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Item 17 – Population projections by age and sex and level of education

Results of the New Wittgenstein Centre Population Projections by age, sex and level of education for 171 countries

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1. Introduction

While the preceding papers in this session have all contributed to building the knowledge base for the actual projections, the focus of this paper is the translation and operationalization of the empirical evidence and the substantive arguments presented so far into specific population projections by age, sex and level of educational attainment for 171 countries in the world. This is a complex exercise in which data and methodology play crucial roles. The cohort-component multi-dimensional projections we are about to present require a large amount of information. In addition to base-year data on population, fertility, mortality and migration – all disaggregated by age and sex and level of educational attainment – we need to assume numerical values of these determinants of population change according to the different scenarios.

The resulting set of expert argument-based projections by age, sex and educational attainment presents an important advancement in international population projections, as well as a logical next step in the tradition of population projections at the World Population Program of the International Institute for Applied Systems Analysis (IIASA) (Goujon and Lutz, 2004; KC et al., 2010). The present effort goes beyond what the United Nations and other agencies have been doing in two important ways: (1) It provides the most comprehensive and systematic summary of expert knowledge on future fertility, mortality and migration to date – including the input of hundreds of demographers from around the world – and (2) it translates this information into the most comprehensive set of human capital projections for 195 countries.[1]

The study builds on and significantly expands earlier IIASA reconstructions and projections of the population by age, sex, and educational attainment for 120 countries of the world, published in 2007 and 2010 (KC et al., 2010; Lutz et al., 2007). These data have already been used by researchers and planners, for example, to analyse the age-dimension of the relationship between human capital and economic growth (Chappuis and Walmsley, 2011; Eberstadt, 2012; Lutz et al., 2008a), to understand the impacts of natural disasters (Cavallo and Noy, 2010) and vulnerability to natural disasters (Pichler and Striessnig, 2013; Striessnig et al., 2013), to study demographic and health related issues (KC and Lentzner, 2010; Prettner et al., 2012), to predict armed conflict (Hegre et al., 2009, p. 200), and to include education as an important dimension of population projections for measuring demographic heterogeneity as shown in (Lutz and KC, 2011, 2010).

[1] The projections by age and sex cover all countries in the world with more than 100,000 inhabitants. Empirical data for the education structure was available for 171 countries. For the remaining 24 countries, the average education-distribution in the region a country belongs to was used as an approximation.

Compared to these earlier population projections, three important changes were implemented regarding data structure and coverage: (1) the projection base-year data were updated to the year 2010 instead of 2000; (2) the number of education categories was increased from four to six to encompass a broader range and more variability in levels of attainment; and (3) more countries were added – from 120 to 195 to cover virtually the entire world population (Bauer et al., 2012). In addition to assumptions regarding the future of fertility, mortality, migration, and educational attainment presented earlier in this session, education differentials in fertility, mortality, and migration were estimated based on census (IPUMS) and survey data, and on the available literature.

This chapter is structured in three parts: The first summarizes the assumptions developed for the projections. The second part walks the reader through the projection methodology. The third part illustrates the results under various scenarios.

2. Data and Methods

2.1 Base year distribution

Internationally comparable data on levels of educational attainment of the adult population by age and sex consistent across time and space cannot be found in nationally aggregated form. This is a serious data deficiency as levels of educational attainment of the working-age population are the main indicator of human capital used in many models relating to economics, information technology, or health.

Toward our original goal of collecting data on shares of the population by age, sex, and educational attainment for 195 countries with a population of at least 100,000, we managed to collect and harmonise data for 171 countries (88 percent of all countries), covering 97.4 percent of the world population in 2010. This makes the Centre's dataset the most comprehensive in comparison to any other widely used dataset, such as Barro and Lee (2013), which covers 146 countries. Another advantage of the WIC dataset consists in the application of clear procedures in cross-national harmonisation of educational data across the globe based on ISCED 1997 classification. (Bauer et al. (2012))

Table 1*: Categories of educational attainment and allocation rules*

Categories	ISCED 1997 level	Allocation rules
No education	No level or ISCED 0 Grade 1 of ISCED 1 not completed	Illiterates and persons who have never attended school; persons who were attending 1st grade of primary education at time of survey; persons attending adult literacy courses at time of survey; khalwa (first level of traditional Koranic schools)
Incomplete primary	Incomplete ISCED 1	persons attending last grade of ISCED 1 at time of survey; persons who indicated an unknown number of grades/years at ISCED 1 level; traditional Koranic schools above khalwa level
Primary	Completed ISCED 1 Incomplete ISCED 2	completed last grade of ISCED 1 level or grades below the last grade of ISCED 2 level; persons attending last grade of ISCED 2 at time of survey; persons who indicated an unknown number of grades at ISCED 2 level
Lower secondary	Completed ISCED 2 Incomplete ISCED 3	completed last grade of ISCED 2 level or grades below the last grade of ISCED 3 level; persons attending last grade of ISCED 3 at time of survey; persons who indicated an unknown number of grades at ISCED 3

Categories	ISCED 1997 level	Allocation rules
		level
Upper secondary	Completed ISCED 3 Incomplete ISCED 4 or 5B	completed last grade of ISCED 3 level; completed number grades or years below the standard duration at ISCED 4 or ISCED 5B level; persons who indicated an unknown number of grades at ISCED 4 or 5 level
Post-secondary	ISCED 4 & 5B {first diploma, shorter post-secondary courses} ISCED 5A & 6 {longer post-secondary courses, post-graduate level}	Persons who have completed number of years or grades corresponding to standard duration of ISCED 4 or ISCED 5B programmes; persons holding degrees corresponding to ISCED 4, ISCED 5B, ISCED 5A and ISCED 6 levels

Note: The post-secondary level encompasses non-tertiary and tertiary. The category is broad because some data sources (e.g. DHS) lacked the level of detail necessary to differentiate between tertiary and non-tertiary higher education.

2.2 From education shares to the 2010 base year population

For the vast majority of our 171 countries, the data on the initial education composition of the population stems from the 12-year period between 1998 and 2010. The few exceptions where data stems from the 1995-1997 period are the Central African Republic, Comoros, Guinea, Iraq, and Turkmenistan. For each country with available data from a year not ending with 0 or 5, a simple rounding procedure was applied such that information from years ending in 1 or 2 were assigned to a year ending in 0 and from years 3 and 4 to a year ending in 5. As the projection base-year for all countries is 2010, for those countries where initial population distributions by age, sex, and education were available only from years other than 2010, those first had to be projected to 2010 by applying the UN's estimates of fertility, mortality, and migration (for details see the methodology section down below).

