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Malawi's Future Human Capital:
Is the country on track to meeting the MDGs on education?

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Contents

Abstract

This study uses demographic and multi-state population projections to estimate the future population structure by age, sex and educational attainment in Malawi, and importantly, to assess the likelihood of meeting the Millennium Development Goals (MDG) related to universal primary education and gender disparity no later than 2015. Data from the 1998 and 1987 censuses, and from the 1992 and 2000 Malawi Demographic and Health Surveys (DHS) are used. First, we examine school enrolment ratios, repetition and dropout rates, and educational attainment, as well as differentials in infant and child mortality by level of the mother's education. Second, we estimate fertility, mortality, and educational transition rates from the DHS. Third, we estimate the population structure in 2000 and then perform forward projections to 2015. Finally, we examine the percentage distribution of the projected population by level of education. Malawi is one of the poorest countries in sub-Saharan Africa, with a population close to 10 million as of 2000. Less than 80 percent of the 6-14 year old children are still in school, and only 15 percent of those aged 14-17 have completed primary school.

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1. Background

There is vast amount of literature on the importance of education, both at the micro and macro levels, both in developed and developing countries. At the micro level in the less developed world, many studies have shown a strong association of education with fertility, and maternal and child health and survival, with consistent evidence of higher fertility, poorer health and higher mortality among less educated people and their families (Bicego and Boerma 1993; Caldwell 1979; Hobcraft 1993). At the macro level, the educational composition of the population has long been considered a key factor in economic, institutional, and social development (Hadden and London 1996; Bellew et al. 1992), and in the rate of technological progress (Romer 1992). Results are less uniform with respect to the gross domestic product (GDP) growth rates, but the differences depend largely on the model specifications and educational indicators used (Lutz and Goujon 2001). Among the eight Millennium Development Goals (MDG), two (goals 2 and 3) specifically relate to education (United Nations 2000). Moreover, better education is expected to positively affect the attainment of other MDGs, particularly those pertaining to child mortality (goal 4), maternal health (goal 5), HIV/AIDS, malaria, and other diseases (goal 6), and to a lesser degree, to poverty and hunger (goal 1).

Forecasting education and human capital is of special importance, especially with regard to planning, orientation, realistic target setting, and motivation for near-term investments that only yield long-term returns (Lutz and Goujon 2001). In countries with rapidly growing numbers of children, or in a process of educational expansion in pursuit of the MDGs, increases in enrolment rates pose challenges both in terms of teachers and infrastructure. On the aggregate level, the expected changing educational composition of the population gives important guidelines for strategic orientation and long-run planning. Target setting has become an important feature of education strategies. Generally, education takes place at young ages; it takes decades until the improved education of the young translates into noticeable improvements for the adult population. Since this momentum follows strict demographic regularities, it can be precisely quantified using demographic methods. Finally, investments in education are usually perceived as costs in the short term. In the context of budget constraints, government policies may be tempted to cut these unproductive expenses. Education projections that clearly show how short-term improvements in enrolment translate into longer-term improvements of the educational composition of the adult population, can be helpful in

convincing governments that indeed the return to their investments will come, but with a significant lag (Goujon and Lutz 2004).

This awareness of the importance of human capital in development has been substantiated by a number of attempts to estimate and project the educational composition of the population. Most such studies, however, tend to capture educational stocks only in terms of cumulated enrolment ratios or literacy rates (Mankiw et al. 1992). What is needed is a complete matrix of the composition of the population by age, sex, and different levels of educational attainment for different time periods (Lutz and Goujon 2001). Many attempts to accurately forecast human capital have failed due to problems with data, but more importantly, to inappropriate methodologies (Ahuja and Filmer 1995; Dubey and King 1994). With regard to methods, the demographic input of most models is typically limited, and as a result, these models scarcely account for mortality and migration of pupils. Particularly problematic is the necessity to adjust for mortality because education and mortality tend to be strongly related, and to allow the educational composition of the population to influence fertility, given the obvious strong educational fertility differentials in most developing countries (Goujon and Lutz 2004).

Against this background, the objectives of this study are methodological and substantive. The methodological goal is to test multi-state, demographic methods for population projections by age, sex, and educational attainment in Malawi. The substantive goal is to assess the likelihood of the country meeting the Millennium Development Goals related to universal primary education and gender disparity no later than 2015.

The rest of the paper is organized as follows: Section 2 sets out the methodologies used and their merits for achieving the purpose of this study, while Section 3 presents the data. The main results are detailed in Section 4 which encompasses (i) baseline (2000) indicators of education with respect to education-related MDGs, (ii) educational differentials in fertility, mortality, and maternal and child health; (iii) parameter estimates of the inputs of the multi-state projection model, and (iv) projected indicators of education for 2015 with respect to MDGs. In Section 5 we summarize and discuss the main findings, present some limitations of the study, and sketch some directions for future research.

