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Demographic and Human-Capital Trends in Eastern Europe and Sub-Saharan Africa

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About the Transatlantic Council on Migration

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I.   Executive Summary

In the next two decades, the world will face two major — and opposing — demographic challenges: rapid population growth and rapid population aging. In an increasingly economically interdependent world, policymakers will simultaneously face a strain on resources caused by population growth and a shortage of labor spurred by the graying of the population.

This paper, based on new data created by the authors, will help inform decision making by forecasting population trends in Eastern Europe and sub-Saharan Africa, regions that epitomize this demographic phenomenon's two disparate poles.

While sub-Saharan Africa will grow faster than any other part of the world in the next century, resulting in a population explosion that will boost the workforce, Eastern Europe will shrink the most quickly. The silver lining in Europe's graying workforce may be that population decline could be compensated to some degree by increases in human capital. One of population growth's most important ramifications is its inverse correlation with educational attainment. While the Eastern European population is expected to decline steadily, educational attainment among its working-age population will increase at the same time, which is likely to lead to higher per capita productivity.

Education is a key part of the picture in Africa, too. While high population growth will expand the labor force, it will not boost economic growth unless education is expanded commensurately. A scenario of rapid population increases without parallel growth in education would precipitate a serious humanitarian and development crisis in sub-Saharan Africa. Human-capital trends and demographic trends must be taken into account when we speculate on future migration patterns to and from these regions.

II.   Introduction: A Demographically Divided World

While large parts of Europe have already experienced a population peak and will soon enter a period of steady population decline, the population trajectory of many developing countries is still on an upward slope. Why are some populations still growing so fast (what some have called a veritable population explosion), while others already have very low fertility and are facing serious decline? People in these societies are not fundamentally different; they are just at different stages in the universal process of demographic transition. According to this model, societies make a transition from the first stage, where population sizes do not change in the long run, to the second stage — population growth — because of falling death rates at a time when birth rates remain high. The decline in mortality rates is usually attributed to better nutrition and health care, while birth rates remain high because large families are normal.[1] If the difference between birth and death rates is as large as it currently is in many African countries (despite AIDS), then population growth will be very rapid.

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[1] In most European countries and their English-speaking offshoots, the demographic transition began some time in the period from the late 18th century to the early 20th. In the developing world it began only after World War II. Frequently, education, and in particular increasing female education, was an important factor in the transition to smaller families.

Some developing countries today have very high population growth rates because of high birth rates (well above the replacement level of two surviving children per woman) combined with a young age structure. These populations, such as those in Nigeria and Pakistan, are likely to more than double over the coming decades. On the global level, this leads us to expect that the world population will increase from its current 6.6 billion to nearly 9 billion by 2050. Yet in other regions, the opposite demographic trend is dominant: birth rates have fallen well below replacement level while life expectancies continue to increase. As a consequence, populations in countries such as Italy and Spain are aging quickly. In the future, we expect an even faster pace of population aging and, in many cases, a shrinking of total population size. This phenomenon is not limited to Europe. We see it quite clearly in East Asia as well, in places such as Japan, the Republic of Korea, Singapore, and Taiwan. Because of these significantly different demographic patterns, there is concern about the negative consequences of rapid population growth in some parts of the world, while simultaneously there is concern elsewhere about the negative implications of rapid population aging.

This paper will focus on the two most demographically extreme regions: sub-Saharan Africa (most rapid population growth) and Eastern Europe (fastest shrinking population), both of which are of special interest to Western Europe in terms of future migration. Our analysis is based on the results of the authors' recent research, some of which has already been published, and some that is presented here for the first time.

Mortality, Fertility, and Population Growth

We cannot predict what the future demographic landscape will look like with certainty, but we can estimate plausible ranges for future fertility, mortality, and migration. While uncertainty still exists, probabilistic population projections translate these uncertainties into quantitative ranges for future population growth and the future path of population aging. Our latest projections tell us that there is over an 85 percent probability that world population will peak over the course of this century and then start to decline.[2]

Figure 1 gives a very long-term perspective of global demographic trends, showing the empirical growth of world population over the past 1,000 years and the likely range for the rest of the century. As can be seen, the rate of world population growth only started to accelerate around 1800, reaching 1.6 billion by 1900. The 20th century, on the other hand, became known for its population explosion, with the population quadrupling in size to 6.1 billion by 2000.

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[2] These new forecasts are based on initial population age structures provided by the United Nations and probabilistic forecasts of fertility, mortality, and migration based on expert opinion. The methodology uses time-series techniques and the results are checked with an ex-post analysis of United Nations forecasting errors. Published in Wolfgang Lutz, Warren Sanderson, and Sergei Scherbov, "The Coming Acceleration of Global Population Ageing," *Nature* 451 (2008): 716-719.

Figure 1. Estimated World Population Size, 1000 to 2000, and Distribution of Forecasted World Population Sizes, 2001 to 2100
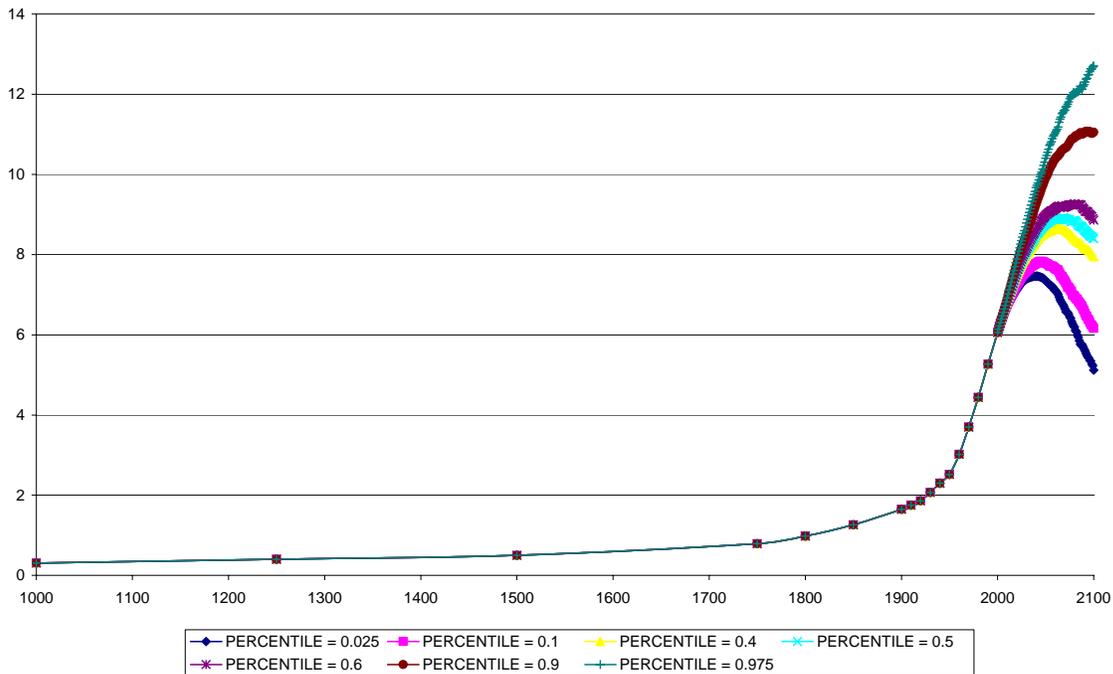
Note: The 95 percent prediction interval lies between the 0.025 and 0.975 percentiles.
Source: Estimates for the years 1000 to 2000 from United Nations 1999). Distribution of future population sizes are from Lutz et al., "The Coming Acceleration of Global Population Ageing," Supplementary Table 1.

The population explosion was predominantly driven by a decline in mortality (in particular infant mortality), which marked the beginning of the developing world's demographic transition and resulted in more population growth than Europe had ever experienced. But by the beginning of this century, a counterbalancing fertility decline in Europe, North America, Australia, and New Zealand had begun on a massive scale. For this reason, the different trajectories shown in Figure 1 mostly show a peak during the second half of the century followed by a decline.

Because of the momentum of population growth, at least another 2 billion people are almost certain to be added to the world population between now and 2050.More and more young women will enter reproductive age due to past high fertility, so even if there are fewer children per woman, the total number of births will increase. This further population growth will be heavily concentrated in the developing world, with the highest growth in Africa.

The theory of demographic transition predicts that as education increases and health conditions and family-planning services improve, countries that have high fertility rates today will eventually see them decline. The faster fertility declines, the lower the population growth and the easier it will be to expand education. This, in turn, will foster economic growth. Many of the countries that have seen rapid fertility declines during the 1960s and 1970s have subsequently experienced significant economic growth — a phenomenon that economists have labeled a "demographic dividend."

While demographers used to assume that fertility would ultimately level off at replacement level,[3] reality turned out differently. In many countries, fertility continued to plunge, falling below replacement level. While there is still no useful theory to predict the future fertility level of posttransition societies, an interesting differential among industrialized countries has recently emerged: countries in Northern Europe and France, where women can more easily combine work and childrearing, have relatively high fertility not far below replacement, whereas countries in Southern Europe and East Asia have much lower birth rates. Faced with traditional family and gender roles *and* a modern economy with good employment opportunities, women in these developed countries have to choose between family and work, and they increasingly choose work. It is not clear whether this is merely a transitory state or a development that will result in very low fertility rates in the longer run. Japan, in its most recent official population projections, forecast a long-term average fertility of only 1.2 children per woman; in Northern Europe, fertility is currently around 1.8 children per woman.

Our probabilistic population forecasts, which are based on an analysis of future mortality, fertility, and migration trends, predict where the world's population will be living in 2050, and how this compares to in 2000 (see Figure 2). The share of the world's population living in sub-Saharan Africa will increase from 10 percent in 2000 to 19 percent by 2050 — the largest increase of any region. The former Soviet Union[4] contained 4 percent of the world's population in 2000, but its share is likely to only be around 2 percent in 2050. Eastern Europe and Western Europe combined, excluding the former Soviet Union, were home to 9 percent of the world's population in 2000 but will only have 6 percent a half-century later. The proportional decrease in Eastern Europe is even larger, with Eastern Europe and the former Soviet Union experiencing comparatively rapid population decreases (both relatively and absolutely). Our population forecasts for selected regions, including Eastern Europe, the European part of the former Soviet Union,[5] and sub-Saharan Africa are presented in Appendix 1.