2.3 Summary of projection assumptions

The assumptions about future trends in fertility, mortality and migration that underlie our projections are a combination of the application of statistical models, the scientific input of hundreds of source experts (who responded to an online questionnaire and assessed the validity of alternative arguments that impact on these trends), and the intensive discussions at five meta-Expert meetings in which the available knowledge was systematically assessed. The detailed descriptions of this process and the substantive arguments that led to the assumptions, as well as the numerical assumptions that were actually used were presented in the preceding papers of this session.

2.4 Summary of methods used

As for the methodological improvements, most notably, various methods of dealing with the education differentials in fertility, mortality, and migration have been fine-tuned and some additional complexities introduced, like child mortality depending on the education of the mother. Also, the education projections were improved by going beyond global trends and allowing country- and regional trends to influence future attainment.

Using the standard cohort-component method, as a first step the population distribution by sex and five-year age groups is projected to the next five year period starting in 2010 and ending in 2100.

As a second step, the level of educational attainment is added to the base-year population distribution by age and sex. On this basis, the age- and sex-specific proportions implied by GET (Global Education Trends) scenario (as described in preceding presentation by Bilal Barakat) are projected in five-year steps along cohort lines, applying the education-specific fertility and mortality differentials described below. This procedure then results in the medium projections of the populations by age, sex and level of education for all countries.

This procedure of starting with a two-dimensional projection by age and sex alone and then converting it into a three-dimensional projection by level of education is a consequences of the fact that there is no basis (either in terms of past time-series or of specific expert knowledge) for directly defining assumptions for education-specific fertility, mortality and migration trends. Instead these education-specific trends that are implicit in overall projections following the GET scenario are made explicit only in a second stage through the iterative procedures described below, applied in one 5-year step after another. Once the full set of education-specific rates has been derived, they can be freely altered and combined in different ways to form other scenarios that differ in their assumptions from the above described medium case.

In the absence of data on the education composition of global bilateral migration flows, we make the commonly used assumption that the education structure of emigration flows is proportional to the origin country's education structure. However, this assumption is not valid in the case of immigration flows, which are rarely proportional to the education structure of the destination country. Hence, we calculate net numbers of migrants in each projected period based on the results of the age-sex projection and then assume that the education distribution of net-migrants is proportional to a country's education distribution.

2.5 Alternative scenarios

In addition to the medium scenario, we developed several alternatives. For all of these, 2010 remains the base-year for all countries and the distribution of population by age, sex, and educational attainment in that year is taken as given. Yet, for the future of fertility, mortality, migration and education, alternative trajectories are defined according to the narrative behind the respective scenario.

Three of the alternative scenarios presented in result section 3 differ only with respect to the education future, while education-specific fertility, mortality, and migration rates are the same as in the medium scenario. Rather than recalculating the education-specific rates for alternative scenarios, we directly apply those rates derived from the medium scenario and apply the new education scenario at the end of each step. The population composition will change due to the changes in education composition, enabling us to analyze the sensitivity of our model to changes in the education assumption.

In summary, any combination of demographic and education assumptions could be projected with the above mentioned inputs.

2.6 Mean years of education

The indicator of mean years of schooling (MYS) used frequently in the literature has the advantage of expressing the distribution of educational attainment in a single number. It is therefore often used for cross-country comparisons as well as in economic and environmental models as the unique indicator of educational attainment and human capital stock.

The computation of mean years of schooling from a given educational attainment distribution is complex for two main reasons. First, the standard duration of different levels of schooling varies from country to country, and within countries each school level can have different lengths in different studies, for example, studies of general secondary as opposed to vocational secondary. Secondly, the calculation is biased by the presence of pupils/students who do not complete the full course at any level, which can amount to a substantial share in some countries. To contravene these difficulties, the methodology used and detailed in Lutz, Butz, and KC (eds, 2014, forthcoming) computes mean years of schooling as the weighted mean of six educational levels (defined in the previous section). Our procedure takes into account country-specific educational systems as well as changes in these systems over time. Information on duration of schooling of completed ISCED levels is taken from the UIS database. For the cohorts that studied prior to 1970, which is the last year for which UIS provides information, we assume that durations are the same as in the last year of observation. For the projected periods we use durations for 2010.

3. The Rise of Global Human Capital and the End of World Population Growth

3.1 The medium path of future world population and human capital

The results of these projections for all countries by five-year age groups, sex, and six education categories for five-year steps in time over the 21st century constitute such a large volume of data that any written description can at best hope to pick up some interesting highlights. Hence, we focus mostly on the global level, the results by continents.

