The Spread of Primary Schooling in sub-Saharan Africa: Implications for Fertility Change

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STATE EDUCATIONAL POLICIES are a critical aspect of the economics of family building in all societies, as well as a primary means of socialization by the state. Caldwell (1980) hypothesized that the onset of the fertility transition in developing countries would be linked with the achievement of "mass formal schooling," by which he meant near-universal enrollment of children in primary or basic schooling. In sub-Saharan Africa, a region in which the fertility transition has begun in some countries but not in others, this hypothesis remains untested. In all of these countries, formal schooling is a foreign import, imposed in a variety of ways over the last century by colonial regimes and foreign churches. In more recent years, as former colonies have gained their independence, most governments have made significant budgetary commitments to education, and educational systems have been revised and reformed to serve the goals of independent states. Today, the educational systems arrayed across the African continent show enormous variation, with many retaining strong links to their colonial roots. Some countries have achieved near-universal enrollment at the primary-school level, but most have not. In many, gender gaps in enrollment rates are closing but, in others, this gap remains large despite significant progress.

Two decades have passed since the publication of Caldwell's (1980) article on "Mass education as a determinant of the timing of fertility decline." The links he hypothesized between mass schooling and fertility were based largely on the historical experience of the West, where state enforcement of compulsory schooling laws was the rule. In that article, he faulted much of the literature on education and fertility in developing countries for having neglected the more immediate impact of children's schooling on the

reproductive decisionmaking of parents, and for having concentrated instead solely on the impact of parents' own education on their subsequent fertility. Even though the period since his article was written has encompassed the start of many fertility declines throughout the world, the same criticism could be equally aptly leveled at the literature today. In a review of the state of knowledge on education and fertility by the Committee on Population of the National Academy of Sciences (Bledsoe et al. 1999), not a single contribution addresses this question.

This article explores the associations between progress toward universal primary schooling in sub-Saharan Africa and the timing of the onset of fertility decline. We begin with a discussion and amplification of Caldwell's hypothesis. Our assessment of educational progress, which follows, is based on the most recent household survey data from each of the 23 sub-Saharan African countries that have participated in the Demographic and Health Survey program (see Table 1).[1]

These countries experienced a range of colonial educational traditions, primarily British and French, but also including Portuguese, German, and Belgian. To our knowledge, this is the first time DHS data have been used to assess trends in children's schooling; elsewhere UNESCO gross enrollment ratios are commonly used despite their severe shortcomings to which we allude below. In the final section, we explore the cross-country relationships between levels of schooling attained and recent markers of the fertility transition.

Caldwell's hypothesis revisited

Classical demographic transition theory predicts that fertility decline will occur naturally in association with socioeconomic development. A transition from large families to smaller families will be accompanied by increased parental investments in children. Both sets of changes are associated with improved survival prospects, expanding opportunities for wage employment for parents, and rising rates of return to educational and health investments in children. Economists call this the quantity–quality transition. Some scholars of the demographic transition have given particular attention to the external factors that might trigger a fertility transition (conventionally defined as the point at which national fertility levels fall more than 10 percent below their historical high: e.g., Bongaarts and Watkins 1996), the timing of which is not predicted by the theory. Each of the mechanisms described by Caldwell for hypothesizing a causal link between the achievement of mass schooling and the onset of demographic transition implies the role of external agents acting in a variety of ways, including through the enforcement power of the state, the conditions on grants and loans imposed by external aid agencies, the content of textbooks, the choice and content of curriculum, and/or the teaching and use of language.

TABLE 1 Historical and demographic characteristics of selected countries of sub-Saharan Africa

