In Kenya, there are is no numerical estimate from the group of meta-experts, thus the final fertility scenario is only constructed by weighting the historical model and the two source experts, bringing up the fertility estimates. While there are only 2 source experts for Ethiopia and Kenya, we are able to employ questionnaire results from 6 experts in Ethiopia and even 9 experts in Ghana. By definition of the weighting scheme in combining the models, source experts in Nigeria and Ghana have a much higher joint weight, than in Ethiopia and Kenya, relative to the historical model and the meta-experts. Remembering the relative weights for meta-experts' estimates and the historical model being 1 each; for example, in Ghana, the expert weights is 0.47=1.8/3.8 (9 experts * 0.2 / (1+1+1.8)), in Ethiopia the respective value is 0.17=0.4/2.4 (2 experts *0.2 / (1+1+0.4)). The weighting scheme thus, explicitly reflects the number of experts answering the questionnaire. Fertility trajectories of countries with large numbers of experts should predominantly rely on the expert judgement from the questionnaire. For countries, where we have little expert knowledge, we instead, put more weight on the historical model and the meta-expert estimates.

Figure 2: Historical fertility and fertility scenarios for Ethiopia and Kenya, 1990-2100