2. Methodological Issues

Many of the drawbacks of previous methods can be overcome by using a demographic, multi-state population projection technique. The method, which is based on a multi-dimensional expansion life table and the traditional cohort-component method of population projections, was developed at IIASA during the 1970s (Rogers 1975; Keyfitz 1985). The multi-state model is based on a division of the population by age and sex into a number of states that could be geographic units, with the movements between states being migration streams, or other clearly-defined subgroups such as groups with different educational attainment, with the movement being educational transition rates. Multi-state models are dynamic in the sense that they account for the linkage between fertility and mortality (and to some extent migration) and education. Since women with more education tend to have significantly lower fertility, lower maternal and child mortality, and greater longevity, as indicated earlier, a change in the educational

composition of the population of young women will have direct effects on the number of children, even if fertility remains constant within each educational group (Lutz and Goujon 2001). This dynamic approach was first applied to human capital projections by Lutz (1994), and then Yousif et al. (1996). The power of this method was evaluated by Lutz et al. (1999), and the approach was applied to produce the first global level projections by age, sex, and educational attainment to 2030 (Goujon and Lutz, 2004).

The standard population projection method by age and sex only consists of the following process: First, each age group is shifted up by one step (e.g., the cohort aged 15-19 in 2000 will be 20-24 in 2005). Mortality and migration are accounted for by applying a set of assumed age- and sex-specific mortality rates and migration patterns over the interval period (generally five years). Second, a set of assumed age-specific fertility rates applied to women of reproductive age results in a certain number of births over the interval period that, according to the assumed sex ratio at birth and assumed child mortality, will be added to the youngest group of the pyramid. In the multi-state model for human capital, the population of each age and sex category is divided into distinct groups of educational attainment (e.g., four groups: no education, primary, secondary, higher). Fertility, mortality, and migration now have four age- and sex-specific schedules, one for each educational group. In addition, there must be three sets of age- and sex-specific educational transition rates reflecting the intensities for people to move from one educational category to another over the interval period. Though this model can handle transition at any age, transitions are typically concentrated in the ages below 25.

The multi-state model can also be extended beyond the defined education groups to accommodate, for example, educational attainment by single grades, school intake by single-year age of entry, as well as promotion, repetition, dropouts, and graduation. Overall, the advantage of this model is that it would be able to more realistically track the complex flows that lead to adult educational attainment; it could be an education sector planning tool, as well as an advocacy tool. A downside is that the more states are included in the model, the more complex the data requirements. In this study, population projections by age, sex, and education are carried out using the Population-Development-Environment (PDE) software developed by IIASA's World Population Program.[1]

3. Data

We use the latest census and Demographic and Health Surveys data for Malawi, a landlocked country south of the equator in sub-Saharan Africa, with a GDP per capita less than USD 170 in 2000. Population censuses were carried out in Malawi in 1998, 1987, 1977, and 1966, while DHS were taken in 2000 and 1992. Selected indicators from census data are displayed in Table 1. The 1998 Population and Housing Census enumerated a total population of 9.9 million, against 8.0 million in 1987, which yields an intercensal population growth rate of almost 2.0 percent per year. With an urbanization rate of 14.4 percent, the population is predominantly rural. An examination

[1] Available at http://www.iiasa.ac.at/Research/POP/pub/sofware

of the 1998 census data also reveals that the total fertility rate (TFR)[2] (i.e., the mean number of ever born children per woman) was 6.6, against 7.4 in 1987. Because of these relatively high levels of fertility in the past, Malawi has a larger proportion of its population in the younger age groups than in older age groups for each sex in both urban and rural areas. At the national level, the percentage of under-five is about 17 percent; for people aged 5-24 it is nearly 48 percent; whereas the proportion of those aged 55 or older stands at almost 7 percent. These figures have scarcely changed between 1987 and 1998. The distribution of the 1998 population by sex and education shows that nearly 33 percent of the total population aged 15 and over is uneducated, 59 percent has primary education, and about 9 percent has reached secondary education or higher.

Table 1. Selected population indicators for Malawi, 1987 and 1998. Source: Author's calculations using the 1987 and 1998 national census data.

	1987	1998
Population	7,988,507	9,933,868
Intercensal population growth rate	3.2	2.0
Population density	84.7	105.4
Distribution by place of residence:		
Urban	10.7	14.0
Rural	89.3	86.0
Total fertility rate	7.4	6.6
Distribution by age:		
0-4	17.4	16.7
5-24	46.7	47.7
25-54	27.7	28.3
55+	8.1	7.3
Distribution by sex:		
Males	48.5	49.0
Females	51.5	51.0
Distribution by education (population aged 5 years or above):		
No education	54.9	32.5
Primary	41.7	59.1
Secondary +	3.2	8.5

4. Results

Section 4.1 presents the baseline education indicators from the 1992 and 2000 Malawi DHS. Section 4.2 deals with the educational differentials in infant and child mortality, whereas Section 4.3 describes the process and the results of the estimation of parameters used in multi-state projections. Finally, Section 4.4 examines the percentage distribution of the projected population by level of education.

[2] TFR is defined as the total number of births a woman would have by the end of her childbearing period if she were to pass through those years bearing children at the currently observed rates of age-specific fertility.