Country	Colonized by	Date of independence	Population (millions)[a] 1995	Percent residing in urban areas[b]			TFR[c]	Date of DHS survey
				1970	1980	1990		
Benin	France	1960	5.3	16.7	27.3	34.5	6.3	1996
Botswana	Great Britain	1966	1.3	8.4	15.1	41.5	5.0	1988
Burkina Faso	France	1960	10.2	5.7	8.5	13.6	6.9	1992–93
Cameroon	Great Britain/France	1960	13.2	20.3	31.4	40.3	5.2	1998
Central African Rep.	France	1960	3.3	30.2	35.1	37.5	5.4	1994–95
Ghana	Great Britain	1957	17.4	29.0	31.2	33.9	4.5	1998–99
Ivory Coast	France	1960	14.1	27.4	34.8	40.4	5.7	1994
Kenya	Great Britain	1963	28.2	10.3	16.1	24.1	4.7	1998
Madagascar	France	1960	14.7	14.1	18.3	23.5	6.1	1997
Malawi	Great Britain	1964	11.1	6.0	9.1	11.8	6.7	1992
Mali	France	1960	10.7	14.3	18.5	23.8	7.0	1995–96
Mozambique	Portugal	1975	17.4	5.7	13.1	26.6	5.6	1997
Namibia	Germany/South Africa	1990	1.5	18.6	22.8	31.0	5.2	1992
Niger	France	1960	9.2	8.5	12.6	16.1	7.5	1998
Nigeria	Great Britain	1960	110.4	20.0	26.9	35.0	6.2	1990
Rwanda	Belgium	1962	5.3	3.2	4.7	5.0	6.5	1992
Senegal	France	1960	8.3	33.4	35.9	40.4	6.3	1992–93
South Africa	Great Britain	1910	41.4	47.8	48.1	48.8	2.9[d]	1998
Tanzania	Germany/Great Britain	1961	29.6	6.7	14.8	20.8	5.9	1996
Togo	Germany/France	1960	4.1	13.1	22.9	28.5	5.4	1998
Uganda	Great Britain	1962	21.0	8.0	8.8	11.2	6.9	1995
Zambia	Great Britain	1964	8.2	30.2	39.8	42.0	6.1	1996–97
Zimbabwe	Great Britain	1980	11.2	16.9	22.3	28.4	4.5	1994

[a]United Nations (1999).
[b]United Nations (1998).
[c]Authors' calculations for women aged 15–49 based on individual DHS country surveys. Total fertility rate (TFR) is an average calculated for the five years before the country's DHS.
[d]The most recent fertility estimate for South Africa is from Medical Research Council (1999).

Caldwell (1980) listed five mechanisms through which the effective imposition of mass schooling by the state would change the family economy: (1) by reducing the time that children are able and/or willing to work on behalf of the family either in or outside the home; (2) by raising the costs of children, not only because of the many costs directly or indirectly associated with school attendance but also because of the additional resource demands placed on parents by children who have gained a new authority in the family; (3) by creating social norms about childhood as a stage of dependency; (4) by speeding up cultural change and creating new cultures; and (5) by propagating Western middle-class values within the less developed countries. He emphasized that the "most potent force for change is the breadth of education (the proportion of the community receiving some schooling) rather than the depth (the average duration of schooling among those who have attended school)" (Caldwell 1980: 249). Caldwell, citing Coale (1969), defined mass schooling as the point at which 90 percent of children of primary-school age attend school.

Mechanisms 1 and 2 are directly related to the economic changes that would ensue in a particular family if a child in that family, who would otherwise not have attended school, were to attend. Mechanisms 3, 4, and 5, however, appear potentially broader in their implications. Indeed, at the point where mass schooling has its effects in generating fertility decline, Caldwell posited that those effects would be universal, affecting all parents simultaneously, regardless of their educational level or the extent of their own children's school attendance. Thus, although he saw the effects of mass schooling on parental reproductive behavior as working primarily through the cumulative changes in the economic situation of families who send their children to school, apparently he also expected that the arrival of mass schooling would raise the costs and reduce the benefits of large families even for those remaining families who choose not to send their children to school. Indeed, for clarity we might re-specify mechanisms 1 and 2 as pertaining directly to changes in the family economy and mechanisms 3, 4, and 5 as pertaining to some of the social externalities of schooling affecting society at large.

Caldwell's hypothesis was based on a review of the experience of industrialized countries related to the onset of fertility decline and the timing of the arrival of mass schooling. He observed that the availability of schools and the adoption of compulsory schooling laws were clearly not sufficient by themselves. Rather, he identified the systematic *enforcement* of compulsory schooling laws as critical. Although recognizing that the beginning of the fertility decline in France antedates the enforcement of compulsory schooling laws, Caldwell linked the acceleration of the French fertility decline in the late nineteenth century to the achievement of effective compulsory schooling that took place during the same period. In discussing the

role of the state in the English fertility transition, Johansson (1991) also pointed to this key dimension of schooling. She identified the enforcement of compulsory schooling along with the raising of school-leaving ages as the most potent state policy in enforcing "altruistic parenting" (p. 400) and effecting fertility decline. Caldwell elaborates this argument in his recent analysis of delayed Western fertility decline in English-speaking countries (1999), in which he asserts that it was only with the enforcement of compulsory schooling laws and the spread of legislation protective of children that the costs of children rose to the point where the strong dictates against the use of contraception within the Victorian family could be overcome.