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[3] Replacement-level fertility is defined as the number of children that an average woman of reproductive age would need to have to replace herself with exactly one daughter of reproductive age in the next generation. Usually this is around 2.1 children per woman.

[4] This region does not include the Central Asian countries that were formerly part of the Soviet Union.

[5] The European part of the former Soviet Union includes Russia, Ukraine, and Belarus as well as Armenia, Azerbaijan, Estonia, Georgia, Latvia, Lithuania, and Moldova.

Figure 2. Shares of the World Population Living in Different Regions, 2000 and 2050
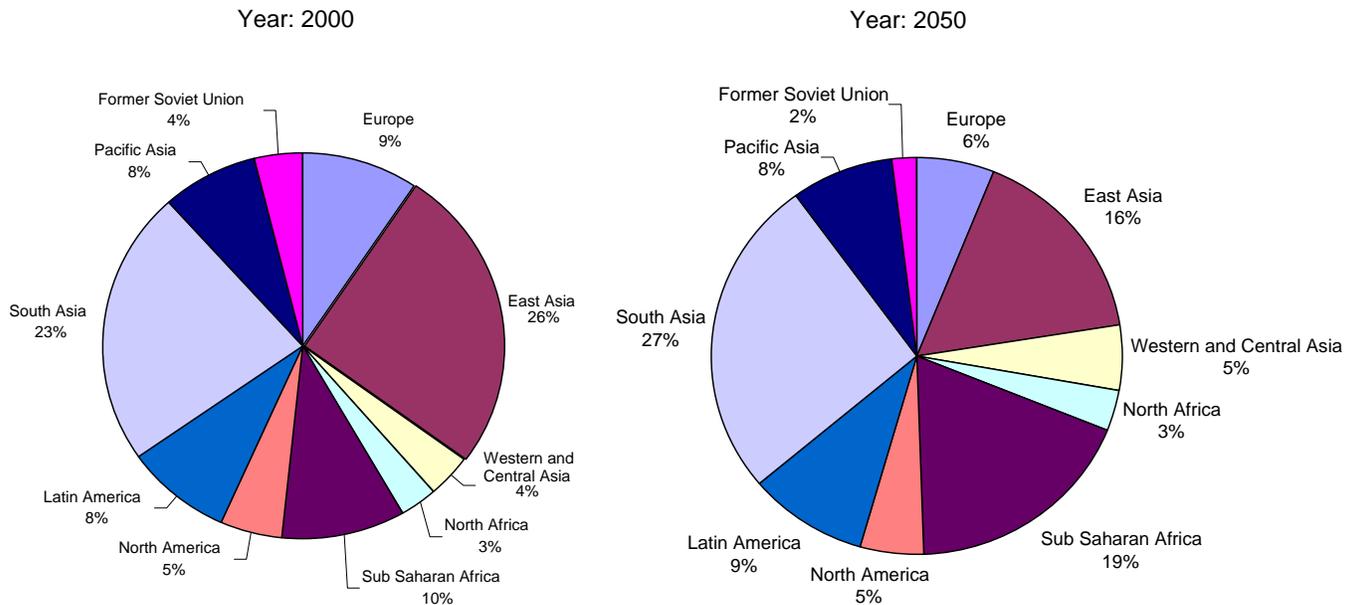
Year: 2000

Year: 2050

Source: Lutz et al., "The Coming Acceleration of Global Population Ageing,", Supplementary Table 1. For the countries in each region, see http://www.iiasa.ac.at/Research/POP/edu01/humancapital.html#0a .

III.   Long-Term Demographic and Human-Capital Trends in Eastern Europe

When we speak of what is commonly referred to as Eastern Europe, we are actually looking at two regions. The first is the European part of the former Soviet Union, which is dominated by the three big countries: Russia, Ukraine, and Belarus. It also includes Armenia, Azerbaijan, Estonia, Georgia, Latvia, Lithuania, and Moldova. The second part, which we refer to here as Eastern Europe, is comprised of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, and Slovenia. The overall decline in population size in both these subregions is a near certainty; the only question is how quickly and by how much the population size will decline.

Our forecast[6] of future population trends in Eastern Europe and the former Soviet Union (see Figures 3 and 4), reveals that the population will shrink steadily throughout the century, although the graph shows the uncertainty range also increasing over time. Figure 3 shows the likely range of population decrease in the European part of the former Soviet Union, whose decline is mainly due to below replacement fertility, out-migration, and relatively low life expectancy.

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[6] There are 13 world regions that form the basis of IIASA projections and analysis, two of which we look at in this section. The demarcation of these regions corresponds to the definition given by the Intergovernmental Panel on Climate Change (IPCC).

Figure 3. Probabilistic Population Forecasts for the Former Soviet Union, 2000 to 2100
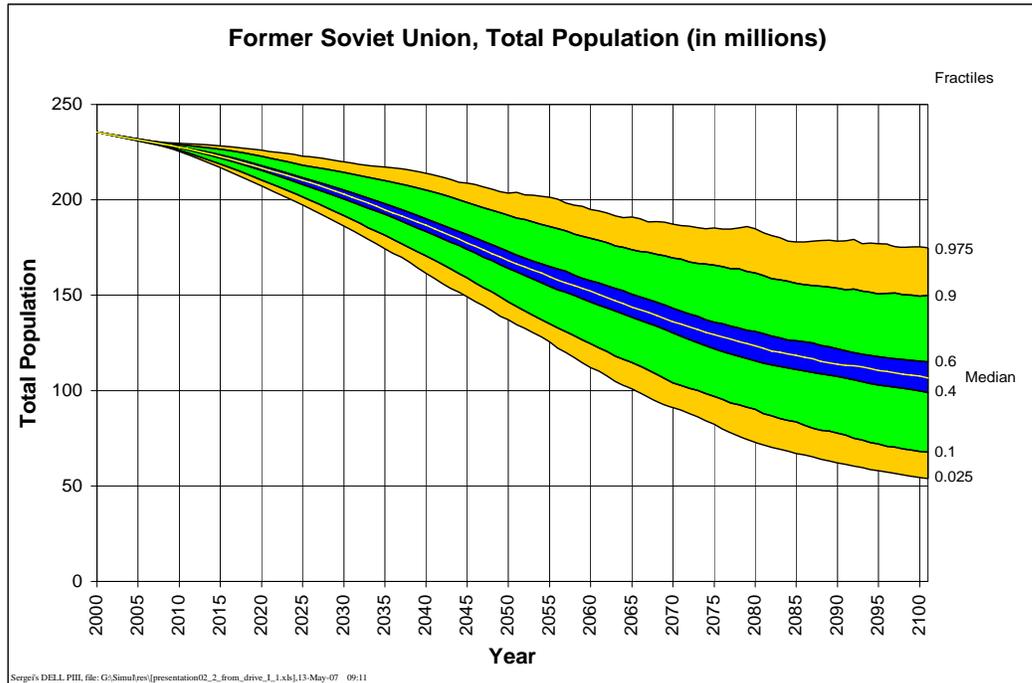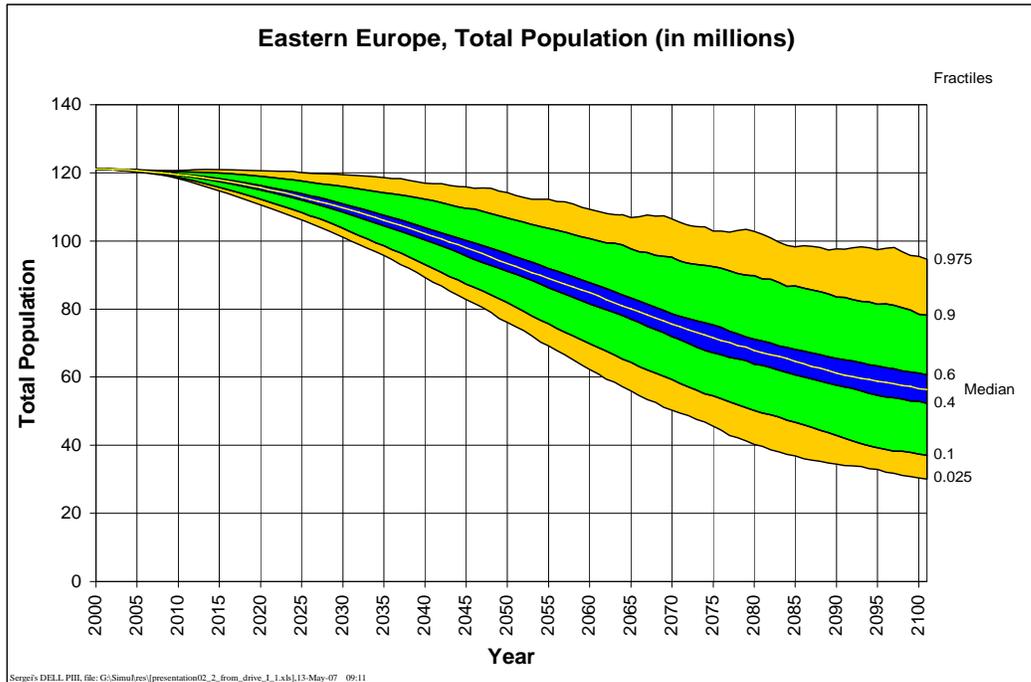

Notes: The inner blue region shows the region between the 40th and 60th percentiles of the forecasted population distribution. The green and blue areas combined show the region between the 10th and the 90th percentiles of the forecasted population distribution. The area between the uppermost and lowermost lines shows the 95 percent prediction interval.
Source: Our computations. See Lutz et al., "The Coming Acceleration of Global Population Ageing."

Figure 4 shows our probabilistic forecast for Eastern Europe. Like the case of the former Soviet Union, the region's population is expected to decline throughout the century. The causes are the same: very low fertility, out-migration, and relatively low life expectancies. The median forecast shows the population size of Eastern Europe shrinking by half over this century. The depicted uncertainty range goes roughly from a 20 percent decline on the upper end to an 80 percent decline on the lower end.

Figure 4. Probabilistic Population Forecasts for Eastern Europe, 2000 to 2100

Notes: The inner blue region shows the region between the 40th and 60th percentiles of the forecasted population distribution. The green and blue areas combined show the region between the 10th and the 90th percentiles of the forecasted population distribution. The area between the uppermost and lowermost lines shows the 95 percent prediction interval.
Source: Our computations. See Lutz et al., "The Coming Acceleration of Global Population Ageing."