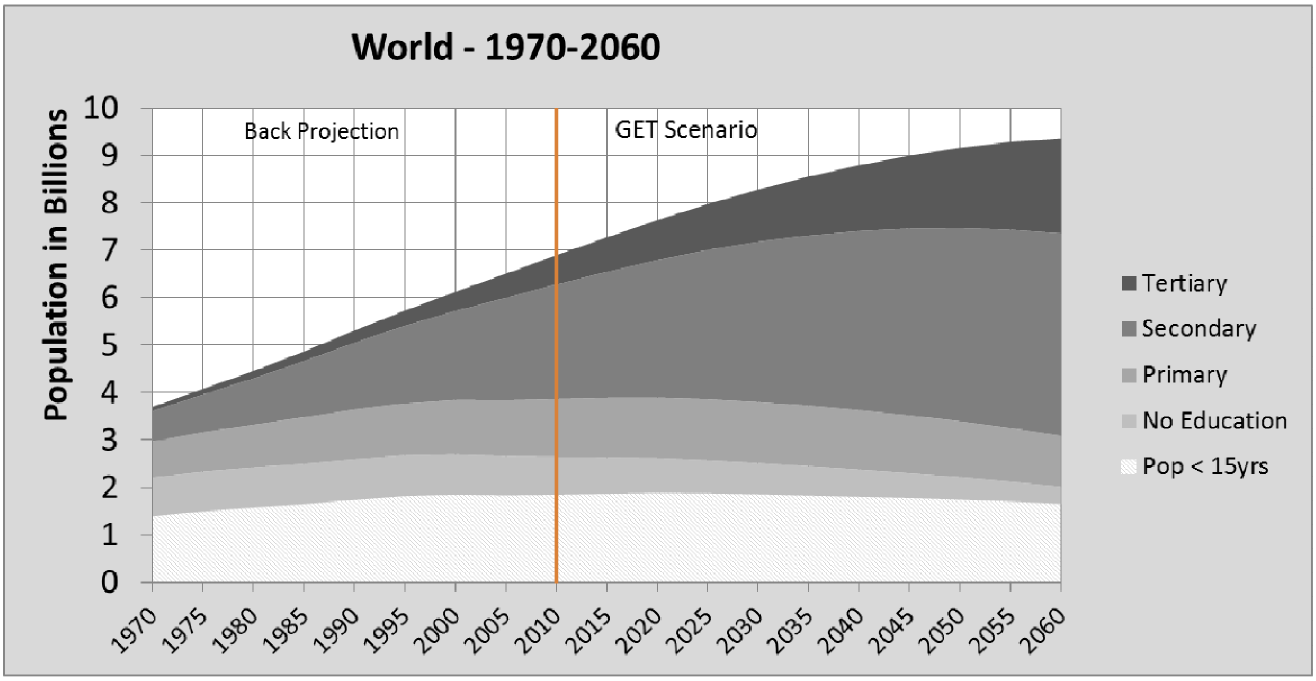

Figure 1: Reconstructed and projected trend of changing world population size by level of education 1970-2060. Most likely scenario (corresponds to SSP2)

Figure 1 illustrates that in 1970 the world population stood at 3.7 billion, of whom around 1.4 billion were children below the age of 15. The remaining 2.3 billion adults were distributed roughly equally among those who never attended school, those with some primary education, and those with at least completed junior secondary school but incomplete post-secondary. Those with tertiary/post-secondary education are hardly visible in the figure in 1970. There were only about 90 million persons with tertiary education in the entire world in 1970, which has increased by a factor of almost 7 to 617 million in 2010 and is likely to further increase to 3.07 billion by the end of the century. Figure 1 summarizes the combined processes of world population growth and increasing average educational attainment. The following two tables will separately address these two issues.

Table 2: Projections of total population size for world and continents to 2100 (under the most likely GET scenario)

	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Population (in million)										
WORLD	6896	7639	8286	8804	9174	9375	9431	9369	9207	8981
AFRICA	1022	1268	1527	1782	2019	2217	2378	2499	2579	2622
ASIA	4164	4557	4855	5049	5135	5111	4999	4826	4611	4380
EUROPE	738	748	753	755	755	750	741	730	717	703
LAC	590	651	702	738	758	762	754	737	712	684
N AMERICA	345	372	400	426	447	470	491	506	516	521
OCEANIA	37	42	48	53	57	61	64	66	67	67

Table 2 shows that according to this medium scenario (GET), which is considered most likely, the world population will increase from 6.90 billion in 2010 to 7.64 billion by 2020, and 8.29 billion by 2030.

This is an increase of 1.4 billion people over the 20-year period starting in 2010. By 2050, world population growth is expected to slow, with only 0.8 billion likely to be added over this second 20-year period. Beyond 2050, the medium scenario shows a further leveling off of world population growth, with the peak around 2070 at a level of 9.4 billion people. Over the rest of the century we expect world population to begin a slow decline, with total world population reaching a level of somewhat below 9.0 billion by 2100.

This picture of a likely end of world population growth before the end of the century reconfirms earlier population projections by Lutz, Sanderson and Scherbov (2008b, 2004, 2001), who studied the end of world population growth in a probabilistic context. These studies indicate that there is a more than 80 percent chance the world population will peak and start to decline before the end of the century. A more detailed comparison of our new scenarios by level of education to these and other recent global population projections (by age and sex) are given below.

The breakdown of population trends by continents, which is given in the lower parts of Table 2, clearly indicates that most of the expected population growth over the coming decades will occur in Africa and Asia. The population of Africa is expected to double from 1.02 billion in 2010 to 2.02 billion in 2050. The population of Asia is expected to increase by 1.0 billion, from 4.16 billion in 2010 to 5.14 billion in 2050. Although the expected absolute increase of 1.0 billion is practically identical for both continents, the relative increase in Asia is only 24 percent as compared to 100 percent in Africa. Moreover, as the more detailed national analysis provided below will show, most of this Asian increase is expected in Southern and Western Asia, with Eastern Asia already experiencing population decline by the middle of the century. Accordingly, for the second half of the century Africa is expected to continue its growth, albeit at a slowing rate, reaching 2.6 billion in 2100. Asia is expected to decline from a peak of 5.14 billion to about 4.4 billion. As for the other continents, North America and Oceania are expected to experience fairly slow population increases over the entire century due primarily to continued migration gains. Europe is expected to peak in 2040-50 and Latin America in 2050-60, at about the same level of 750-760 million, and then enter a slow decline for the rest of the century. In Europe the picture is rather heterogeneous and much of the expected population increase will be due to migration, as is discussed below.

Table 3: Changes in educational attainment of the future population of the world and the continents by age and sex for the period 2010 to 2060 und the mostly likely (GET) scenario