4.1. Baseline indicators of education

Table 2 presents the net attendance ratios[3] (NAR) by sex and urban-rural residence for primary and secondary school. It shows that almost 77 percent of the children within the official age range for primary school (6-13 years) were attending primary school in 2000, against 58 percent in 1992. Slightly more girls are attending school (77.8 percent) than boys (75.4 percent) at the national level; the male advantage in urban areas is more than compensated by the female advantage in rural settings. As expected, NAR for primary school is higher in urban than in rural areas. It is worthwhile to note that in 1992, there were almost no sex differentials in primary NAR. At the national level, less than 7 percent of the people within the official age range for secondary school (14-17 years) were attending secondary school in 2000, with a slight advantage for girls in both urban and rural areas (7.5 percent versus 5.6 percent at the national level). Though modest, these levels of secondary NAR are substantially higher than in 1992.

Table 3 displays the repetition[4] and dropout[5] rates in primary school for the population aged 5-24 years, by sex and place of residence in 2000. Repetition rates are gigantic in Standard 1 (41 percent), which may have to do with the school officials' decision to ensure a more uniform preparedness before promoting children to Standard 2. Repetition rates then decline steadily to an average of 21 percent in Standards 2-4, and 11 percent in Standards 5-7, but sharply increase in Standard 8, due in part to failed attempts at getting a secondary school. While repetition rates are higher for females than for males in Standard 1 (42 percent versus 40 percent), they are almost the same in Grades 2-4; they are higher among boys in Grades 5-7 and in Grade 8. Table 3 also shows a pattern of increasing dropout rates with increasing years in school. The rates gradually rise from 5 percent in Grade 1 to an average of 6 percent in Grades 2-4, 11 percent in Grades 5-7, and 20 percent in Grade 8. Notable is the fact that dropout rates at Standards 5-8 are higher for girls than for boys, while repetition rates at those same levels are higher for boys than for girls. This suggests that, despite initiatives to promote continuation of girls' schooling, boys are still able (to a greater extent than girls) to persist in moving and completing primary education. In particular, boys are more likely to repeat Grade 8, which allows repeat attempts at entry to secondary schools, while girls are more likely to leave school. Note, however, that net attendance ratios for secondary school are better for girls than for boys.

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[3] The NAR for primary school is the percentage of the primary-school-age (6-13 years) population that is attending primary school. The NAR for secondary school is the percentage of the secondary-school-age (14-17 years) population that is attending secondary school.

[4] The repetition rate is the percentage of students in a given standard who are repeating that standard.

[5] The dropout rate is the percentage of students in a given standard in the previous school year who are not currently attending school.

Table 2. School net attendance ratios by sex and residence for Malawi, 1992 and 2000. Source: Author's calculations using the Demographic and Health Surveys.

	2000				1992				Annual absolute variation		
	Males	Females	Total	Cases	Males	Females	Total	Cases	Males	Females	Total
Primary school											
Urban	89.8	87.5	88.5	1,956	78.2	76.3	77.2	741	1.5	1.4	1.4
Rural	73.4	76.4	74.9	13,117	55.4	55.1	55.2	5,352	2.3	2.7	2.5
Total	75.4	77.8	76.7	15,073	58.1	57.8	57.9	6,093	2.2	2.5	2.3
Cases (6-13 years)	7,351	7,722	15,073		2,940	3,153	6,093				
Secondary school											
Urban	21.2	24.3	22.7	828	5.0	7.8	6.4	313	2.0	2.1	2.0
Rural	2.7	4.5	3.6	4,588	0.6	1.0	0.8	1,948	0.3	0.4	0.4
Total	5.6	7.5	6.5	5,416	1.2	2.0	1.5	2,261	0.5	0.7	0.6
Cases (14-17 years)	2,804	2,612	5,416		1,196	1,065	2,261				

Table 3. Repetition and dropout rates in primary school by sex and residence for Malawi, 2000. Source: Author's calculations using the Demographic and Health Surveys.

	Grades 1				Grades 2-4				Grades 5-7				Grade 8			
	Males	Females	Total	Cases	Males	Females	Total	Cases	Males	Females	Total	Cases	Males	Females	Total	Cases
Repetition rates																
Urban	25.3	24.9	25.1	2,677	17.4	15.5	16.5	5,706	11.5	11.7	11.6	3,056	23.0	20.4	21.8	563
Rural	42.3	44.3	43.3	1,885	22.1	22.1	22.1	1,547	13.0	9.9	11.5	399	36.6	32.9	35.2	260
Total	40.3	42.3	41.3	4,562	21.5	21.2	21.3	7,253	12.8	10.3	11.5	3,455	33.2	29.3	31.6	823
Cases	2,272	2,290	4,562		3,640	3,613	7,253		1,772	1,683	3,455		488	335	823	
Dropout rates																
Urban	0.5	2.2	1.4	206	1.9	3.8	2.8	415	5.3	5.3	5.3	336	18.4	16.0	17.4	161
Rural	6.0	4.5	5.2	4,043	6.9	6.4	6.7	6,338	11.4	13.5	12.4	2,743	17.8	26.6	21.2	640
Total	5.5	4.2	4.8	4,249	6.2	6.1	6.1	6,753	10.2	11.7	10.9	3,079	18.0	23.4	20.1	801
Cases	2,113	2,136	4,249		3,377	3,376	6,753		1,642	1,437	3,079		489	312	801	

Table 4. Educational attainment by sex in Malawi, 1992 and 2000. Source: Author's calculations using the Demographic and Health Surveys.