Very low fertility is the main reason why populations in Eastern Europe and the former Soviet Union will decline. It seems plausible, therefore, to expect that the proportion of the population that will be below age 20 will continue to decrease as populations fall. While this is certainly the case for the coming decades, it does not hold for the longer-term future (see Appendix 1). The median forecast of the population declines from around 25 percent to around 15 percent in 2040 and then stabilizes (see Figure 5). The reason lays in the fact that fertility is assumed to stabilize at a low level below replacement. These stable fertility rates will result in a stable age structure even though total population and the absolute number of children below age 20 will decline.

Figure 5. **Probabilistic Forecasts of the Proportion of the Population of Eastern Europe Below Age 20, 2000 to 2100**
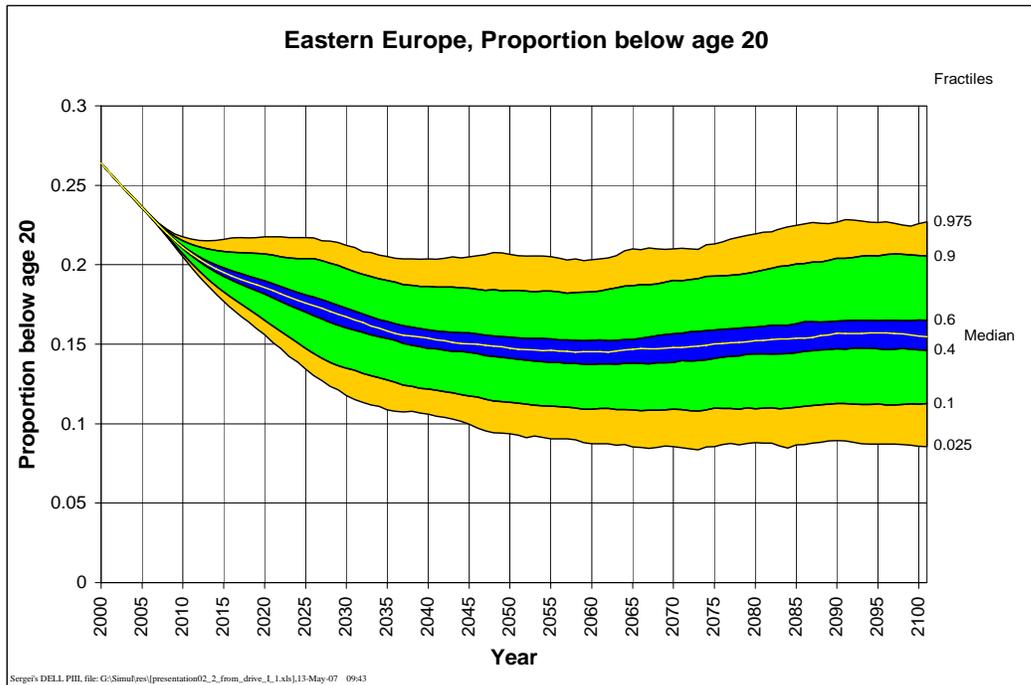

Notes: The inner blue region shows the region between the 40th and 60th percentiles of the forecasted population distribution. The green and blue areas combined show the region between the 10th and the 90th percentiles of the forecasted population distribution. The area between the uppermost and lowermost lines shows the 95 percent prediction interval.
Source: Our computations. See Lutz et al., "The Coming Acceleration of Global Population Ageing."

The counterpart of this at the older end of the age distribution is the proportion of the population in Eastern Europe above the age of 60. This proportion increases swiftly at the beginning of the century and then holds steady in the second half of the century (see Figure 6). This again is primarily a consequence of assuming stabilizing fertility levels together with only moderate long-term increases in life expectancy. Should life expectancy increase faster than assumed in the median trend, then the path would fall in upper parts of the uncertainty range and vice versa.

In summary, in the first half of this century, we expect to see rapid changes in the size of the population in Eastern Europe and the former Soviet Union as well as rapid changes in the age structures of those populations. After mid-century, we expect to see continued population decline coupled with a stabilizing age structure.

Figure 6. Probabilistic Forecast of the Proportion of the Eastern European Population Age 60 and Older
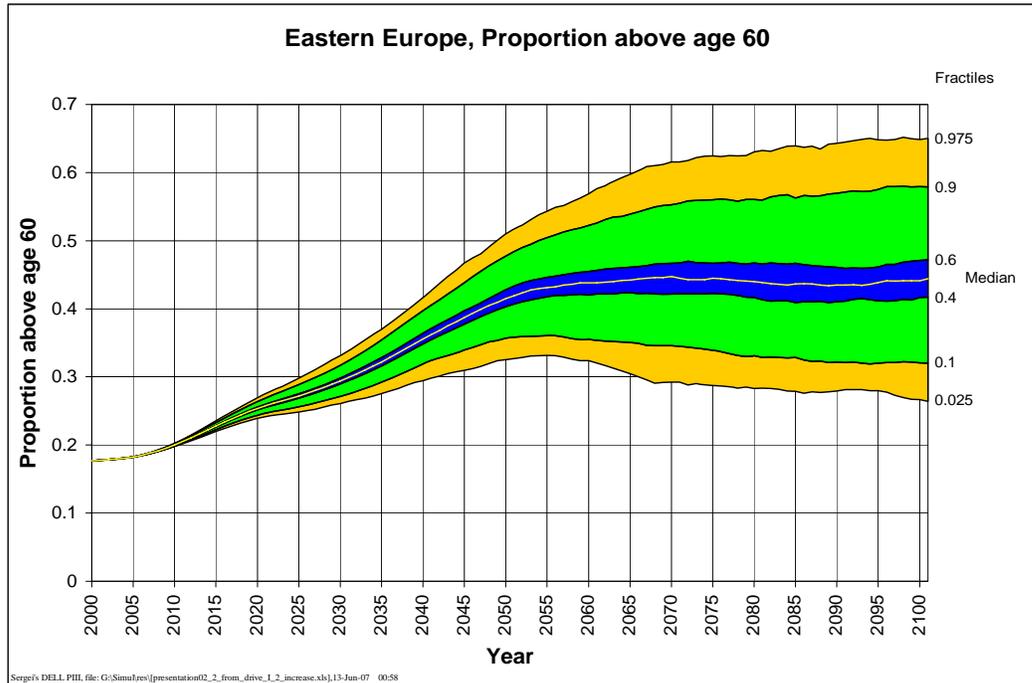

Notes: The inner blue region shows the region between the 40th and 60th percentiles of the forecasted population distribution. The green and blue areas combined show the region between the 10th and the 90th percentiles of the forecasted population distribution. The area between the uppermost and lowermost lines shows the 95 percent prediction interval.
Source: Our computations. See Lutz et al., "The Coming Acceleration of Global Population Ageing." Also see http://www.iiasa.ac.at/Research/POP/proj07/index.html?sb=5

## Educational Attainment Levels and Labor Force Trends

This section is based on our new population projections by level of educational attainment.[7] We have added the dimensions of educational attainment and the productivity of the working-age population in Eastern Europe to that of purely demographic change, as both are significant determinants of economic growth.

Figure 7 shows the population pyramid of Ukraine for the year 2000, with age and sex plotted against the four categories of educational attainment. To construct this projection, methods of

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[7] For more details on our population projections by level of education and the detailed data used here, see http://www.iiasa.ac.at/Research/POP/edu01/humancapital.html#0a These data come from the new IIASA-VID global human capital database, which includes back-projections to 1970 and alternative scenarios to 2050 for more than 120 countries. See Wolfgang Lutz, A. Goujon, Samir K.C., and Warren Sanderson, "Reconstruction of Populations by Age, Sex, and Level of Educational Attainment for 120 Countries for 1970-2000," in *Vienna Yearbook of Population Research 2007* (Vienna: Verlag der Österreichischen Akademie der Wissenschaften: 2007), 193-235.

multistate population dynamics[8] were applied to the empirical data for 2000, taking into account the fact that both fertility and mortality tend to vary greatly with education. Almost universally, men and women with higher education have higher life expectancies, and women with higher education have lower fertility. This new time series of data on human capital by five-year age groups and four educational levels allows researchers to analyze human capital and the returns on investments in education using a new empirical method. We have shown that unlike earlier assessments based on less detailed age-specific information, increases in the educational attainment of the working-age population represent a consistently positive and significant determinant of economic growth.[9]

Figure 7. Population Pyramid of Ukraine by Level of Education, 2000
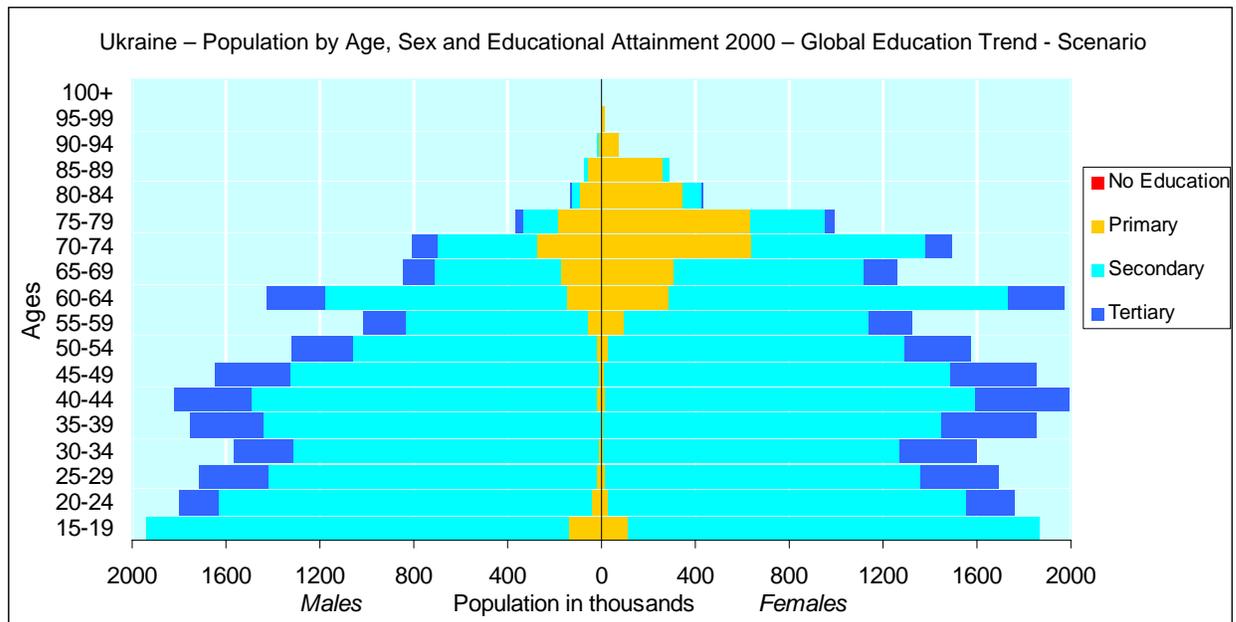
Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: Samir K.C., Bilal Barakat, Anne Goujon, Vegard Skirbekk, and Wolfgang Lutz, "Projection of Populations by Level of Educational Attainment, Age and Sex for 120 Countries for 2005-2050," Interim Report IR-08-038 (Laxenburg, Austria: International Institute for Applied Systems Analysis, 2008). See also http://www.iiasa.ac.at/Research/POP/edu01/humancapital.html#0a

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[8] Multistate population dynamics means looking at the rates and probabilities that individuals within an age cohort will transition from one state to another, e.g., from single to married, from healthy to diseased, from residency in one region to another.
[9] Lutz et al., "The Coming Acceleration of Global Population Ageing."