		Proportion 25+				Proportion	Mean Years of Schooling		
Region	*Year*	*No Edu*	*Prim*	*Sec*	*Ter*	*ALS 20-39*	*25+*	*25-29*	*60-64*
Males									
WORLD	2010	13%	25%	47%	15%	70%	9,8	10,8	9,0
WORLD	2030	8%	19%	53%	19%	77%	11,0	12,0	10,2
WORLD	2060	4%	13%	54%	28%	87%	12,7	13,8	12,1
AFRICA	2010	31%	31%	30%	8%	47%	7,0	8,4	4,7
AFRICA	2030	19%	29%	41%	11%	58%	9,1	10,0	7,5
AFRICA	2060	8%	24%	50%	18%	74%	11,5	12,3	10,3
ASIA	2010	14%	27%	46%	12%	71%	9,0	10,5	7,7
ASIA	2030	9%	20%	53%	18%	79%	10,5	11,9	9,5
ASIA	2060	4%	13%	55%	28%	90%	12,4	14,0	11,8
EUROPE	2010	1%	11%	66%	22%	96%	13,2	14,0	12,8
EUROPE	2030	0%	6%	67%	27%	98%	14,1	14,8	13,6
EUROPE	2060	0%	2%	58%	40%	99%	15,1	15,5	15,1
LAC	2010	8%	39%	39%	13%	65%	9,3	10,9	7,6
LAC	2030	4%	28%	49%	18%	80%	11,1	12,7	9,8
LAC	2060	1%	16%	55%	29%	93%	13,1	14,7	12,6
N AMERICA	2010	1%	5%	56%	38%	96%	14,9	15,0	15,1
N AMERICA	2030	0%	3%	54%	43%	98%	15,2	15,4	15,1
N AMERICA	2060	0%	1%	46%	53%	99%	15,7	15,9	15,6
OCEANIA	2010	2%	14%	55%	29%	88%	13,8	15,2	13,1
OCEANIA	2030	1%	9%	55%	35%	90%	14,8	15,7	13,9
OCEANIA	2060	0%	6%	48%	46%	95%	15,7	16,0	15,7
Females									
WORLD	2010	22%	25%	39%	13%	65%	8,5	10,2	7,3
WORLD	2030	14%	21%	46%	19%	75%	10,3	11,9	8,9
WORLD	2060	6%	14%	51%	28%	87%	12,4	13,7	11,9
AFRICA	2010	48%	26%	21%	5%	37%	4,9	6,9	2,1
AFRICA	2030	28%	28%	34%	9%	54%	7,7	9,5	5,0
AFRICA	2060	11%	24%	48%	17%	74%	11,1	12,3	9,7
ASIA	2010	27%	28%	35%	9%	63%	7,3	9,7	5,4
ASIA	2030	16%	23%	46%	15%	76%	9,4	11,8	7,8
ASIA	2060	7%	14%	53%	27%	90%	12,0	14,0	11,4
EUROPE	2010	1%	14%	63%	22%	97%	12,7	14,5	12,1
EUROPE	2030	1%	7%	62%	30%	98%	14,0	15,2	13,7
EUROPE	2060	0%	2%	55%	43%	99%	15,1	15,5	15,3
LAC	2010	10%	38%	38%	15%	69%	9,2	11,4	7,0
LAC	2030	5%	27%	47%	21%	83%	11,2	13,2	9,9

Region	*Year*	*No Edu*	**Proportion 25+** *Prim*	*Sec*	*Ter*	**Proportion** *ALS 20-39*	**Mean Years of Schooling** *25+*	*25-29*	*60-64*
LAC	2060	1%	15%	52%	31%	93%	13,2	14,7	13,0
N AMERICA	2010	1%	5%	57%	38%	97%	14,9	15,3	14,9
N AMERICA	2030	0%	2%	50%	47%	99%	15,4	15,6	15,3
N AMERICA	2060	0%	1%	42%	57%	99%	15,7	15,9	15,7
OCEANIA	2010	3%	18%	48%	31%	89%	13,4	15,4	12,3
OCEANIA	2030	2%	11%	48%	40%	91%	14,7	15,8	13,9
OCEANIA	2060	1%	6%	44%	50%	95%	15,7	16,0	15,9

As depicted in Figure 1, the world population, in addition to growing by more than two billion, is also expected to experience a marked increase in average human capital over the coming half century. This increase is clearly more pronounced for women than for men. Because of these important gender differences Table 3 provides the educational attainment information separately for men and women. Here as in the rest of this volume, the detailed projections for age, sex, and education are only tabulated for the 50-year period up to 2060 because they are more sensitive to specific assumptions and therefore more uncertain in the very long run than projections of the aggregate population.[2]

Table 3 shows that in 2010 about 13 percent of adult men (above the age of 25) were without any formal education, while among women the proportion was about 22 percent. This situation is expected to improve significantly over the next five decades so that under the Global Education Trend (GET) scenario in 2060, only six percent (one out of 17) of adult women will have never been to school. This major improvement is due both to the improving school enrolment rates assumed under this scenario, and to the fact that in virtually every country in the world young women today are already better educated than older ones. The better educated women will, over the years, move up the age pyramid and replace the less educated cohorts.

[2] Although the specific results are not given here, the scenarios had to be extended by level of education up to the end of the century in order to produce consistent time series of results at the aggregate population level.