	2000					1992				
	None	Primary	Secondary	Tertiary	Total	None	Primary	Secondary	Tertiary	Total
Both sexes										
5-14	22.0	77.6	0.3		100.0	40.2	59.6	0.1	0.0	100.0
15-19	6.9	79.9	13.2		100.0	24.3	71.5	4.2	0.0	100.0
20-24	14.5	60.7	24.4	0.3	100.0	31.7	57.9	10.1	0.3	100.0
25+	33.6	55.6	10.3	0.5	100.0	44.2	49.5	5.9	0.4	100.0
Total 5+	24.3	66.8	8.7	0.2	100.0	39.2	56.7	4.0	0.2	100.0
Cases	12,767	35,111	4,589	127	52,594	8018.0	11601.0	814.0	39.0	20,472
Males										
5-14	23.4	76.4	0.3		100.0	40.3	59.6	0.1		100.0
15-19	5.8	81.6	12.7		100.0	19.3	76.4	4.3	0.1	100.0
20-24	9.5	57.9	32.0	0.6	100.0	22.6	63.0	14.0	0.4	100.0
25+	9.5	62.9	15.6	0.9	88.9	26.4	63.4	9.6	0.6	100.0
Total 5+	18.5	69.4	11.6	0.4	100.0	30.1	63.7	5.9	0.3	100.0
Cases	4,759	17,823	2,991	109	25,682	3006.0	6359.0	587.0	30.0	9,982
Females										
5-14	20.8	78.9	0.4		100.0	40.2	59.7	0.1	0.0	100.0
15-19	8.2	78.1	13.7		100.0	29.7	66.1	4.2		100.0
	19.0	63.3	17.6	0.1	100.0	40.1	53.2	6.6	0.1	100.0
25+	45.8	48.8	5.3	0.1	100.0	60.9	36.5	2.4	0.2	100.0
Total 5+	29.8	64.2	5.9	0.1	100.0	47.8	50.0	2.2	0.1	100.0
Cases	8,008	17,288	1,598	18	26,912	5,012	5,242	227	9	10,490

Table 4 presents the percent distribution of the population aged 5 and over, by highest level of education attained, in 2000 and 1992. The five-year age groups are 5-14, 15-19, 20-24 and 25+, which, we assume, correspond to primary school, secondary school, tertiary school and working age, respectively.[6] Among the children aged 5-14 years, almost 78 percent had attended some primary school in 2000, compared to about 60 percent in 1992. While in 1992 there was almost no differential in educational attainment by sex in that age group, in 2000 girls fare better than boys (80 percent versus 76 percent). This advantage for females is consistent with the primary NAR. Among people aged 15-19, about 13 percent have attended some secondary school, compared to 4 percent eight years earlier. As for the precedent age group, there is a slight advantage for females compared to males (13.7 percent versus 12.7 percent). This probably reflects the repeating patterns whereby boys are more likely than girls to repeat grades 5-8 of primary school, despite higher dropout rates among girls than among boys. In the age group 20-24, the proportion with tertiary education is negligible in 2000, as it was in 1992. Interestingly, contrary to the age group 15-19, the proportion of people with secondary education in the age group 20-24 is substantially higher among males (32 percent) than among females (18 percent), reflecting at least in part the joint effects of the repeating and dropout patterns in primary school, as described earlier.

Among the population aged 25 and over, the proportion with secondary education is higher among men (62.9 percent) than among women (48.8 percent). The differential in tertiary educational attainment by sex is also in the same direction (10.3 percent versus 5.3 percent). Overall, the proportion of the population aged 5 years or older that has achieved any education varied from 60.1 percent in 1992 to 75.7 percent in 2000. This later figure resulted from a proportion of 81.5 among men and 70.2 among women.

4.2. Educational differentials in fertility, mortality, and health

Table 5 presents the differentials in infant and child mortality by level of mother's education. Surprisingly, these differentials are not in the expected direction. As can be seen, children from mothers with some primary education are significantly more likely to die, than those born from mothers with no formal education. Splitting primary education into two categories reveals that infant and under-five mortality rates are higher among children whose mothers have reached grades 1-4 of primary school than among those whose mothers have reached grades 5-8 of primary school. Overall, if we exclude children born to mothers with no formal education, there appears a strong graded relationship between education (primary 14-, primary 5-8, secondary or higher) and infant and child mortality. Importantly, this pattern of higher mortality rates among children whose mothers have some primary education, compared to those whose mothers have no formal education, is also noticeable with regard to other mortality indicators (neonatal, post-neonatal, child) (National Statistical Office and ORC Macro 2001).

[6] Though the actual age groups are 6-13 for primary school and 14-17 for secondary school, we aim to keep five-year age groups for the sake of comparison with the 2015 projected population.

Table 5. Infant and child mortality, fertility, and maternal and child health by level of mother's education in Malawi, 2000. Source: Author's calculations using the Demographic and Health Surveys.