Figure 8. Population Pyramid of Ukraine by Level of Education, 2050
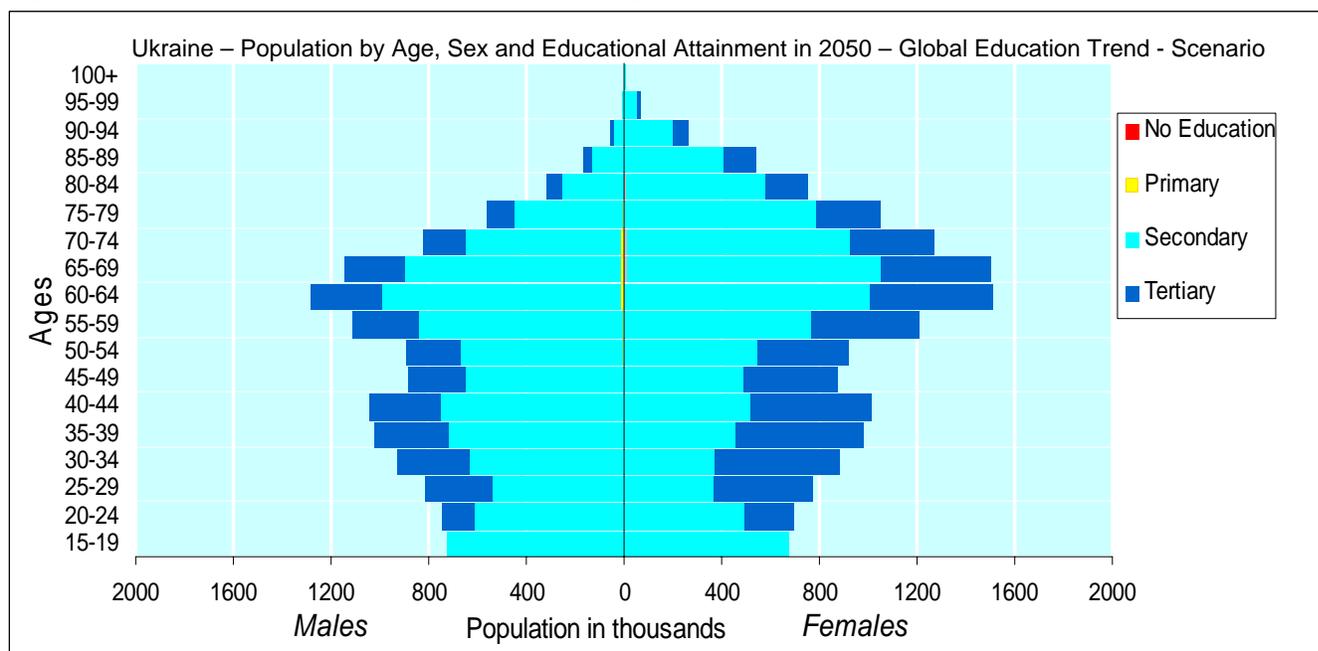

Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

Figure 8 shows the projections for Ukraine according to the global trend scenario,[10] which can be considered a most likely or medium scenario. This scenario employs fertility assumptions similar to those the European Union's statistical agency Eurostat uses and that the Vienna Institute of Demography (VID) recently applied to all Eastern European countries.[11] A comparison of Figures 7 and 8 first shows a significant transformation of the overall population age distribution. In 2000, the age structure still looks somewhat like a pyramid. In 2050, the age distribution is more like an inverted pyramid. In terms of the educational structure, the proportion of the population at each age with tertiary education increases between Figure 7 and Figure 8. The higher levels of educational attainment and the correlate increase in per capita productivity in the population may potentially

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[10] The data that we present here are from our global education trend scenario. This scenario is based on the general assumption that future trends of school enrollment (transitions to higher education categories) in each country will follow the overall trajectory of historical global trends. Fertility and mortality rates in the future are both assumed to differ by level of education with the relative differentials remaining stable over time. In the aggregate, the fertility and mortality rates assumed under this scenario generally match those of the medium variant of the UN population projections, which do not differentiate the population by level of education. For more information on our global education trend scenario, see K.C. et al., "Projection of Populations" and http://www.iiasa.ac.at/Research/POP/pub/Asia_datasheets08.html.

[11] Long-term fertility rates are assumed to be around the level of current fertility rates adjusted for changes in the timing of births within the lifecycle. Educational progression rates follow the average global pattern of recent educational improvements.

compensate for the shrinking size of these cohorts. It is also interesting to note that according to current trends, women will be better educated than men in the future. Also, as the better-educated cohorts age, the 2000 levels of low education among the elderly will give way to a much better-educated elderly population by 2050.

For the Russian Federation, the pattern is even more extreme because of the higher mortality differentials between men and women (see Figure 9). Projections show that by 2050, the group of females ages 60 to 64 (those born during the last years of the Soviet Union when fertility was still fairly high) will dominate the picture and outnumber their male counterparts. Partly because of their much higher educational status, these women are also likely to be in better health than women of the same age today. And given the huge size of the projected population above age 60 relative to that below age 60, it is unlikely that these large cohorts will be able to enjoy comfortable retirement benefits. In terms of labor demand, the rapidly shrinking size of the younger labor force will also likely result in a situation in which the labor market will still need these well-educated older women.

Figure 9. Population Pyramid of Russian Federation by Level of Education, 2050
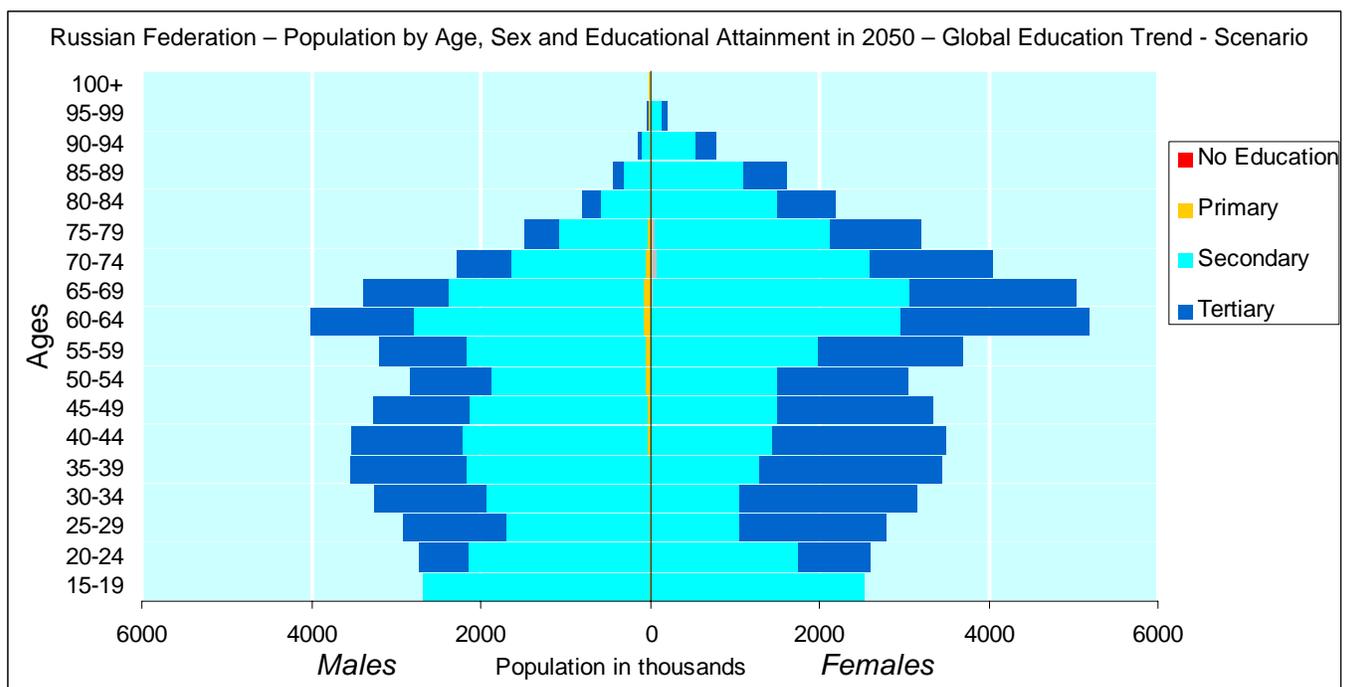
Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

Figure 10 shows the aggregate long-term population projection for Eastern Europe from 1970 to 2050 using the working-age population plotted against different levels of educational attainment. After a peak within the coming years, the absolute size of the labor force is forecast to decline steadily, though the labor force's educational profile will improve. Once again, the question for analysts is whether the higher educational attainment of the population will be able to compensate — economically speaking — for its shrinking size.