Caldwell's hypothesis, particularly as it relates to mechanisms 1 and 2, which are directly linked to the economics of the family, is entirely consistent with Becker's (1991) predictions of rapid fertility decline in response to rises in the price of children as parents trade off quality against quantity. Although Becker did not use the enforcement of compulsory schooling laws as an example of the rising costs of children, it could have been a particularly good one. With the enforcement of compulsory schooling laws, the price of each child rises and, at the same time, parents are no longer free to discriminate between children according to sex or birth order, at least during the basic years of schooling. This situation implies a shift in demand from quantity to quality, which leads to further increases in the price of children as parents incur the additional out-of-pocket expenses of sending their children to school and the opportunity costs of losing their children's time for domestic work or in support of family enterprises. By identifying the ways in which power shifts from the older to the younger generation as parents increase their demand for quality, Caldwell put sociological flesh on the bare bones of economic theory by illustrating some of the processes through which the change from quantity to quality may occur. In particular, he emphasized the importance of mass schooling for both boys and girls, because only when girls are required to go to school to the same extent as boys will intergenerational relationships within the family be strongly affected through the equalization of treatment of boys and girls.

Caldwell's hypothesis, particularly that part concerning mechanisms 3 and 4 which relate to the social externalities of schooling, is consistent in its implications with some of Watkins's (1991) theorizing about the social forces underlying the demographic integration of Western Europe during the years 1870 to 1960. In her book, Watkins makes a compelling case for the decline in linguistic diversity, the rise in national markets, and the expansion of state power and control as key factors in the shift to greater national demographic homogeneity as fertility decline spread from just a few pockets within each country to encompass, ultimately, the whole of every European nation. Indeed, Watkins identifies schooling as the most important aspect of nation building, particularly because of the enforcement of a na-

tional language (or languages, in countries having more than one) as the medium of instruction in schools. She focuses primarily on the role of schools in bringing diverse regions of the state together through a common language. The imposition of a common curriculum, often taught by teachers from different parts of a country, might also be considered an important aspect of nation building. Watkins also confirms Caldwell's interpretation of the French case, dating the decline in the use of other languages and dialects in France to the reforms of Jules Ferry, Minister of Public Instruction under the Third Republic, which introduced free and compulsory primary schooling in the French tongue in 1875. Beyond this date, fertility decline accelerated in France as traditionally non-francophone areas of the country joined in the decline that had emerged earlier in francophone areas.

Thus, Watkins emphasizes the role of the state in promoting social interaction or diffusion through linguistic homogeneity and market integration as the main determinant of fertility decline. Caldwell, on the other hand, emphasizes the role of schools as socializing agents external to the family in changing norms about childrearing, both through their effects on the economics of individual families and through their more global effects on the national culture. These perspectives can be reconciled if changing norms about childrearing are, in fact, being diffused as a result of near-universal school attendance, greater linguistic homogeneity, and the growing role of the state in setting a uniform national curriculum. The role of schools in the development of common state languages in sub-Saharan Africa may be of particular salience to fertility decline because of the roughly 1,250 languages estimated to be in current use, only nine of which are spoken as a first or second language by as many as 10 million people each (World Bank 1988).

The fifth mechanism through which Caldwell hypothesized that mass schooling might operate in developing countries was through the importation of Western middle-class values, as presented by teachers trained with Western teaching materials and portrayed by textbooks either imported from the West or heavily influenced by Western pedagogy and images. Given the limits of technology during the time he was writing, Caldwell probably saw formal schooling as the primary vehicle through which such values could be spread. Today, with radio and television nearly universally accessible, new and powerful forces of globalization are at work that can reinforce the effects of mass schooling and possibly substitute for them. Bongaarts and Watkins's (1996) analysis of the pace of change in contemporary fertility transitions, primarily in Asia and Latin America, suggests that once fertility decline begins in a few countries within a region, it spreads to others, even to those where socioeconomic conditions are less favorable, suggesting a process of cross-border diffusion.

