New set of population projections by age, sex, and educational attainment for 170 countries of the world: methods and challenges

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Introduction
The reconstruction and projection of the population by age, sex, and educational attainment for 120 countries of the world were first published in 2007 and 2010, respectively (Lutz et al. 2007; K.C. et al. 2010). The data have been used by researchers and planners, for example, to analyze the age-dimension of the relationship between human capital and economic growth (Lutz, Cuaresma, and Sanderson 2008; Chappuis and Walmsley 2011; Eberstadt 2012), to study the impacts of natural disasters (Cavallo et al. 2010) as well as the determinants of vulnerability to natural disasters (Striessnig, Lutz, and Patt in review), demographic and health related issues (KC and Lentzner 2010; Prettner, Bloom, and Strulik 2012), predicting armed conflict (Herge et al. 2011, unpublished paper). Detail discussion about including education as an important variable in addition to age and sex for measuring demographic heterogeneity were published recently (Lutz and KC 2010; Lutz and KC, 2011).

In the past, the basic assumptions regarding the future of fertility, mortality, and migration were mostly taken over from the World Population Prospects (UNPD, 2008). The education projections by four levels, namely never been to school, some primary, secondary, and tertiary, were derived from fitting a single global trend (by age and sex). Education differentials in fertility and mortality were mostly based on the literature as well as own analysis of a few censuses (IPUMS) and surveys. These differentials were assumed to be constant for the entire period of projection without making use of further available expertise. Population distribution by age, sex, and educational attainment were compiled from various sources. The initial distribution along with the assumptions, the distribution of population by age, sex, and education was projected up to the 2050 for 120 countries of the world.

The aim of this contribution is to present for the first time a new set of basic assumptions regarding the future of fertility, mortality, and migration currently under development at the newly established Wittgenstein Centre for Global Human Capital and Demography (WiC) for a total of 196 countries of the. In contrary to previous assumption-gathering exercises, the new set of assumptions is derived from argument-based expert opinions. These WiC assumptions will be the basic demographic inputs for the new population projections by age, sex, and education that we will present in this paper. The number of education categories is increased from four to six to allow for more detailed disaggregation and the number of countries is expanded from 120 to 170 countries, for which the data were available, covering more than 99% of the World's population. Initial distribution of population by age, sex, and education are prepared using most recent censuses (IPUMs) or surveys and the education variables were recoded to match the ISCED

definition. Education differentials in fertility, mortality, and migration are mostly based on the estimation using census (IPUMS) and survey data as well as available literature. Various methods of dealing with the differentials are fine-tuned and some additional complexities have been introduced (e.g. allowing child mortality to depend on the education of the mother). Finally, the education projection is improved by allowing, in addition to the global, country as well regional trends to influence future attainment levels.

Our aim, therefore, is to present the methodological advancement and challenges in introducing education as an additional dimension in the evolution of population distributions. The ultimate goal of this paper is to serve as a step-by-step manual to conduct population projections by age, sex, and educational attainment which will be a tool highly regarded by users who want to do their own multi-state projections. At the same time, this paper will eventually serve as a background paper for a population projection software package in R in the coming future. The details of the projection including assumptions, results, and analysis will be included in a proposed book edited by Wolfgang Lutz and Bill Butz. (Lutz and Butz ed, proposed)

Data and Methods
Over the last two years, six teams of researchers at the WiC have been working to prepare a new set of assumptions regarding the future evolution of fertility, mortality, and migration in 196 countries with a population of more than 100,000. The assumptions do primarily rely on the argument-based opinions of experts from all around the world collected through a web survey as well as from six smaller groups of top experts who validated the experts' opinions. These opinions, together with the past country-, region- and global-experience, were then used by the different teams of researchers at the WiC to come up with a final set of assumptions for TFR, sex-specific life expectancies, and migration flows for 196 countries of the world between 2010-2100. This is equivalent to the UN's Medium scenario in terms of "middle of the road" or "business as usual" scenario.

Education differentials in fertility, mortality, and migration are estimated from various censuses (IPUMS) and surveys (e.g. DHS). In many cases the differentials are also derived and compiled from the existing literature. Country-specific assumptions for the future differentials were prepared based on the analysis of the differentials observed in the past, e.g., for countries with a TFR above 1.8, current fertility differentials are assumed to converge to a standard set of differentials by the time TFR reaches below 1.8 or by 2030, whichever occurs later.