Figure 10. Long-Term Trend in the Size of the Working-Age Population in Eastern Europe by Level of Educational Attainment, 1970 to 2050

Non-EU Eastern Europe Population Ages 20-65 by Level of Educational Attainment, 1970-2050
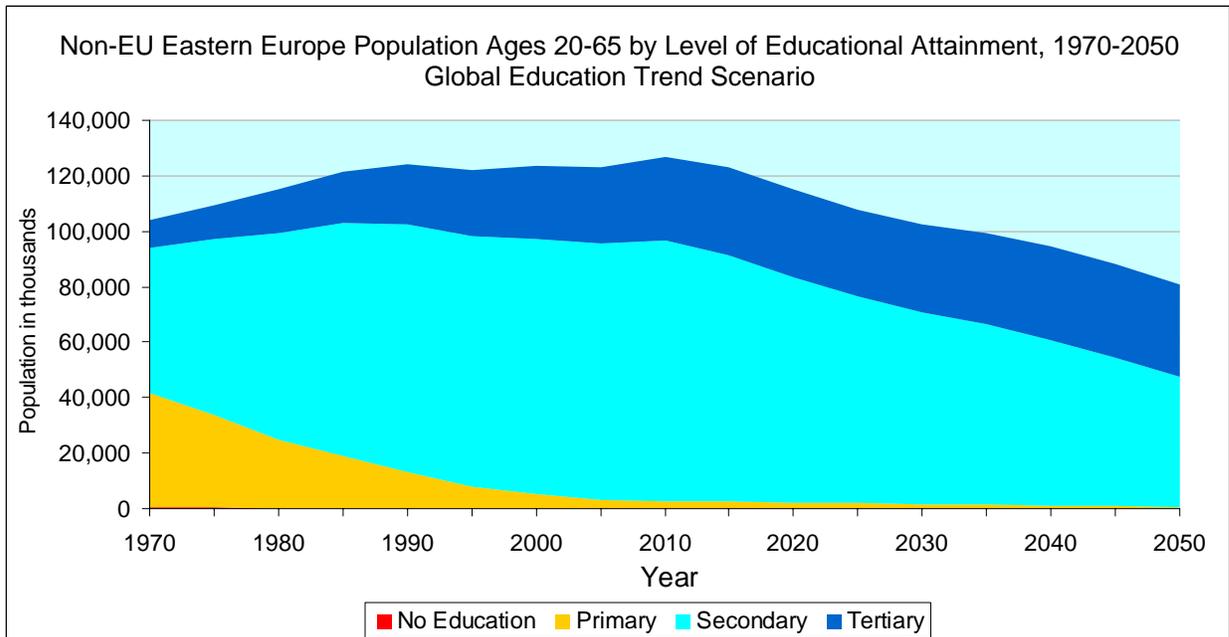Global Education Trend Scenario

Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

IV. Long-Term Demographic and Human-Capital Trends in Sub-Saharan Africa

The countries of sub-Saharan Africa currently have around 700 million inhabitants, a population that is on a swiftly increasing trajectory and is likely to grow by a magnitude of three or four over the coming decades (see Figure 11). With just a handful of exceptions, all of the countries in the region are facing deep development crises that are closely related to rapid population growth and limited progress in expanding educational opportunities. In many countries, these development problems are exacerbated by HIV/AIDS. However, the region's overall fertility level is still so high that it overshadows the higher mortality rate due to AIDS on an aggregate level. AIDS, therefore, has not

had a visible impact on the region's overall population growth. The only exception is in the case of the Southern African countries (Botswana, Lesotho, Namibia, South Africa, and Swaziland), in which HIV prevalence rates are very high and fertility is above replacement level but lower than in other sub-Saharan countries, thus significantly affecting the pattern of population growth.

While fertility rates began to decline in many developing countries all over the world during the 1980s and 1990s, recent indicators show this pattern of decline has actually stopped in a number of countries. This trend can be attributed to various sources, such as discontinued national family planning programs, actual declines in female school enrollment rates in some countries, worsening mortality conditions, and a general lack of comprehensive government policies. If fertility does not resume its decline in these countries in the near future, the population growth trajectories will be on the higher end of the uncertainty range depicted in Figure 11.

Figure 11. Probabilistic Population Forecasts for Sub-Saharan Africa, 2000 to 2100
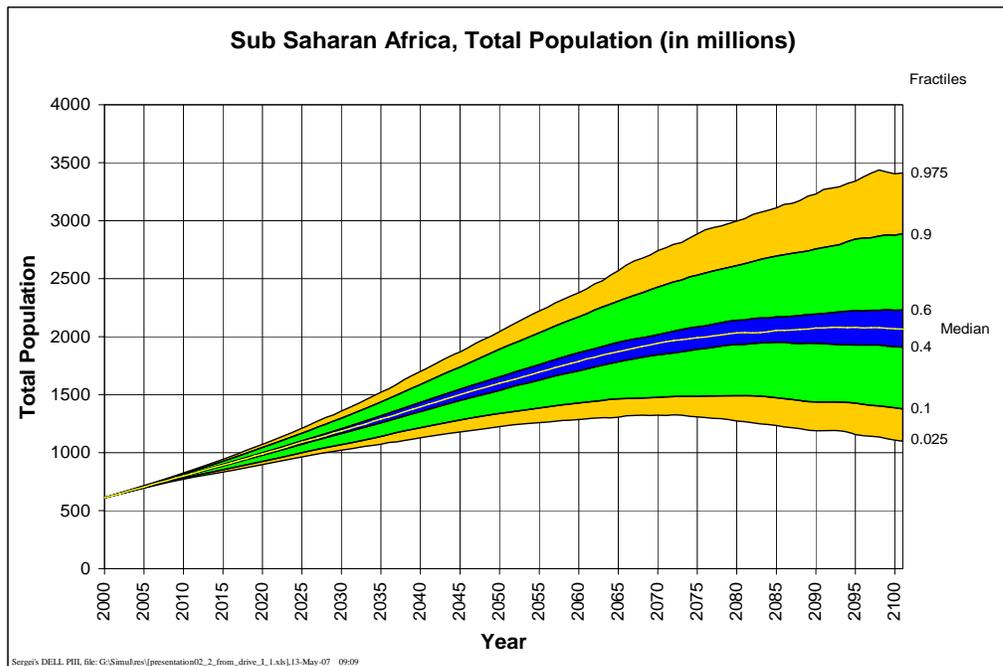
Notes: The inner blue region shows the region between the 40th and 60th percentiles of the forecasted population distribution. The green and blue areas combined show the region between the 10th and the 90th percentiles of the forecasted population distribution. The area between the uppermost and lowermost lines shows the 95 percent prediction interval.
Source: Our computations. See Lutz et al., "The Coming Acceleration of Global Population Ageing."
Also see http://www.iiasa.ac.at/Research/POP/proj07/index.html?sb=5

Educational Attainment Levels and Labor Force Trends

Education has an important effect on development outcomes in sub-Saharan Africa, where population growth has precipitated significant development and humanitarian challenges. Figure 12 illustrates the changes in child mortality rates in three large African countries (Ethiopia, Kenya, and Nigeria), providing a window into the region's recent developmental crises. In all three countries, the child mortality of women with secondary education has been significantly lower than that of women with no education or primary education only. Better education, therefore, results in better health for mothers and children because of improved access to crucial information and health care. Over time, we see that out of the three countries, only Ethiopia has been improving. In both Kenya and Nigeria, the overall child mortality conditions have actually worsened. And in this context, female education has become even more important. While circumstances for women with low or no education have clearly become worse over time, circumstances for women with secondary education have actually improved or at least not worsened. This also illustrates the fact that the development and humanitarian crisis in Africa is to a large extent an education crisis and — as we will illustrate in the following analysis — coincides with a population growth crisis.

Figure 12. Mortality Rates for Children under Age 5 in Three African Countries by Mothers' Education Level, 1989 to 2003
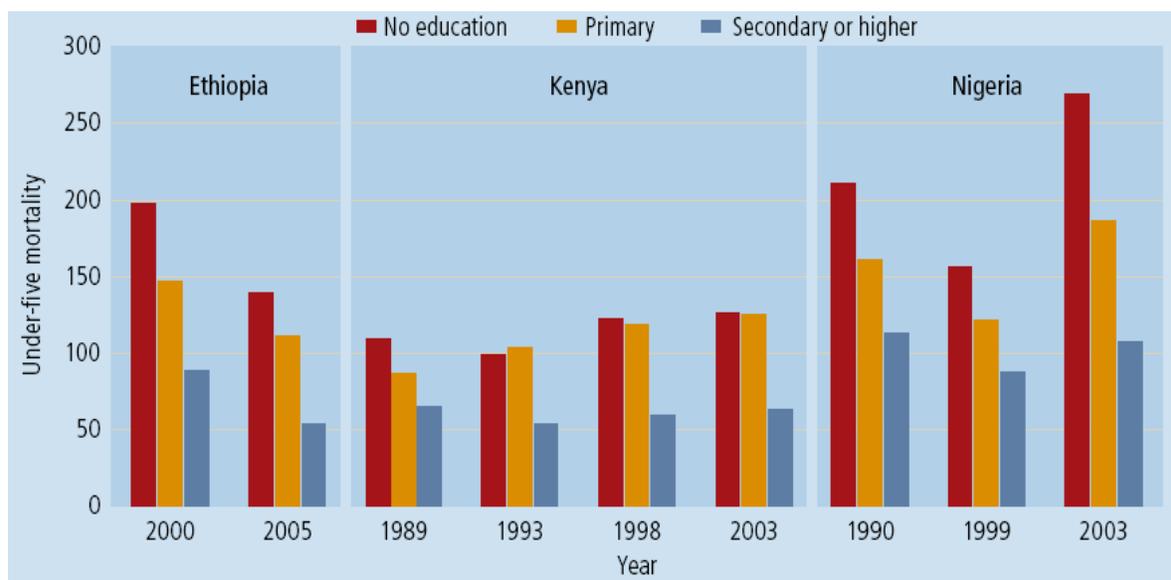
Source: MEASURE DHS, STATCompiler, 2008.

The chart for fertility rates by level of education looks almost identical to that of child mortality rates discussed above, and is therefore not repeated here. Women with secondary education have consistently lower fertility rates, and in all three countries their fertility rates have continued to decline. Fertility rates for uneducated women and those with only some primary education have increased somewhat, the reason for the stalled overall fertility decline. In Ethiopia today, women

with no formal education have on average six children, while those with primary education have five, and those with secondary education only two. These are stunning differentials.