In our review of the empirical evidence, we found only three studies that have explored statistically the direct effects of children's schooling at

the community level on fertility or contraceptive use and only one that is specifically focused on a sub-Saharan African country. In each case, it was hypothesized that access to school at the community level served as a measure of the supply of schooling by the state or by a local administrative authority and therefore represented a factor exogeneous to the family in affecting the economics of family building. Casterline (1985) used rural data from the 1980 World Fertility Survey for Egypt to test whether children's access to schools at the village level as well as the primary-school attendance ratio for girls and boys might affect parents' educational aspirations for their children and their own contraceptive use. He found that the desired number of years of schooling was negatively affected by distance to school, with parental educational aspirations for boys being more greatly affected by distance to secondary school while educational aspirations for girls were more greatly affected by distance to primary school. He found, too, that current contraceptive use was affected positively by the village primary-school attendance ratio for girls but negatively by the primary-school attendance ratio for boys. More recently, Guilkey and Jayne (1997), analyzing data from the 1989 Zimbabwe DHS, show that the number of educational opportunities in the community (the measurement of which was not defined) had a positive and statistically significant effect on contraceptive use. Most recently, Axinn and Barber (1999), using rich contemporary and retrospective data on 171 communities in Nepal, find that living near a school significantly increases a woman's chance of adopting a permanent contraceptive, even controlling for the proximity of a school during a woman's childhood—a variable with its own independent effect on contraceptive use.[2]

Interpretation of these studies is disadvantaged by the nature of their data. A theory about the onset of fertility decline cannot be tested by looking at cross-sectional correlations at a single point in time; comparisons across countries over time are required. Educational policy that affects the accessibility, price, and quality of schooling as well as the degree of enforcement of compulsory schooling operates at the level of the state. Indeed, if educational systems at the state level are the most salient in their implications for demographic change, then none of the extant empirical evidence reviewed can be used to prove or disprove the demographic importance of mass schooling (see Amin and Lloyd 1998 for an analogous point about gender systems). As Mason (1997) points out, the impact of changes in opportunity structures at the level of the state (she uses the example of women's opportunities as mediated by gender systems) can only be elucidated through the observation of successive cohorts. Furthermore, the experiences of one country over time must be set against the experiences of others in order to observe commonalities and differences.

In sub-Saharan Africa, where states are relatively weak and compulsory schooling laws (when on the books) are rarely enforced, cross-country

differences in educational trends reflect the differential role of external agents, such as the state, international donors, and Western pedagogy, as well as underlying economic and social forces—factors that cannot be easily disentangled. For this reason, our empirical assessment of Caldwell's hypothesis relies on description and deduction rather than on the estimation of multivariate models. By comparing the strength of the relationship between children's schooling and fertility among countries that have not yet achieved mass schooling levels with the strength of that relationship among countries that have achieved mass schooling levels, we can use statistical measures of the changing relationship as indirect evidence of a shift in attitudes and behaviors regarding fertility associated with the achievement of mass schooling. From this we seek to infer the role of external agencies in intensifying the schooling–fertility relationship.

Trends and patterns of formal schooling

Formal schooling as a Western import has been a presence in sub-Saharan Africa since colonial times and exhibited rapid spread in the early postindependence years as a result of substantial state investments. Between 1960 and 1980, new African governments outperformed most other world regions in the growth of educational expenditure and enrollment (Schultz 1987). Since Caldwell first elaborated his mass-schooling hypothesis in 1980, however, much has changed. The economic and political conditions of the 1980s led to a sharp curtailment of enrollment growth and, in some countries, even a cessation of the impressive education gains of the prior two decades. In 1990, various international initiatives, including the World Conference on Education for All, held in Thailand, and the ratification of the Convention on the Rights of the Child,[3] led to a renewal, at least on paper, of national and international commitments to universal schooling. In the ensuing decade, however, many African economies continued to flounder while the international donor response was weak (Bennell and Furlong 1997). These disappointing trends are confirmed in the country assessments prepared for the World Education Forum, convened in Dakar in April 2000.