One of the most time consuming tasks was the preparation of the distribution of the initial population by age, sex, and education. A team of three researchers prepared a final set of distributions by scanning all possible data sources. In case there were multiple sources of data available, the decision on which was the best was based on the careful analysis of the data quality. Country-specific education categories were harmonized according to the UNESCO's International Standard Classification of Education   (ISCED-97) and a final set of data was prepared for 170 countries with six levels of educational attainment namely: no education (E1),

incomplete primary (E2), completed primary (E3), completed lower secondary (E4), completed upper secondary (E5), and completed post-secondary education (E6).

Given this data, we projected the population by age, sex, and educational attainment by using the multi-state population projection model. The details of the model will be presented in the conference.

Results

Our preliminary results show that the Global population will peak at a level of 9.1 billion around the year 2065 and will then start to decline. This result is different from the UN's projected medium scenario, where population will keep on rising till the end of the century beyond 10 billion. The difference in the projected number at the global level is mainly due to different sets of assumptions on fertility.

In terms of educational attainment, according to the education trend scenario, the population in 2060 will be much more educated than in 2010. Figure 1 shows the total population for 170 countries by six levels of education for population aged 15 and above along with the total population for children under 15 years of age. Population will increase by about 2 billion in the next 50 years. However, the proportion of adults with at least high school completed will increase significantly.
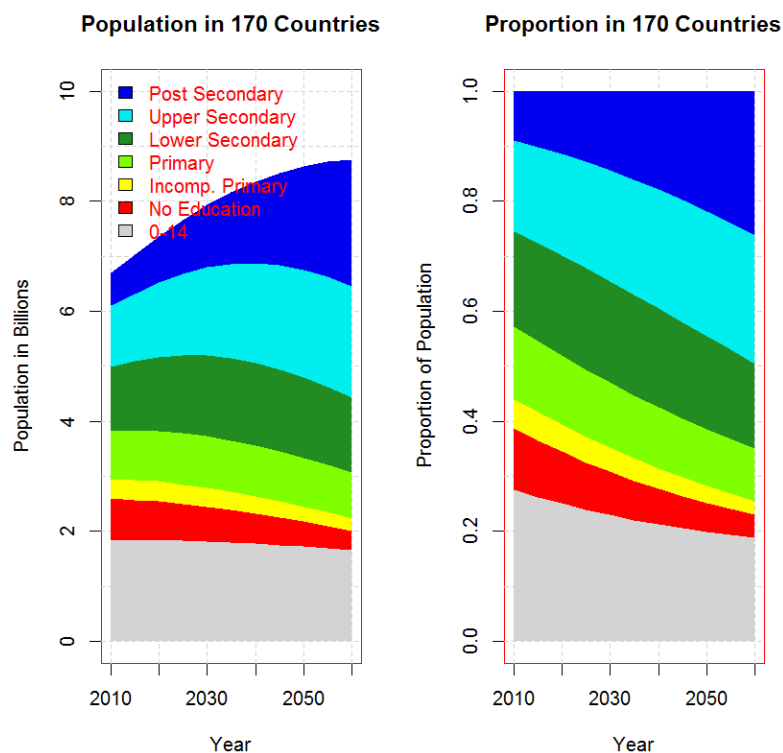
Figure1. Global Population Projection by Educational Attainment in 170 Countries (more than 97% of the World Population) under Medium Scenario

Discussion and Conclusion

This paper will present a step-by-step methodology developed in producing a set of population projection by age, sex, and educational attainment for almost all countries of the world. The details regarding the assumptions and the results are not presented and discussed in this extended abstract at this stage because they are in the process of finalization. This is an ongoing work that started two years ago involving more than 15 researchers and will be completed by the end of the year 2012. We will present all the details in the final paper.

Usefulness of the data and methodology

Since the Vienna University of Economics and Business, one of the pillar institutions of the WiC, also hosts an eminent platform for the development of "The Comprehensive R Archive Network" (CRAN), the "WiC-Model" is entirely programmed in R (R Development Core Team 2008). The plan behind this is to later use CRAN to make the model publicly available in the form of a population projection software package. Eventually, it should be possible for anyone in the interested community to do multi-state population projections for a range of different scenario options at the cost of a few mouse clicks.

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