The following three graphs forecast potential demographic changes in Ethiopia over the next few decades. Figure 13 shows the adult population of Ethiopia in 2000, by age, sex, and level of educational attainment. The age pyramid shown here is typical of a poor, largely uneducated, highly fertile population. Figures 14 and 15 project the best-case and worst-case scenarios by 2050, based on educational attainment. Figure 14 assumes that Ethiopia is going to experience relatively rapid improvements in educational transition rates, which essentially mirror those experienced by more advanced countries over the past decades (what we call the global trend scenario). Therefore, although Ethiopia's population will be much bigger in the future, it could also be much better educated. In particular, the younger cohorts will have benefited from the presumed improvement in schooling. Under this scenario, Ethiopia in 2050 will look like some of the highly performing Asian countries today in terms of education. In particular, the significant increase in the number of young adults with a secondary education is expected to facilitate a kick-start in economic growth, assuming other necessary conditions are also met.[12]

If, on the other hand, absolute school enrollment were to remain constant instead of expanding, Ethiopia's educational attainment would look like the pyramid depicted in Figure 15. The population would be increasing but there would be no further expansion of schools, therefore the proportion of children attending school would actually decline. This is indeed a very pessimistic scenario, but it mirrors what could happen in some African countries if school enrollment rates decline due to high population growth and government neglect of education.

The comparison between Figures 14 and 15 shows that not only do the education structures differ but also that overall population growth will depend crucially on future education policies and efforts to improve enrollment. Both scenarios assume identical education-specific fertility rates. Hence the difference is entirely driven by different projected educational structures. Since more educated women in Africa tend to have significantly fewer children, less education implies more population growth, which in turn would lead to less economic growth.

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[12] We do not expect education to have much of an effect on economic growth in a country that is extremely corrupt or has antigrowth economic policies. See Wolfgang Lutz, J. Crespo Cuaresma, and Warren Sanderson, "The Demography of Educational Attainment and Economic Growth," *Science* 319 (2008): 1047-1048.

Figure 13. Population Pyramid by Level of Education for Ethiopia, 2000
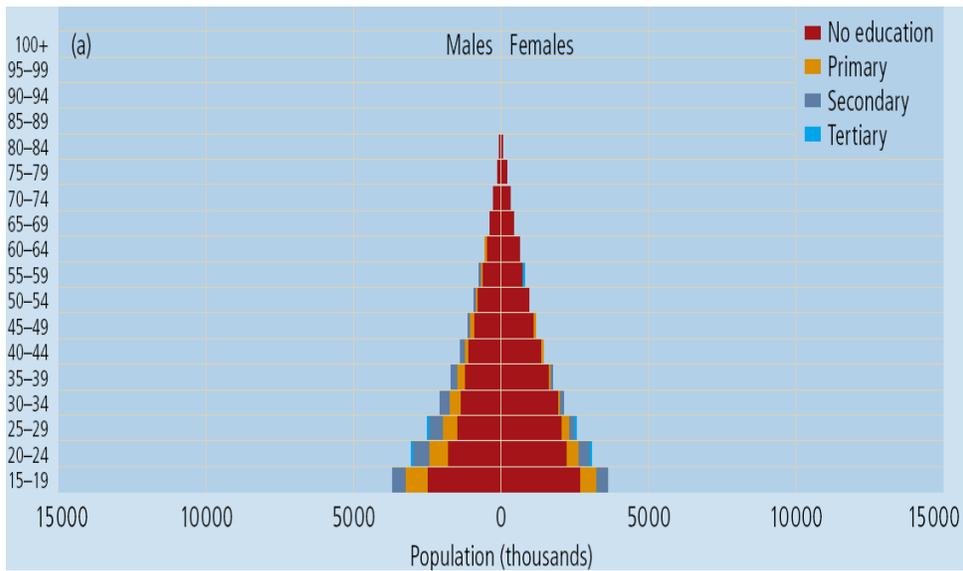
Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

Figure 14. Population Pyramid by Level of Education for Ethiopia in 2050, Global Trend Scenario
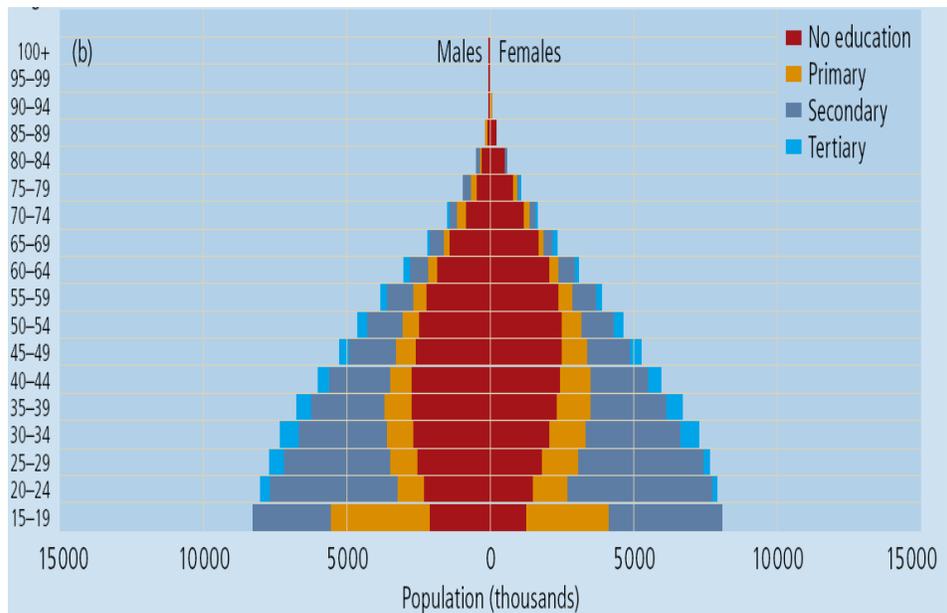
Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

Figure 15. Population Pyramid by Level of Education for Ethiopia in 2050, Constant Absolute School Enrollment Scenario
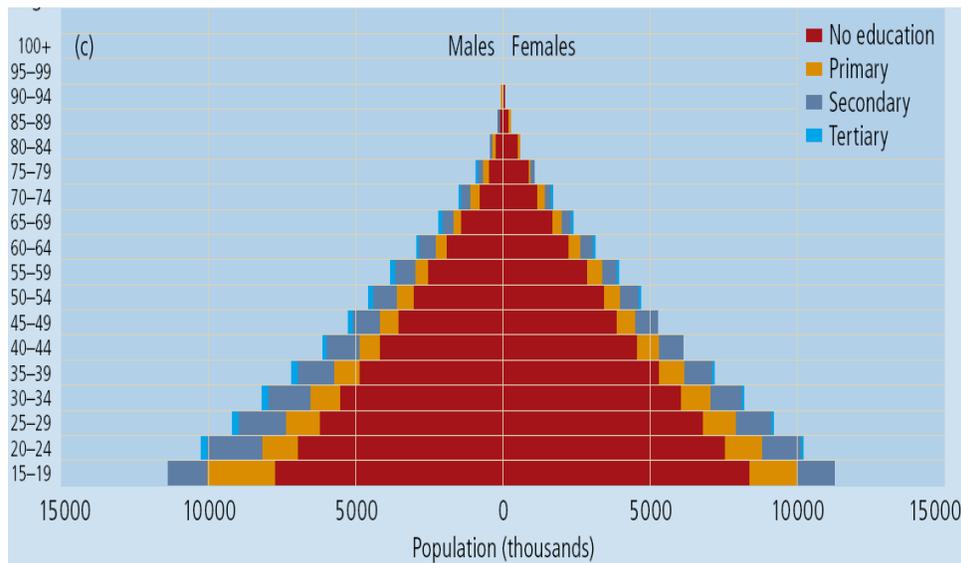
Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
*Source*: K.C. et al., "Projection of Populations."

Figure 16 shows long-term educational attainment predictions for sub-Saharan Africa's working-age population under the optimistic global trends scenario. Under this scenario, the absolute number of uneducated adults will stay roughly constant, whereas all other educational categories are likely to increase very significantly. If things should follow this trend, then by the middle of the century, more than half of the sub-Saharan African adult population should have secondary or higher education, up from a virtually nonexistent number in 1970 and a still-insignificant number today. Particularly in light of our analysis on the relationship between educational attainment distributions and economic growth,[13] where a large proportion of adults with secondary education turns out to be critical for moving a country out of poverty, this scenario gives rise to optimism about future development in Africa. But it will only materialize if sub-Saharan African governments make serious efforts to improve educational enrollment rates and at the same time ensure a certain quality of education.

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[13] Lutz et al., "The Demography of Educational Attainment and Economic Growth."

Figure 16. Long-Term Trend in Size of the Working-Age Population in Sub-Saharan Africa by Level of Educational Attainment, 1970 to 2050

Sub-Saharan Africa – Population Ages 20-65 by Level of Educational Attainment, 1970-2050 Global Education Trend (GET) Scenario
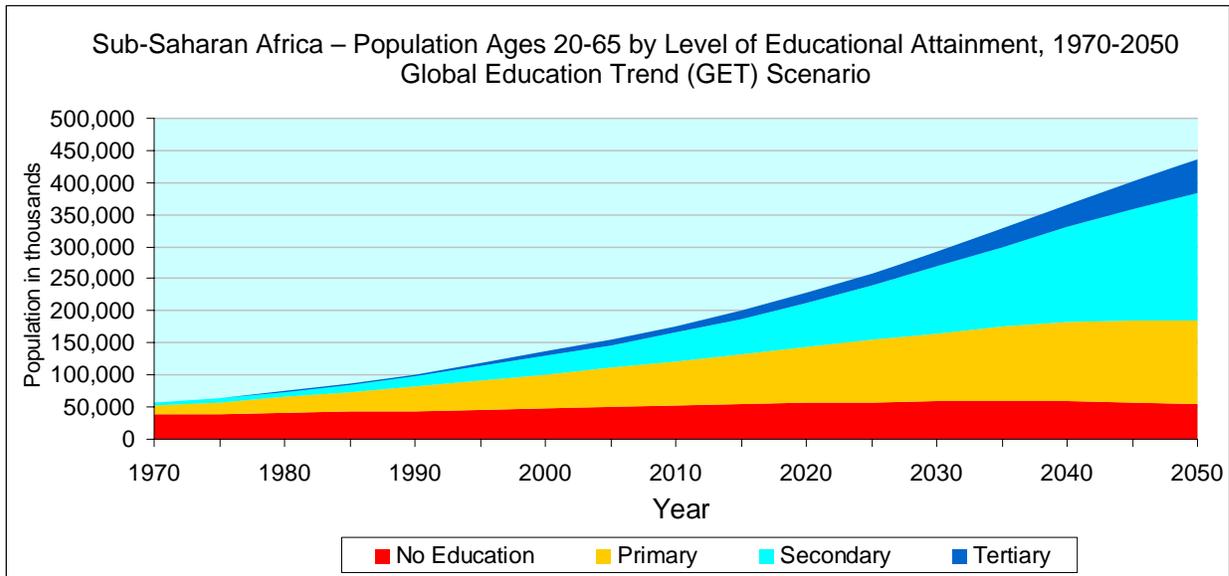
Notes: *Sub-Saharan Africa includes Cameroon, Central African Republic, Chad, Comoros, Eritrea, Ethiopia, Gabon, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe.