	Infant and child mortality		Fertility	Maternal and child health		
	IMR[1]	U5MR[2]	TFR	Delivery	Vaccination	Underweight
Values						
No education	98.6	197.3	7.3	44.4	64.0	29.5
Primary	116.3	215.5	6.4	57.7	70.8	25.7
Grades 1-4	128.9	242.2	6.7	51.7	66.5	27.9
Grades 5-8	104.0	189.9	6.0	64.1	75.1	23.6
Secondary+	64.6	116.9	3.1	87.5	87.5	10.4
Total	107.2	203.8	6.3	55.4	70.1	25.9
Ratio (Reference: No education)						
Primary	1.18	1.09	0.87	1.30	1.11	0.87
Grades 1-4	1.31	1.23	0.93	1.16	1.04	0.95
Grades 5-8	1.05	0.96	0.82	1.44	1.17	0.80
Secondary+	0.65	0.59	0.43	1.97	1.37	0.35

[1] Infant mortality rate: The number of deaths of children up to the age of one year, per 1,000 live births in a given year

[2] Under-five mortality rate: The number of deaths of children up to the age of five years, per 1,000 live births in a given year

We further investigate the effects of education on other aspects of health, namely, fertility and maternal and child health. Table 5 shows that there are notable education-related variations in the total fertility rates. Women with no formal education have a TFR of 7.3 children per woman, compared with 6.7 for those with one to four years of primary education, 6.0 for those with five to eight years of primary education, and 3.1 for those with secondary education or higher. Another important component of efforts to reduce health risks of mothers and children is increasing the proportion of babies that are delivered in facilities where medical intervention is available. Proper medical attention and hygienic conditions during delivery can reduce the risk of complications and infections that can cause the death or serious illness of the mother and/or the neonate (National Statistical Office and ORC Macro 2001).

Table 5 also shows that patterns of graded relationship are noticeable between education and maternal health (delivery at a health facility), child vaccination, and child nutritional status. A mother who did not go to school at all is more than four times more likely to deliver at home than a mother who attended some secondary school; a child aged 12-23 born from a mother with secondary or higher education is almost 40 percent more likely to be fully vaccinated than his counterpart from a mother with no formal education; children of women who have not attended formal school are almost three times as likely to be underweight (smaller weight-for-age) than those of women who attended some secondary or tertiary school. Importantly, primary education has notable positive effects on each health outcome. We can, therefore, speculate that the mortality pattern whereby children from mothers with some primary education stand greater risk

to die than those whose mother have no formal education, reflect, at least in part, the differentials in under-reporting of deaths by education.

4.3. Parameter estimates and assumptions for multi-state population projections

Given that the proportion of the population with tertiary education is less than 1 percent (see Table 4), our multi-state projections involve three states: No education, primary, and secondary or higher. We also contemplated the possibility of disaggregating the primary education group into two categories (Primary 1-4 and Primary 5-8) as in Table 5. Though this approach is reasonable for Malawi, it would certainly weaken any international comparison of the results. On the other hand, given that the objective of the study is to assess the likelihood of Malawi meeting the education-related MDGs, we carried out the projections to 2015.

Census data provides the population by age, sex, and education in 1998. We applied the percentage distribution of education in each age and sex group to the Malawi National Statistics Office (NSO) estimates of population by age and sex for the year 2000.

The baseline for the age- and education-specific fertility rates were estimates from the 2000 Malawi DHS data, using the software developed by Macro for this purpose. As shown in Table 5, the TFR is 6.3, that is 7.3 among women with no formal education, 6.4 among those with some primary education, and 3.1 among secondary or higher educated women. On the other hand, the NSO estimate of TFR in 2002[7] stands at 6.54. Applying the education differentials from the DHS data to the overall TFR above, and adjusting[8] in the PDE software, yields the following TFR by educational group: 7.59 for women with no education; 6.17 for women with some primary education; and 3.84. According to the NSO, TFR is anticipated to reach 5.96 in 2012. This value was disaggregated with regard to education in a similar way as for the 2000 TFR.

In practical terms, we first inputted in PDE the age- and education-specific rates derived from the DHS data. After modifying the TFRs generated by PDE to those derived from the NSO estimates, the software readjusted the age-specific values accordingly. The same procedure was applied for the estimates during the period 2010-2015. Detailed results are shown in Table 6.

According to the NSO, life expectancy at birth (LEB) in 2002 is estimated to be 42.84 years for males and 45.75 for females. According to a family of the Coale and Demeny (1983) life table (West), these values of LEB almost correspond to level 11 of mortality 11. In the absence of information on differentials in LEB by education for males and females, we further assumed that the LEB of people with no formal education corresponds to level 10 (39.7 for men and 42.5 for women); that of people with some primary education corresponds to level 11 (42.1 for males and 45.0 for females); and

[7] Where possible we use values related to 2002 for the projection over the period 2000-2005, and those related to 2012 for the projection over the period 2010-2015.

[8] The overall TFR generated by the PDE software from the age- and education-specific fertility rates may be different from the overall TFR expected. Therefore, we had to adjust and obtain the targeted overall TFR. Indeed, PDE readjusts the age-specific rates to fit a given TFR.

that of people with some secondary or tertiary education corresponds to level 12 (44.5 for men and 47.5 for women). The NSO projections of LEB for 2012 (for the period 2010-2015) stand at 50.7 years for males and 53.3 years for females, which represent an increase of almost seven years between 2000 and 2012. These estimates seem unrealistic, given the previous trends of LEB derived from the census data (an increase of two years between 1977 and 1987, followed by a slight decline of almost one year between 1987 and 1998). Instead, we used the NSO estimates for 2007 (45.7 for males and 48.3 for females) as the anticipated LEB for the period 2010-2015.