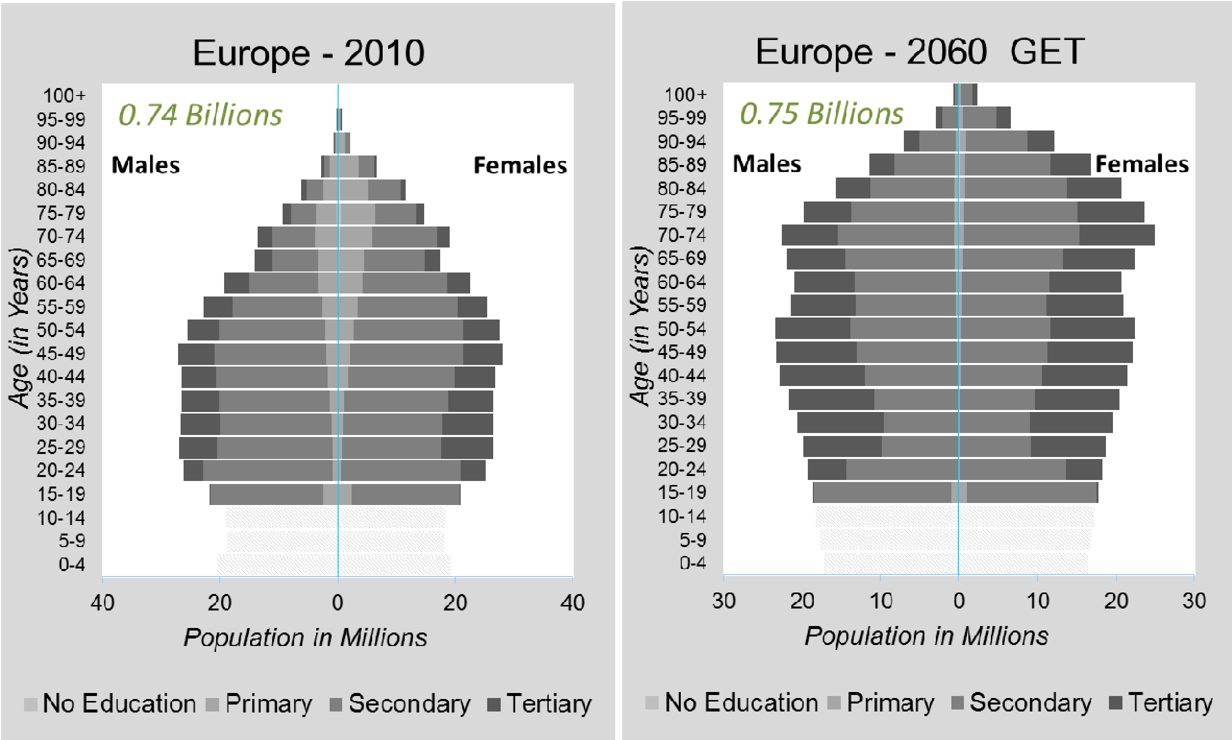

Figure 4: Age and education pyramids for the entire European continent in 2010 and projected to 2060 under the most likely GET scenario

The pyramid for Europe (extending from Portugal to Russia) shows that Europe is the oldest continent today in terms of age structure. Due to the decline of fertility to very low levels in recent decades, the base of the pyramid has become much smaller than the middle section. The pyramid also shows that there are many more elderly women than men in Europe, which results from gender differences in life expectancy, and to a minor extent from World War II for the oldest cohorts. As is the case on every other continent, younger cohorts in Europe are on average better educated than older ones. Among those below age 35, women are better educated than men. This is an interesting reversal of traditional gender differences in education. Table 3 shows that mean years of schooling among women aged 60-64 in Europe (10.3 years) is lower than that of men (10.9 years). For women aged 30-34 schooling is higher (12.2 years) than for men of the same age group (11.8 years). Over the coming half century the average educational attainment among Europeans is expected to continue to increase under this likely GET scenario to more than 14 average years of schooling, while total population size will stay about the same or increase slightly from 738 million to 750 million. At the same time, the proportion of elderly will be increasing significantly. It is important to note that the elderly of the future will be much better educated than the elderly today, which may have important positive implications for their health, cognitive functioning, and ability to continue contributing to society.

It is worth noting that in all tables in this chapter that list mean years of schooling (MYS) for different age groups there is an interesting pattern appearing in the case of several low fertility countries and continents. By the middle of the century MYS 25+ (i.e. the mean years of schooling for the entire population above the age of 25) can turn out to be lower than those for the elderly age group 60-64. This may seem strange particularly under the assumption of rapid education expansion among the younger cohorts. The reason, however, lies in the fact that in those countries the proportion of elderly above the age of 65 is already very significant and their on average much lower level of education depresses the MYS 25+. This fact also cautions against the uncritical use of this indicator (MYS25+) which among economists is by far the most often used human capital indicator. The patterns derived from age-specific education indicators can hence be quite different than that derived from MYS25+ which also includes the very old cohorts who tend to have much lower education and typically do not any more contribute to economic productivity.

4. Remeasuring 21st century population ageing

4.1 Introduction

We easily recognize the three ages of man. Humans are born dependent on the care of others. As they grow, their capacities and productivities generally increase, but eventually these reach a peak. After a while, capacities and productivities decline and eventually, if they are lucky enough to survive, people become elderly, often again requiring transfers and care from others. The human life cycle is the basis of all studies of population ageing and the key to understanding population ageing in the 21st century is to recognize that not all people age at the same rate and populations cannot be categorized into the stages of infancy, adulthood, and old-age.

4.2 A new way of thinking about ageing is needed

As individuals we care about ageing for personal reasons. For those we care about and for ourselves, we need to ensure that the gap between an acceptable standard of consumption in old-age and labor income is covered. It is incorrect, however, to think that the defining feature of old-age is a positive difference between consumption and labor income. Sometimes, a vague argument is made that the elderly are more dependent on others than younger people. There is never a precise moment at which some index of an individual’s characteristics passes a particular threshold and the person enters the state of being old.

Also on a social level, we are concerned about how populations cope with the problems of growing older. At the societal level, the effects of an ageing population depend not only on the changing capacities and productivities of people, but on the interactions of these with the social and political structures. Public provision of health care is another reason to care about ageing.

Given the complexity of defining and measuring population ageing, researchers and policymakers have fallen back on an expedient and simplistic approach. They have formalized the human life cycle in three phases. Young extends to age 14 (or sometimes 20), adulthood usually to age 64, and old-age begins after that.

These threshold-ages are then treated as constants that do not change over time. Thus, traditional measures of ageing assume people became “old” at age 65 in 1900 and will become “old” at age 65 in 2100. This time invariance is assumed although there have been substantial changes in the life expectancy of 65 year olds, their health, their education, and a host of other characteristics. While this approach is computationally simple, it is certainly inadequate for a full, even useful understanding of population ageing. Population ageing has two main sources, reductions in fertility, and increases in life expectancy, both of which are frequently associated with increases in average levels of education. In a situation where education is an important cause of ageing, assuming that the characteristics of older people do not change is inconsistent and implies inappropriate policy guidance.

4.3 A new approach to quantifying population ageing

The first step in the new approach to quantifying population ageing we define people who have the same remaining life expectancy as having the same age. We use the term “prospective” to denote measures of age and ageing that use remaining life expectancy as the defining characteristic, because they are forward-looking measures (Sanderson and Scherbov, 2010, 2005).

In this section, for simplicity, we compare conventional measures of ageing only with their prospective counterparts. In previous research, we have found, more broadly, that remaining life expectancy is a useful summary measure of people’s productivities and capacities (Sanderson and Scherbov, forthcoming). Remaining life expectancy at specific ages changes at the societal level because of two factors: a generalized country-specific path of improvement and the mix of people by educational attainment. When we come to look at different education scenarios, we hold the generalized country-specific path of life expectancy constant and allow age-specific remaining life expectancies to vary because of variations in the education composition of the population at each age. Within an education scenario, overall life expectancy of a society at different ages reflects the past history of educational attainments, because these are influenced by the education distribution of the population at each age.