"No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

V. Implications for Future Migration Pull and Push Factors to Europe

Conventional wisdom predicts that Europe's graying population and declining labor force will create a huge need for skilled migrants in the coming decades. An alternative view is that increasing educational attainment levels can reduce the need for migrants by making native populations more productive.

On the aggregate European Union level (including Norway and Switzerland), the projected labor force decline after 2020 (assuming median migration) will be low and gradual, and it will be offset by a further increase in the labor force's educational attainment (see Figure 17). It seems to be an open question whether this combination of trends will actually result in the oft-mentioned need for migrants for demographic reasons. If labor input into production keeps diminishing due to technological change, this combination of fewer but better educated workers may just be what the European labor market needs.

Figure 17. Long-Term Trend in Size of the Working-Age Population in the European Union by Level of Educational Attainment, 1970 to 2050

EU, Norway, Switzerland – Population Ages 20-65 by Level of Educational Attainment, 1970-2050
Global Educational Trend (GET) Scenario

Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
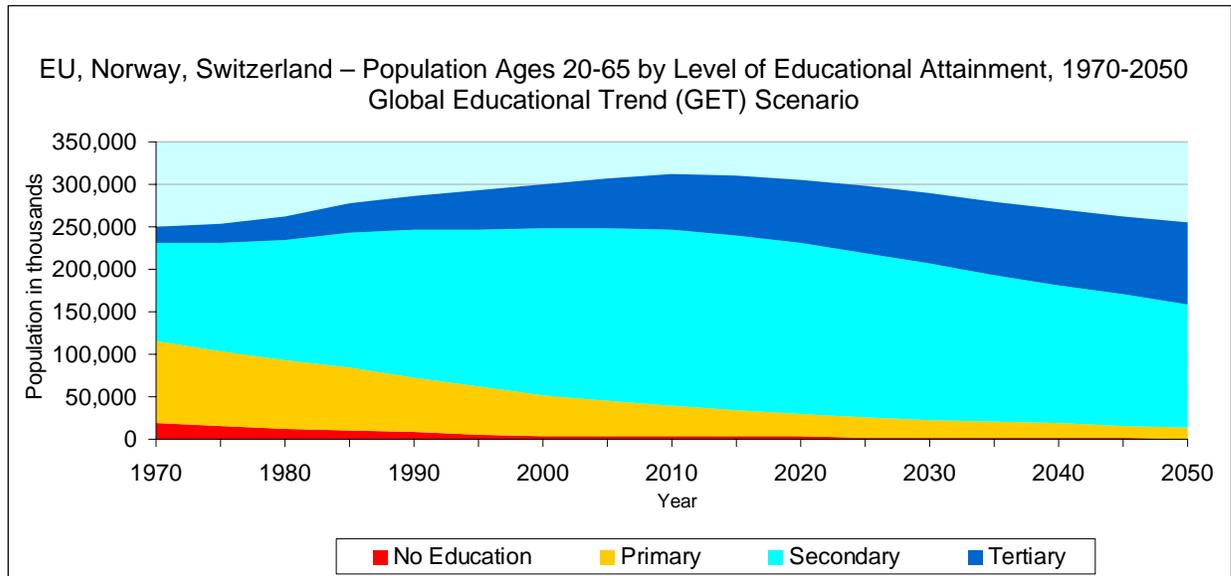*Source*: K.C. et al., "Projection of Populations."

Notwithstanding the optimistic forecast at the aggregate EU level, individual countries such as Italy (see Figures 18 and 19) will face much more serious labor force declines, which are unlikely to be compensated by better education — in particular if educational enrollment rates at the tertiary level (especially for men) do not improve significantly.

Figure 18. Population Pyramid of Italy by Level of Education, 2000

Italy – Population by Age, Sex, and Educational Attainment, 2000
Global Education Trend (GET) Scenario

Legend:
- No Education (red)
- Primary (yellow)
- Secondary (cyan)
- Tertiary (blue)

Y-axis (Ages): 100+, 95-99, 90-94, 85-89, 80-84, 75-79, 70-74, 65-69, 60-64, 55-59, 50-54, 45-49, 40-44, 35-39, 30-34, 25-29, 20-24, 15-19

X-axis: 2500, 2000, 1500, 1000, 500, 0, 500, 1000, 1500, 2000, 2500

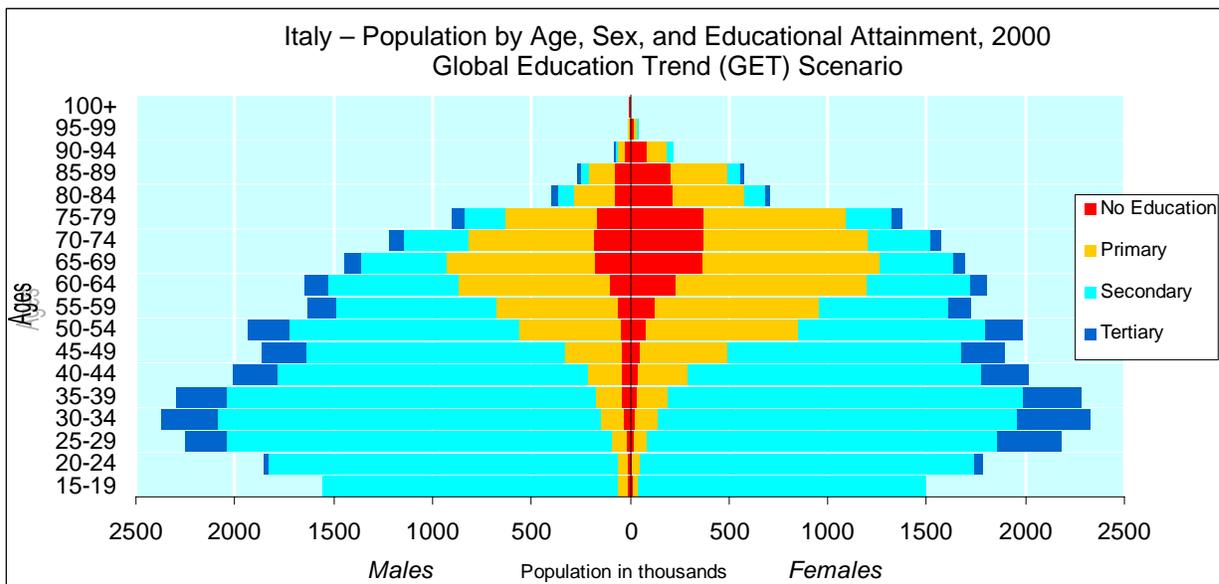*Males*   Population in thousands   *Females*

Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education (i.e., high school), whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education" includes those who undertook third-level studies (i.e., university), regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

Figure 19. **Population Pyramid of Italy by Level of Education, 2050**
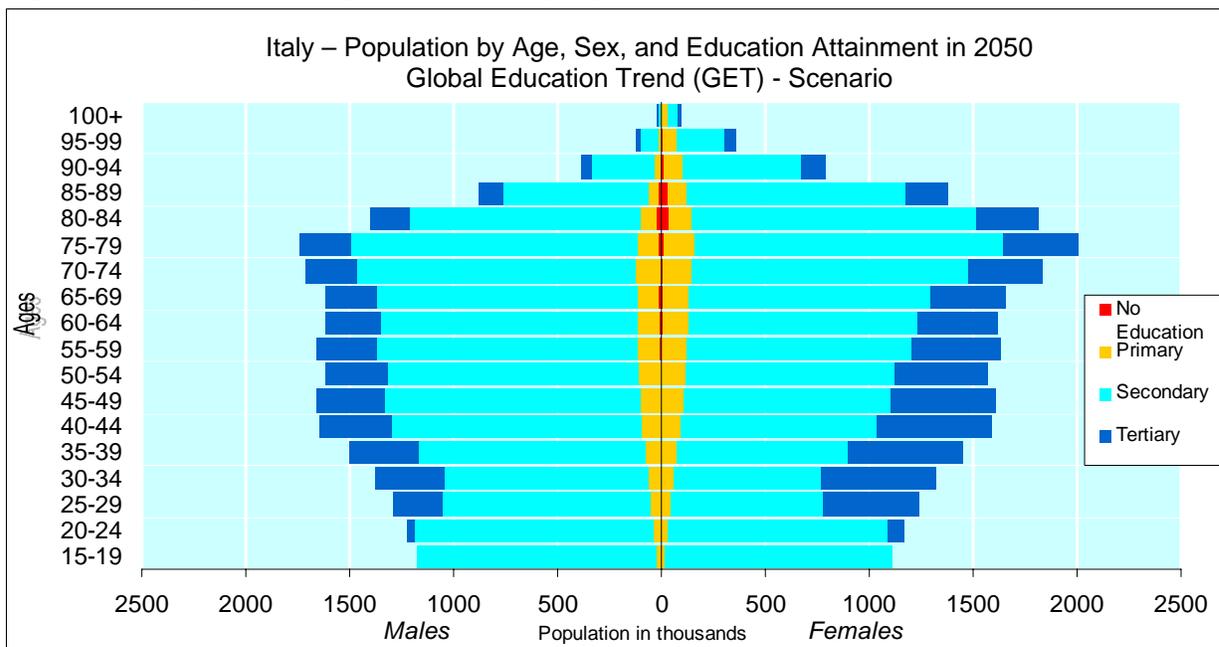
Italy – Population by Age, Sex, and Education Attainment in 2050
Global Education Trend (GET) - Scenario

Notes: "No education" applies to those who have completed less than one year of formal schooling. "Primary education" includes all those who have completed at least one year of education at the first level (primary), but who did not go on to second-level studies. "Secondary education" consists of those who moved to the second level of education, whether or not they completed the full course of study, but who did not proceed to studies at the tertiary level. "Tertiary education," includes those who undertook third-level studies, regardless of whether or not they completed them.
Source: K.C. et al., "Projection of Populations."