Table 6. Age- and education-specific fertility rates for multi-state population projections, Malawi. Source: Author's calculations and assumptions.

	2000-2005			2010-1015		
Age	None	Primary	Secondary+	None	Primary	Secondary+
15-19	0.2516	0.1765	0.0911	0.2420	0.1702	0.0902
20-24	0.3288	0.3171	0.2260	0.3163	0.3058	0.2236
25-29	0.3159	0.2595	0.2097	0.3038	0.2503	0.2075
30-34	0.2402	0.2196	0.1030	0.2311	0.2117	0.1019
35-39	0.2085	0.1495	0.0461	0.2005	0.1442	0.0456
40-44	0.1182	0.0813	0.0461	0.1137	0.0784	0.0456
45-49	0.0547	0.0305	0.0461	0.0526	0.0294	0.0456
TFR	7.59	6.17	3.84	7.30	5.95	3.80
Overall TFR		6.54			5.96	

Given that Malawi is among the countries most affected by HIV/AIDS, and that the age patterns of AIDS deaths seem to deviate from those of non-AIDS deaths, applying a standard set of mortality rates from the life table would substantially bias our results. We first use the software SPECTRUM[9] to estimate the age- and sex-specific deaths rates (including AIDS deaths) in 2000. To do so, we hypothesized that the prevalence of HIV/AIDS rose from 5 percent in 1990 to 15 percent in 2000, and will decline to 10 percent in 2015. These age- and sex-specific mortality rates were then inputted in PDE and adjusted to fit the levels of LEB estimated above.[10] The age-, sex-, and education-specific mortality rates for the periods 2000-2005 and 2010-2015 are shown in Table 7.

[9] SPECTRUM is a software prepared by the Policy Project, funded by the US Agency for International Development. It is accessible online at http://www.futuresgroup.com/Resources.cfm?area=2a&get=Spectrum

[10] Interestingly, while adjusting the mortality rates to fit a given level of LEB, PDE rigorously maintains the age patterns of the mortality rates.

Table 7. Age- and education-specific mortality rates for multi-state population projections, Malawi. Source: Author's calculations and assumptions.

Age	None	Primary	Secondary	None	Primary	Secondary
	Males, 2000-2005			Females, 2000-2005		
0-4	0.0625	0.0583	0.0540	0.0553	0.0519	0.0483
5-9	0.0061	0.0057	0.0053	0.0063	0.0059	0.0055
10-14	0.0042	0.0039	0.0036	0.0046	0.0043	0.0040
15-19	0.0057	0.0053	0.0049	0.0058	0.0054	0.0051
20-24	0.0073	0.0069	0.0063	0.0071	0.0067	0.0062
25-29	0.0084	0.0078	0.0073	0.0081	0.0076	0.0071
30-34	0.0097	0.0091	0.0084	0.0093	0.0087	0.0081
35-39	0.0117	0.0109	0.0101	0.0101	0.0095	0.0089
40-44	0.0142	0.0132	0.0123	0.0112	0.0105	0.0098
45-49	0.0176	0.0165	0.0153	0.0133	0.0125	0.0116
50-54	0.0236	0.0221	0.0204	0.0174	0.0163	0.0152
55-59	0.0296	0.0276	0.0256	0.0233	0.0219	0.0204
60-64	0.0436	0.0407	0.0377	0.0338	0.0318	0.0296
65-69	0.0566	0.0528	0.0490	0.0487	0.0457	0.0426
70-74	0.0774	0.0722	0.0669	0.0669	0.0628	0.0585
75-79	0.1190	0.1110	0.1029	0.0962	0.0903	0.0841
80+	0.1355	0.1264	0.1172	0.1771	0.1663	0.1549
LEB[a]	41.59	43.35	45.27	44.58	46.17	47.95
Overall LEB		42.84			45.47	
	Males, 2010-2015			Females, 2010-2015		
0-4	0.0561	0.0522	0.0482	0.0501	0.0465	0.0431
5-9	0.0055	0.0051	0.0047	0.0057	0.0053	0.0049
10-14	0.0038	0.0035	0.0033	0.0042	0.0039	0.0036
15-19	0.0051	0.0048	0.0044	0.0052	0.0049	0.0045
20-24	0.0066	0.0061	0.0057	0.0065	0.0060	0.0056
25-29	0.0075	0.0070	0.0065	0.0073	0.0068	0.0063
30-34	0.0087	0.0081	0.0075	0.0084	0.0078	0.0073
35-39	0.0105	0.0097	0.0090	0.0092	0.0085	0.0079
40-44	0.0127	0.0119	0.0109	0.0102	0.0094	0.0087
45-49	0.0158	0.0147	0.0136	0.0120	0.0112	0.0104
50-54	0.0212	0.0198	0.0183	0.0157	0.0146	0.0136
55-59	0.0265	0.0247	0.0228	0.0211	0.0196	0.0182
60-64	0.0392	0.0365	0.0337	0.0306	0.0284	0.0264
65-69	0.0508	0.0473	0.0437	0.0441	0.0410	0.0380
70-74	0.0695	0.0647	0.0597	0.0606	0.0563	0.0522
75-79	0.1069	0.0995	0.0919	0.0871	0.0809	0.0750
80+	0.1217	0.1132	0.1046	0.1604	0.1490	0.1382