Figure 4.1 shows the difference between chronological and prospective ages for French women in 1952 and 2005. Panels A and B show bars whose lengths represent people’s lifetimes. Each bar is divided into two segments. The segment on the left shows the number of years a person has already lived and the one on the right, the expected number of years left to live. Panel A shows the conventional view of age. The left parts of the bars indicate that the women were both 30 years old, so those parts are of equal length. Remaining life expectancies, however, are different and therefore the right parts of the bars have different lengths. The 30 year old woman in 1952 had a remaining life expectancy of 44.7 years, while her counterpart in 2005 had a remaining life expectancy of 54.4 years.

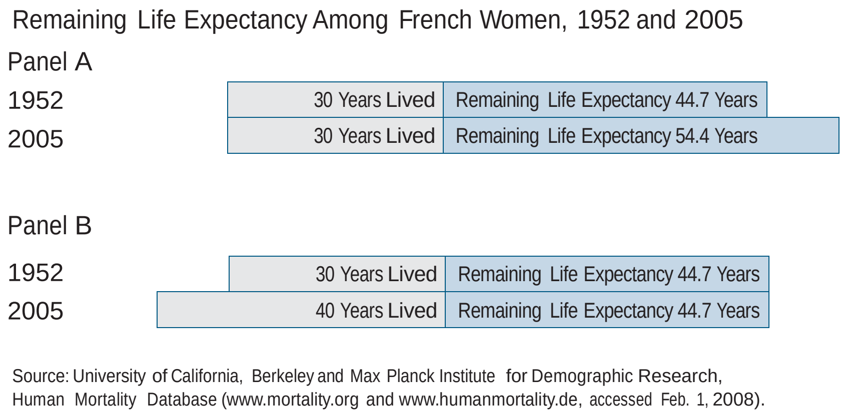

Figure 4.1 Remaining Life Expectancy Among French Women, 1952 and 2005

The new approach to establishing age equivalence emphasizes the length of the right-hand portions of the bar. This is done in Panel B. Here the remaining life expectancy in 1952 and 2005 is 44.7 years.

However, when the right-hand portions of the bars are of the same length, the left-hand sides are generally of different length. In this example, a 30 year old woman in 1952 and a 40 year old woman in 2005 have the same remaining life expectancy, and therefore have the same characteristic-based age. In this example, 40 is the new 30 for French women in 2005 when compared with women in 1952, or to put the matter more technically, the prospective age of 40-year old French women in 2005 is 30 when 1952 is the base year.

Our first application of the new meaning of age is to compare prospective median ages with their conventional counterparts by world region and for selected countries, using our central projections. Prospective median age is just the prospective age of median-aged people. Table 4.1 shows conventional and prospective median ages for the world's population at decadal intervals from 2010 to 2090 (for technical reasons, prospective median ages for 2100 cannot be computed). Median ages are computed for three education scenarios, the general education trend scenario (GET), the constant enrollment rate scenario (CER), and the fast track scenario (FT). These are described in preceding paper by Barakat (2013). All the tables in this chapter use our medium fertility, mortality, and migration assumptions.

Table 4.1: World Conventional and Prospective Median Ages by Education Scenario

	GET		CER		FT	
Panel A: Levels						
Year	MA	PMA	MA	PMA	MA	PMA
2010	28.4	28.4	28.4	28.4	28.4	28.4
2020	31.2	29.4	31.0	29.3	31.3	29.5
2030	33.9	30.5	33.4	30.2	34.4	31.0
2040	36.2	31.4	35.3	30.7	37.3	32.2
2050	38.5	32.3	37.1	31.2	40.2	33.6
2060	40.7	33.3	38.7	31.9	42.9	35.0
2070	42.7	34.0	40.1	32.3	45.2	36.0
2080	44.5	34.5	41.4	32.4	47.3	36.8
2090	46.4	34.9	42.7	32.5	49.2	37.4
Panel B: Decadal Changes						
Start Year						
2010	2.8	1.0	2.6	0.9	3.0	1.1
2020	2.7	1.1	2.4	0.9	3.1	1.5
2030	2.3	0.8	1.9	0.5	2.8	1.2
2040	2.3	0.9	1.7	0.5	2.9	1.4
2050	2.2	1.0	1.7	0.7	2.7	1.3
2060	2.0	0.7	1.4	0.4	2.4	1.0
2070	1.8	0.5	1.3	0.2	2.1	0.8
2080	1.8	0.4	1.3	0.1	1.9	0.6

The median age of the world's population in 2010 was 28.4 years. In the GET scenario, it would increase to 46.4 years in 2090, about the same as the median age of Germany at this writing. The prospective median age, in contrast, rises only to 34.9 in that scenario, close to the current median (and prospective median) age of China. Over the eight decades the median age of the world's population increases by 18.0 years, while the perspective median age rises by only 6.5 years. This substantial difference in the extent of measured ageing arises from the fact that the prospective median age takes increases in life expectancy into account, while the conventional approach does not.

The time patterns of changes in median and prospective median ages are also different. Decadal changes in the median age tend to decline over time. The speed of change in the prospective median age does not change much over the next few decades. Only beginning in 2060 do we see a significant reduction in the speed of ageing there.

The different education scenarios have two kinds of effects on the median ages. First, because education affects fertility and mortality, as discussed in proceeding paper (by Fuchs et al.), it changes the age distribution of the population, causing the median age to change. Second, eventually the different education scenarios change the education composition of people at the median age and therefore their remaining life expectancy. In the CER scenario, where fertility is higher and life expectancy lower than in the GET scenario, ageing is slower. Indeed, toward the end of this century, the prospective median age barely changes. Ageing is faster in the FT scenario, with its lower fertility and higher life expectancy. In that scenario, the increase in the conventional median age from 2010 to 2090 is 20.8 years and the increase in the prospective median age is 9.0 years. In 2090, the differences between the CER and FT scenarios result in a difference of 6.5 years in the world's median age and a difference in 4.9 years in its prospective median age.