It is not yet clear what educational profile of workers Europe will need in the future and therefore what "pull factors" of migration we can expect. Some experts argue that Europe will need unskilled workers in the health-care sector due to the aging population. Yet unskilled workers in Europe today have by far the highest unemployment rates. In the EU-27 in 2007, the unemployment rate among workers with low education was 10.6 percent. Among workers with average education it was 6.9 percent and among those with high education it was 3.9 percent.[14] It may be more a question of salaries in the health-care sector and the native born's willingness to work in such jobs than a question of labor supply. In addition, health care and other personal services increasingly require specialized training. And industrial production and agriculture are likely to see further increases in the levels of skills required of workers in those sectors. Hence, from a labor demand perspective, there should be detailed study of what overall spectrum of skills Europe will require in the future.

The "push factors" of migration are limited as well. Due to the projected population decline in Eastern Europe, immigration potential from the region into Western Europe is limited unless Eastern European economies collapse and people are forced to move westward to seek a better living. However, if Eastern Europe sees robust economic growth, then the East may be in greater need of immigrants than the West due to its more extreme population shrinking and aging. In light

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[14] Belgian Federal Public Service Employment and Labor Dialogue (2009)

of the vast and highly fertile agricultural lands in the Ukraine and parts of Russia, and the fact that climate change is likely to increase agricultural productivity in those countries and expand the arable land, the longer-term future may well see international migration streams redirected into these areas.

Finally, with respect to Africa, much will depend on the continent's future course of development, which will crucially depend on governments successfully expanding basic and secondary education. Only if economic growth takes off in Africa will the economy be able to absorb the very rapidly growing numbers of young adults. And, as shown in previous research, education is a necessary (but not always sufficient) precondition for such a takeoff.[15] If Africa fails to educate its population, we can expect conflict and significant increases in humanitarian crises that coincide with the expected negative consequences of climate change on African livelihood and health. Both outcomes are likely to produce more asylum seekers and people who are desperately looking for a better life in the North. Such migration flows may pose serious challenges for efforts to develop a planned and orderly migration regime into Europe.

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[15] Lutz et al, "The Coming Acceleration of Global Population Ageing."

Appendix 1. Population Size for Selected World Regions, 2000 to 2100

Medians of the probabilistic IIASA projections plus the 80 percent uncertainty interval,
(i.e., leaving out the highest and lowest 10 percent of the projected distributions).

	Population size (millions)					Population size (billions)
	Western Europe	Eastern Europe	North America	Sub-Saharan Africa	Former Soviet Union	World
2000	455.63 (455.63-455.63)	121.19 (121.19-121.19)	313.67 (313.67-313.67)	611.19 (611.19-611.19)	235.64 (235.64-235.64)	6.06 (6.06-6.06)
2010	462.29 (458.27-465.95)	119.51 (118.70-120.29)	338.43 (331.98-345.05)	799.74 (781.31-815.49)	227.58 (226.09-228.92)	6.82 (6.74-6.88)
2030	466.66 (441.58-494.13)	109.76 (103.79-115.97)	391.93 (365.48-419.15)	1186.09 (1069.15-1297.45)	203.01 (191.89-214.50)	8.05 (7.59-8.52)
2050	446.64 (391.87-507.86)	93.41 (81.94-106.74)	425.29 (372.84-484.01)	1597.37 (1337.20-1892.69)	168.25 (146.59-192.04)	8.75 (7.78-9.90)
2075	389.43 (311.34-489.26)	71.53 (54.54-92.42)	446.67 (362.18-538.46)	1989.61 (1485.51-2531.33)	129.38 (96.91-165.80)	8.87 (7.15-10.80)
2100	350.10 (246.86-462.16)	56.62 (37.41-78.52)	460.26 (336.80-598.46)	2068.36 (1386.07-2874.26)	107.57 (68.06-149.52)	8.39 (6.16-11.05)
	Proportion below age 20					
	Western Europe	Eastern Europe	North America	Sub-Saharan Africa	Former Soviet Union	World
2000	0.25 (0.25-0.25)	0.26 (0.26-0.26)	0.28 (0.28-0.28)	0.55 (0.55-0.55)	0.27 (0.27-0.27)	0.39 (0.39-0.39)
2010	0.23 (0.22-0.23)	0.21 (0.21-0.22)	0.27 (0.26-0.27)	0.57 (0.56-0.57)	0.21 (0.20-0.21)	0.36 (0.35-0.36)
2030	0.19 (0.16-0.22)	0.17 (0.13-0.20)	0.24 (0.21-0.27)	0.49 (0.45-0.53)	0.17 (0.13-0.20)	0.30 (0.27-0.33)
2050	0.17 (0.14-0.21)	0.15 (0.11-0.18)	0.22 (0.19-0.26)	0.42 (0.36-0.46)	0.16 (0.12-0.19)	0.27 (0.23-0.30)
2075	0.16 (0.13-0.21)	0.15 (0.11-0.19)	0.21 (0.17-0.25)	0.33 (0.28-0.37)	0.17 (0.13-0.22)	0.23 (0.20-0.27)
2100	0.16 (0.12-0.20)	0.16 (0.11-0.21)	0.20 (0.16-0.24)	0.26 (0.22-0.29)	0.19 (0.14-0.23)	0.20 (0.16-0.24)

Population size (millions)						Population size (billions)
Proportion above age 60						
	Western Europe	**Eastern Europe**	**North America**	**Sub-Saharan Africa**	**Former Soviet Union**	**World**
2000	0.20 (0.20-0.20)	0.18 (0.18-0.18)	0.16 (0.16-0.16)	0.05 (0.05-0.05)	0.19 (0.19-0.19)	0.10 (0.10-0.10)
2010	0.21 (0.21-0.22)	0.20 (0.20-0.20)	0.18 (0.18-0.18)	0.04 (0.04-0.04)	0.19 (0.19-0.19)	0.11 (0.11-0.11)
2030	0.31 (0.28-0.33)	0.29 (0.27-0.32)	0.27 (0.24-0.29)	0.05 (0.05-0.05)	0.29 (0.27-0.31)	0.17 (0.15-0.18)
2050	0.37 (0.31-0.43)	0.42 (0.36-0.48)	0.30 (0.24-0.35)	0.07 (0.06-0.08)	0.40 (0.34-0.46)	0.22 (0.19-0.26)
2075	0.42 (0.32-0.51)	0.44 (0.34-0.56)	0.35 (0.26-0.42)	0.13 (0.11-0.17)	0.41 (0.31-0.52)	0.27 (0.22-0.34)
2100	0.46 (0.34-0.57)	0.44 (0.32-0.58)	0.39 (0.28-0.49)	0.20 (0.16-0.25)	0.39 (0.28-0.51)	0.32 (0.25-0.41)
Proportion above age 80						
	Western Europe	**Eastern Europe**	**North America**	**Sub Saharan Africa**	**Former Soviet Union**	**World**
2000	0.03 (0.03-0.03)	0.02 (0.02-0.02)	0.03 (0.03-0.03)	0.00 (0.00-0.00)	0.02 (0.02-0.02)	0.01 (0.01-0.01)
2010	0.04 (0.04-0.04)	0.03 (0.03-0.03)	0.03 (0.03-0.03)	0.00 (0.00-0.00)	0.03 (0.03-0.03)	0.01 (0.01-0.01)
2030	0.06 (0.05-0.07)	0.05 (0.04-0.06)	0.05 (0.04-0.06)	0.00 (0.00-0.00)	0.04 (0.03-0.05)	0.02 (0.02-0.02)
2050	0.11 (0.07-0.17)	0.09 (0.06-0.14)	0.09 (0.05-0.14)	0.00 (0.00-0.01)	0.08 (0.06-0.12)	0.04 (0.03-0.06)
2075	0.16 (0.08-0.27)	0.16 (0.09-0.30)	0.13 (0.06-0.20)	0.01 (0.01-0.02)	0.14 (0.07-0.25)	0.07 (0.04-0.12)
2100	0.21 (0.09-0.37)	0.19 (0.08-0.36)	0.18 (0.07-0.29)	0.02 (0.02-0.05)	0.14 (0.06-0.29)	0.10 (0.05-0.19)

Source: Lutz et al., "The Coming Acceleration of Global Population Ageing," Supplementary Table 1.

VI. About the Authors

Wolfgang Lutz is Co-Principal Investigator at the International Institute for Applied Systems Analysis in Laxenburg, Austria; he has led their Population Project since 1992. He has also been Director of the Vienna Institute of Demography of the Austrian Academy of Sciences since 2002. Dr. Lutz is an Adjunct Professor for demography and social statistics at the University of Vienna and has served as Secretary General for the International Union for the Scientific Study of Population (IUSSP). His main interests are in population forecasting, family demography, and population-environment analysis. Dr. Lutz studied philosophy, mathematics, and statistics at the Universities of Munich, Vienna, Helsinki, and Pennsylvania. In 1983, he received his PhD in demography from the University of Pennsylvania and in 1998 a second doctorate (habilitation) from the University of Vienna. He has written/edited 19 books and more than 120 scientific articles and book chapters (including contributions to *Nature* and leading journals in the field of population). His books include *Frontiers of Population Forecasting* (Population and Development Review Special Supplement 1999), *Population and Climate Change* (Cambridge University Press 2000), *Population and Environment: Methods of Analysis* (Population and Development Review Special Supplement 2002), and *The End of World Population Growth, Human Capital and Sustainable Development in the 21st Century* (Earthscan 2003).

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