LEB	44.58	46.17	47.95	47.07	48.91	50.75
Overall LEB		45.75			48.30	

[a] Life expectancy at birth

Age- and sex-specific transitions rates (from no education to primary, referred to as P_{12}, and from primary to secondary or higher, referred to as P_{23}) were estimated from the 2000 Malawi DHS. This dataset retrieves information on school enrolment, educational attainment, and highest grade of school for the previous and the current school year. It also provides information on repetition and dropout. More specifically, among children aged 0-4 years, P_{12} (the probability of being enrolled in primary school over a five-year period) is estimated as the proportion of people aged 5-9 who are currently (in 2000) enrolled in primary school (64 percent for boys and 67.4 percent for girls). Transition to primary school for the age groups 5-9 and 10-14 were estimated from the proportion of people not enrolled the previous school year who are currently in school. On the other hand, age- and sex-specific transition rates from primary to secondary and higher were estimated by using information on repetition and advance rates. Values are summarized in Table 8.

Table 8. Age- and sex-specific educational transition rates for multi-state population projections, Malawi. Source: Author's calculations and assumptions.

	2000-2005				2010-2015			
	Males		Females		Males		Females	
Age	P_{12}	P_{23}	P_{12}	P_{23}	P_{12}	P_{23}	P_{12}	P_{23}
0-4	0.640	0.000	0.674	0.000	0.749	0.000	0.775	0.000
5-9	0.679	0.016	0.655	0.018	0.794	0.016	0.753	0.018
10-14	0.426	0.199	0.368	0.174	0.499	0.199	0.423	0.174
15-19	0.000	0.223	0.000	0.133	0.000	0.223	0.000	0.133
20+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes:
P_{12} is the transition rate to primary school.
P_{23} is the transition rate from primary to secondary or higher education.
We assume an increase of 17 percent in P_{12} among males and 15 percent among females. P_{23} is constant over time.

In the absence of information on international migration, we assume that net migration is zero. The NSO estimates of population forwarded the same assumption.

Table 9. Estimated school attainment by sex, Malawi, 2000 and 2015. Source: Author's calculations using the Demographic and Health Surveys.

	2015				2000			
Both sexes	None	Primary	Secondary+	Total	None	Primary	Secondary+	Total
5-14	15.5	83.9	0.6	100.0	29.0	70.7	0.3	100.0
15-19	5.1	77.1	17.8	100.0	15.5	71.6	12.8	100.0
20-24	8.2	61.7	30.1	100.0	25.5	54.7	19.8	100.0
25+	25.8	54.8	19.4	100.0	41.2	48.3	10.5	100.0
Total 5+	18.0	68.1	13.9	100.0	32.0	59.4	8.6	100.0
Cases	2,364,255	8,943,584	1,832,505	13,140,344	2,730,653	5,073,151	733,656	8,537,459
Males								
5-14	16.1	83.4	0.5	100.0	29.9	69.8	0.3	100.0
15-19	4.7	76.4	18.9	100.0	12.3	73.9	13.8	100.0
20-24	7.7	57.9	34.4	100.0	17.7	54.8	27.5	100.0
25+	18.1	56.8	25.0	100.0	28.5	55.8	15.7	100.0
Total 5+	14.7	68.4	16.9	100.0	25.6	62.8	11.6	100.0
Cases	945,330	4,397,341	1,087,935	6,430,606	1,068,371	2,618,945	485,774	4,173,090
Females								
5-14	15.0	84.4	0.6	100.0	28.1	71.6	0.3	100.0
15-19	5.5	77.7	16.8	100.0	18.7	69.4	11.9	100.0
20-24	8.7	65.4	25.9	100.0	31.9	54.7	13.4	100.0
25+	32.9	53.0	14.1	100.0	53.5	41.0	5.5	100.0
Total 5+	21.1	67.8	11.1	100.0	38.1	56.2	5.7	100.0
Cases	1,418,925	4,546,243	744,570	6,709,738	1,662,281	2,454,206	247,882	4,364,369

4.4. Education indicators for 2015

Table 9 presents the percent distribution of the estimated 2015 population aged 6 and over by the highest level of education attained. A comparison with values in 2000 is also provided. Nearly 84 percent of the population aged 5-14 in 2015 is estimated to have some primary school, compared with about 71 percent in 2000. In so far as these estimates are plausible, the country will fail to meet the second MDG which relates to universal primary education. Indeed, 15.5 percent of the people aged 5-14 (assumed to be the age range for primary school) have no formal education. Though the actual assessment of the MDG involves the net enrolment ratios in primary education, the proportion of people with no formal education constitutes the necessary starting point. The fact that the gap between girls and boys has narrowed between 2000 and 2015 is the result of our hypotheses whereby transition rates to primary school will rise by 17 percent for males and 15 percent for females between 2000-2005 and 2010-2015. Note that girls still enjoy a slight advantage over boys (84.4 percent versus 83.4 percent).