The evolution of population ageing will be quite different on different continents. Tables 4.2 and 4.3 show the situations for Africa and Europe. In the GET scenario, the median age of Africans increases from 19.6 years in 2010 to 37.9 years in 2090. The prospective median age increases much more slowly, only to 25.7 in 2090. So adjusting for life expectancy improvements reduces the median age in 2090 by 12.2 years. Without adjustment for life expectancy change, the African median age increases over time, then stabilizes at a decadal gain of 2.7 years after 2060. The pattern of change in the prospective median age is somewhat different. It decreases between 2010 and 2020, then after 2030 changes at a roughly constant pace to 2090. Hence, the education scenario chosen has a substantial effect on the speed of ageing. The decadal changes in the prospective median age are almost twice as fast in the FT scenario as in the CER scenario.

Table 4.2: Africa Conventional and Prospective Median Ages by Education Scenario

	GET		CER		FT	
Panel A: Levels						
Year	MA	PMA	MA	PMA	MA	PMA
2010	19.6	19.6	19.6	19.6	19.6	19.6
2020	20.8	19.1	20.7	19.0	21.1	19.1
2030	22.7	19.6	22.1	19.3	23.5	19.9
2040	24.9	20.6	23.8	20.0	26.3	21.3
2050	27.2	21.6	25.8	20.8	29.2	22.7
2060	29.8	22.6	27.9	21.5	32.2	23.9
2070	32.5	23.7	30.1	22.3	35.2	25.3
2080	35.2	24.7	32.3	23.0	38.1	26.6
2090	37.9	25.7	34.6	23.5	40.8	27.8

Panel B: Decadal Changes						
Start Year						
2010	1.3	-0.5	1.1	-0.5	1.5	-0.4
2020	1.8	0.5	1.4	0.2	2.4	0.8
2030	2.2	1.0	1.7	0.7	2.8	1.4
2040	2.4	1.0	2.0	0.8	2.9	1.4
2050	2.6	1.0	2.1	0.7	3.0	1.2
2060	2.7	1.1	2.2	0.8	3.0	1.4
2070	2.7	1.0	2.3	0.7	2.9	1.3
2080	2.7	1.0	2.2	0.5	2.7	1.1

Table 4.3: Europe Conventional and Prospective Median Ages by Education Scenario

	GET		CER		FT	
Panel A: Levels						
Year	MA	PMA	MA	PMA	MA	PMA
2010	40.2	40.2	40.2	40.2	40.2	40.2
2020	42.5	40.2	42.5	40.1	42.5	40.2
2030	45.1	40.7	45.0	40.7	45.3	40.9
2040	47.4	41.1	47.1	40.9	47.8	41.5
2050	47.8	39.4	47.2	39.0	48.4	40.1
2060	48.6	38.2	47.8	37.6	49.5	39.1
2070	49.6	37.1	48.5	36.3	50.8	38.2
2080	50.5	35.8	49.1	34.8	51.8	37.1
2090	51.7	34.9	50.1	33.7	53.1	36.2
Panel B: Decadal Changes						
Start Year						
2010	2.3	0.0	2.3	-0.1	2.4	0.0
2020	2.7	0.6	2.6	0.6	2.8	0.7
2030	2.3	0.3	2.1	0.2	2.5	0.5
2040	0.4	-1.7	0.1	-1.9	0.7	-1.4
2050	0.8	-1.2	0.6	-1.4	1.1	-1.0
2060	1.0	-1.1	0.7	-1.3	1.3	-0.8
2070	0.9	-1.3	0.6	-1.5	1.0	-1.2
2080	1.2	-0.9	1.0	-1.1	1.3	-0.9

Europe’s population is much older than Africa’s. Even in 2090, Africa’s population will not be as old as Europe’s is in 2010. The median age of Europe’s population in 2010 was 40.2. Under the GET scenario, it is forecast to increase to 51.7 in 2090. But the prospective median age in Europe shows a dramatically different evolution. The prospective median age rises from 40.2 in 2010 to 41.1 in 2040 and then decreases. The prospective median age of Europeans in 2090 is only 34.9, 5.3 years lower than it was in 2010. Once we incorporate the effects of life expectancy change into our measurement of age, we see that Europe will be ageing slowly between 2010 and 2040 and then will become effectively younger.

The difference between thinking of ageing on a personal level and on a population or societal level can be envisioned as the difference between moving along a fixed piece of string and moving along a rubber band that is being stretched. An individual life can be viewed as movement along a fixed piece of string. The farther one is from birth the closer one is to death. In the case of populations with increasing life expectancies, though, ageing is like moving along a stretching rubber band. It is possible, as the rubber band stretches, for the median-aged person both to be farther from birth and simultaneously farther from death. If we think chronological age is a good proxy for our productivities and capacities then, after a certain age, moving farther from birth means that our productivities and capacities have, on average, declined. On the other hand, if we think that our remaining life expectancy is a good proxy for our productivities and capacities, then, after a certain age, being farther from our death implies that our productivities and capacities have, on average, increased. A falling prospective median age in Europe means that median-aged Europeans will, after 2040, have more and more years ahead of them. As people and societies adjust to these longer remaining lifetimes, we may well see consistent changes in behavior and policy.

As we would expect, the difference between prospective median ages in the CER and FT scenarios is smaller in Europe than in Africa. In 2090, the difference in prospective medians in Africa is 4.3 years, while in Europe it is 2.5 years. Education attainment levels are already high in Europe and there is less difference there between the two scenarios than there is for Africa. Nevertheless, the difference of 2.5 years shows that even in Europe faster education improvements can still matter.

In Table 4.4, we limit our attention to the GET education scenario and focus on ageing as measured by forecasted conventional and prospective median ages in African, Asia, Europe, Latin America and the Caribbean (LAC), and North America. One interesting feature of the table is the pattern of ageing in North America. The median age there in 2010 was 37.2, after which it rises in every decade reaching a peak of 48.5 in 2090. In contrast, the prospective median age in North America falls in every decade, except between 2020 and 2030 when it remains roughly constant. While median-aged people in North America are growing older over time in the conventional sense, they are also having longer average lifetimes ahead of them. As the century progresses, median-aged North Americans will have experienced more birthdays and simultaneously have more future birthdays left to enjoy.

Table 4.4: Median and Prospective Median Ages by Continents

	AFRICA		ASIA		EUROPE		LAC		NORTH AMERICA	
	MA	PMA	MA	PMA	MA	PMA	MA	PMA	MA	PMA
2010	19.6	19.6	28.5	28.5	40.2	40.2	27.4	27.4	37.2	37.2
2020	20.8	19.1	32.0	30.2	42.5	40.2	30.9	28.8	38.4	36.9
2030	22.7	19.6	35.6	32.1	45.1	40.7	34.4	30.3	40.1	37.0
2040	24.9	20.6	38.8	33.6	47.4	41.1	38.0	32.1	41.5	36.7
2050	27.2	21.6	41.6	34.9	47.8	39.4	41.3	33.8	42.6	35.8
2060	29.8	22.6	44.2	36.3	48.6	38.2	44.4	35.2	43.5	34.5
2070	32.5	23.7	46.5	37.2	49.6	37.1	47.2	36.2	44.9	33.8
2080	35.2	24.7	48.3	37.6	50.5	35.8	49.6	37.0	46.7	33.5
2090	37.9	25.7	49.9	37.8	51.7	34.9	51.8	37.4	48.5	33.1

In Table 4.4, the oldest population group in 2010 was the Europeans with a prospective median age of 40.2. By 2090, they will no longer be the oldest under this scenario. Their prospective median age will have declined to 34.9. Europeans will effectively be younger in 2090 than they are today. In Asia and in the Latin America and Caribbean region, on the other hand, populations age relatively rapidly. In Asia, the prospective median age rises from 28.5 in 2010 to 37.8 in 2090. The increase in the Latin America and Caribbean region is similar, from 27.4 years in 2010 to 37.4 in 2090. Europe is currently a relatively old region that over time will become effectively younger. Asia, Latin America, and the Caribbean region are all relatively young regions today that will become effectively older.

If we exclude Africa, the gap in prospective median ages across the remaining four regions in 2010 is 12.8 years (27.4 in LAC and 40.2 in Europe). In 2090, the gap is much smaller, only 4.7 years (33.1 in North America and 37.8 in Africa.) For a number of reasons this convergence is likely exaggerated compared to what may actually transpire. For one thing, we have considered in Table 4.4 only a single education scenario. It is likely that there will be more education variation than assumed here. Also, our calculations used only the central fertility and mortality assumptions. Inevitably, variability in our fertility, mortality, and education assumptions would result in less convergence. Nevertheless, as more and more countries complete their demographic and education transitions, we think that prospective median ages across continents will slowly become more similar.

Table 4.5 shows conventional and prospective median ages for 2010, 2050, and 2090 for 11 selected countries. For simplicity, we present figures based on only a single scenario that uses our medium assumptions with respect to fertility, mortality, migration, and education. When we look at the conventional median age measures, we obtain the traditional view of population ageing. Median ages rise in each interval for all of the 11 countries. However, when we take life expectancy increases into account, the picture changes substantially.

Table 4.5: Conventional and Prospective Median Ages: Selected Countries

Countries		MA			PMA	
	2010	2050	2090	2010	2050	2090
Africa						
Egypt	24.4	36.1	47.3	24.4	30.0	34.1
Kenya	18.5	27.4	38.6	18.5	22.1	25.5
Nigeria	18.4	23.1	34.1	18.4	17.6	21.2
South Africa	24.9	33.2	41.9	24.9	24.7	23.4
Asia						
China	34.6	51.6	58.4	34.6	45.0	44.9
India	25.1	38.0	48.2	25.1	29.4	35.4
Indonesia	27.7	42.3	51.7	27.7	34.1	37.4
R of Korea	37.9	55.4	60.5	37.9	48.4	46.1
Europe						
Germany	44.3	52.2	55.3	44.3	44.2	39.2
Russian Fed.	37.8	44.6	48.7	37.8	36.4	31.6
North America						
USA	36.9	42.3	48.2	36.9	35.6	32.9

The traditional view occurs in only four of our eleven countries: Egypt, Kenya, India, and Indonesia. In the other 7 countries, the prospective median age falls in at least one of the intervals. The prospective median age falls in both intervals, 2010 to 2050 and 2050 to 2090, in South Africa, Germany, the Russian Federation, and the US. South Africa is a particularly interesting example of this pattern. Its median age rises from 24.9 in 2010 to 41.9 in 2090. When we do not take increasing life expectancy into account, it appears that South Africa should plan for substantial ageing. However, when we do take increasing life expectancy into account, the median age of South Africans in 2090 is not expected to be very different from what it is today. More generally, Table 4.5 shows that when we measure ageing while ignoring the effects of the life expectancy changes that are built into our forecasts, we get a picture of uniformity that is unjustified. Taking those life expectancy changes into account yields a far more nuanced picture, with some countries having increasing prospective median ages, some having decreasing ones, and some where the prospective median age goes up in one period and down in another.

5. Conclusions

In this paper, we have described the base-line data and summarized the methodology that underlies the projections presented for 171 countries of the world by age, sex, and educational attainment. We have tried to highlight some of the difficulties related to the large amount of empirical information that is necessary to compute these projections, ranging from disaggregated base-year distributions to data on educational differentials of fertility and mortality. Also, we summarized the procedures by which the assumed trajectories for future fertility, mortality and migration were derived combining structured expert judgments with statistical models and how they were then translated into education-specific trajectories used to calculate the implications of alternative education scenarios.

The medium scenario following the global education trend (GET) in education is considered to be most likely from today's perspective. It shows further world population growth to around 9.4 billion around the year 2070 (peak population) followed by a moderate decline to 9.0 billion by the end of the century, together with a significant increase in the average educational attainment of the world population. A comparison to the constant enrolment rates (CER) scenario shows that much of this future improvement is already embedded in today's education structures where almost universally the young are better educated than the older cohorts. This shows that knowing how the population composition by level of education changes along cohort lines is important for understanding the process of the "demographic metabolism".

Finally, we presented the results of alternative education scenarios using two approaches to measuring ageing; the conventional one based on chronological age and an alternative approach that takes increasing life expectancy into account. The conventional ageing indicators lose some of their meaning when people live longer in good health. In contrast, the new view – reflected in the saying "70 is the new 60" – produces corresponding new indicators of population ageing such as prospective median age and the proportion of the population with less than 15 years of remaining life expectancy. Based on these new indicators, population ageing over the 21st century is less rapid than according to the conventional ones.

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