Among the population aged 15-19 (hypothesized to be the age range for secondary school), less than 18 percent have some secondary education. The fact that the percentage of people with no formal education in that age group is relatively low (about 5 percent) reflects high repetition and dropout rates, as mentioned in Section 4.1. The proportion of people aged 15-19 with secondary education is higher among men (18.9 percent) than among women (16.8 percent). However, gender disparities in primary and secondary education (MDG 3) seem overall negligible.

5. Summary and Discussion

This study used multi-state population projections to assess the likelihood of Malawi meeting the education-related MDGs. Importantly, it has used mortality rates that account to some extent for HIV/AIDS, given that Malawi is one of the most affected countries. In so far as our estimates and assumptions are reasonable, this work shows that the country is not on track to meet the MDG on full primary education. The study presents some limitations. First, having failed to get the percent distribution of the population by age, sex, and education according to the 1987 census, we could not carry out analyses of mortality differentials according to educational attainment as initially planned. This would have allowed us to provide some insights into adult mortality differentials by sex and level of education, and presumably, on AIDS deaths differentials by education. Second, we have failed to access the actual 1998 census data. Almost all descriptive analyses and parameter estimates are thus based on DHS data. Third, some of our assumptions, especially those related to LEB by level of education or to transition rates, need to be refined.

The way forward includes (i) collecting actual census data for 1998, 1987 and if possible 1997; (ii) carrying out mortality differentials by education and comparing with results from other projects (Kenya, Uganda); (iii) refining parameters for multi-state projections. It may also be interesting to split primary education into two categories (primary 1-4 and primary 5-8). The estimates of death rates including AIDS deaths also need to be refined.

6. References

Ahuja, V. and D. Filmer. 1995. *Educational Attainment in Developing Countries: New Estimates and Projections Disaggregated by Gender*. Washington, D.C.: The World Bank.

Bellew, R., L. Raney, and K. Subbaro. 1992. Educating girls. *Finance and Development* 29: 54-46.

Bicego, G.T. and J.T. Boerma. 1993. Maternal education and child survival: A comparative study of survey data from 17 countries. *Social Science and Medicine* 36(9): 1207-1227.

Caldwell, J.C. 1979. Education as a factor in mortality decline: An examination of Nigerian data. *Population Studies* 33(3): 395-413.

Coale, A. and P. Demeny. 1983. *Regional Model Life Tables and Stable Populations*. 2nd Edition. New York: Academic Press.

Dubey, A. and E. King. 1994. A New Cross-country Education Stock Series Differentiated by Age and Sex. Typescript. Washington, D.C.: The World Bank.

Goujon, A. and W. Lutz. 2004. Future human capital: Population projections by level of education. Pages 121-157 in W. Lutz, W.C. Sanderson, and S. Scherbov (eds.), *The End of World Population Growth in the 21st Century: New Challenges for Human Capital Formation and Sustainable Development*. London: Earthscan.

Hadden, K. and B. London. 1996. Educating girls in the third world: The demographic, basic needs, and economic benefits. *International Journal of Comparative Sociology* 37: 31-47.

Hobcraft, J. 1993. Women's education, child welfare and child survival: A review of the evidence. *Health Transition Review* 3(2): 159-173.

Keyfitz, N. 1985. *Applied Mathematical Demography*. Second Edition. New York: Springer Verlag.

Lutz, W., Ed. 1994. *Population-Development-Environment: Understanding their Interactions in Mauritius*. Berlin: Springer Verlag.

Lutz, W. and A. Goujon. 2001. The world's changing human capital stock: Multi-state population projections by educational attainment. *Population and Development Review* 27: 323-339.

Lutz, W., A. Goujon, and G. Doblhammer-Reiter. 1999. Demographic dimensions in forecasting: Adding education to age and sex. Pages 42-58 in W. Lutz, J.W. Vaupel, and D.A. Ahlburg (eds.), *Frontiers of Population Forecasting*. A Supplement to Vol. 24, 1998, *Population and Development Review*. New York: The Population Council.

Mankiw, N.G., D. Romer, and D.N. Weil. 1992. A contribution to the empirics of economic growth. *Quarterly Journal of Economics* 107(2): 407-437.

National Statistical Office [Malawi] and ORC Macro. 2001. *Malawi Demographic and Health Survey 2000*. Zomba, Malawi and Calverton, MD, USA: National Statistical Office and ORC Macro.

Rogers, A. 1975. *Introduction to Multiregional Mathematical Demography*. New York: John Wiley.

Romer, P.M. 1992. Two strategies for economic development: Using ideas and producing ideas. Pages 63-115 in L.H. Summers and S. Shah (eds.), *Proceedings of the World Bank Annual Conference on Development Economics*. Washington, D.C.: The World Bank.

United Nations. 2000. *The Millennium Declaration*. New York: United Nations.

Yousif, H.M., A. Goujon, and W. Lutz. 1996. *Future Population and Education Trends in the Countries of North Africa.* Research Report RR-96-11. Laxenburg, Austria: International Institute for Applied Systems Analysis.