Before exploring the association between fertility trends and the provision of mass schooling, we first consider trends and patterns of education in the region using recent survey data from 22 sub-Saharan countries, including all the countries that are known to be leaders in educational investments.[4] The indicator of educational progress chosen for this analysis is the proportion of 15–19-year-olds who have completed four or more years of schooling. There are several reasons why we feel that this indicator is more readily interpreted and compared across countries than two commonly used alternatives—UNESCO's gross primary-school enrollment ratio (e.g., Wils and Goujon 1998) and the proportion of 15–19-year-olds who have com-

pleted primary school (e.g., Filmer and Pritchett 1999).[5] First, UNESCO's gross primary-school enrollment ratio, which is calculated as the number of children *of any age* enrolled at the primary-school level as reported by the Education Ministry[6] divided by the number of children *of the appropriate age* as estimated by the United Nations on the basis of national data collected from households, is misleading. It does not provide a proper participation rate for school-age children and, because of changing patterns of school entry and grade repetition, it tends to exaggerate levels of school enrollment (see Table 2) and distort trends.[7] Second, in a context in which ages of entry and rates of retention vary across countries, the measure of current enrollment suggested by Caldwell (1980) sometimes understates and other times overstates the proportion of any cohort that will ultimately complete some minimal level of basic schooling such as grade 4 (see Table 2). Third, our sample of countries contains enormous variation in the structure of school systems, with the duration of the primary-school cycle varying from as few as five years in Madagascar and Mozambique to as many as eight in Kenya and Malawi (UNESCO 1999)—making the proportion of 15–19-year-olds who have completed primary school a noncomparable indicator across countries. Furthermore, late ages of entry and grade repetition are common in these countries, increasing the probability that some 15–19-year-olds will still be attending primary school and, therefore, will not yet have had the opportunity to complete the primary cycle.[8] Finally, in recent years UNICEF (1993) has singled out grade 4 completion as a meaningful educational indicator in international comparisons for the purpose of assessing progress toward education for all.

Using the educational distribution of the population by age from the most recently available DHS data for each of our sample countries, we estimate the percentage of 15–19-year-olds who have completed four or more years of schooling at five-year intervals starting with 1960. The percentage for 1960, for example, is estimated as identical with the percentage characterizing the current educational attainment of those who would have been aged 15–19 in 1960. For this calculation to be seen as an accurate estimate of the actual percentage of those who have completed four or more grades for each cohort, we must assume that no one in the sample was still enrolled in grades 1–4 at the time of their fifteenth birthday—a reasonable assumption given that even a child starting school at age ten should have had a chance to complete four years of schooling by age 15.

However, to the extent that systematic biases exist in age reporting and to the extent that survival rates differ significantly by educational attainment, estimates of trends will be biased. Because of differential survival rates by education, we expect older cohorts to appear more highly educated than they actually are, with the bias being greatest for the earliest estimates (those for 1960) and lessening for more recent years. Typical errors

TABLE 2 Alternative indicators of educational attainment in selected countries of sub-Saharan Africa

Country	Survey date(s)	Gross primary-school enrollment ratio[a]	Percent aged 7–14 currently enrolled in primary school[b]	Percent aged 15–19 who have completed 4+ years of primary school[b]
Benin	1996	78	44	36
Burkina Faso	1992–93	39	28	27
Cameroon	1998	96	70	75
Central African Rep.	1994–95	65[c]	59	45
Ghana	1998–99	80	68	82
Ivory Coast	1994	68	49	51
Kenya	1998	85[d]	88	91
Madagascar	1997	92[d]	55	42
Malawi	1992	80	63	51
Mali	1995–96	44	28	23
Mozambique	1997	60[d]	59	44
Namibia	1992	136	85	76
Niger	1998	29[d]	24	26
Nigeria	1990	85	54	66
Rwanda	1992	70[c]	57	63
Senegal	1992–93	71	33	40
South Africa	1993	115	95[e]	95[e]
Tanzania	1996	66	52	78
Togo	1998	119[d]	71	59
Uganda	1995	74	72	65
Zambia	1996–97	89	65	80
Zimbabwe	1994	114[c]	85	94

NOTE: See discussion in text.
[a]UNESCO (1999).
[b]Authors' calculations from DHS household surveys, based on current survey year; not available for Botswana.
[c]1990.
[d]1995.
[e]Authors' calculations based on the 1993 South Africa Living Standards Survey.

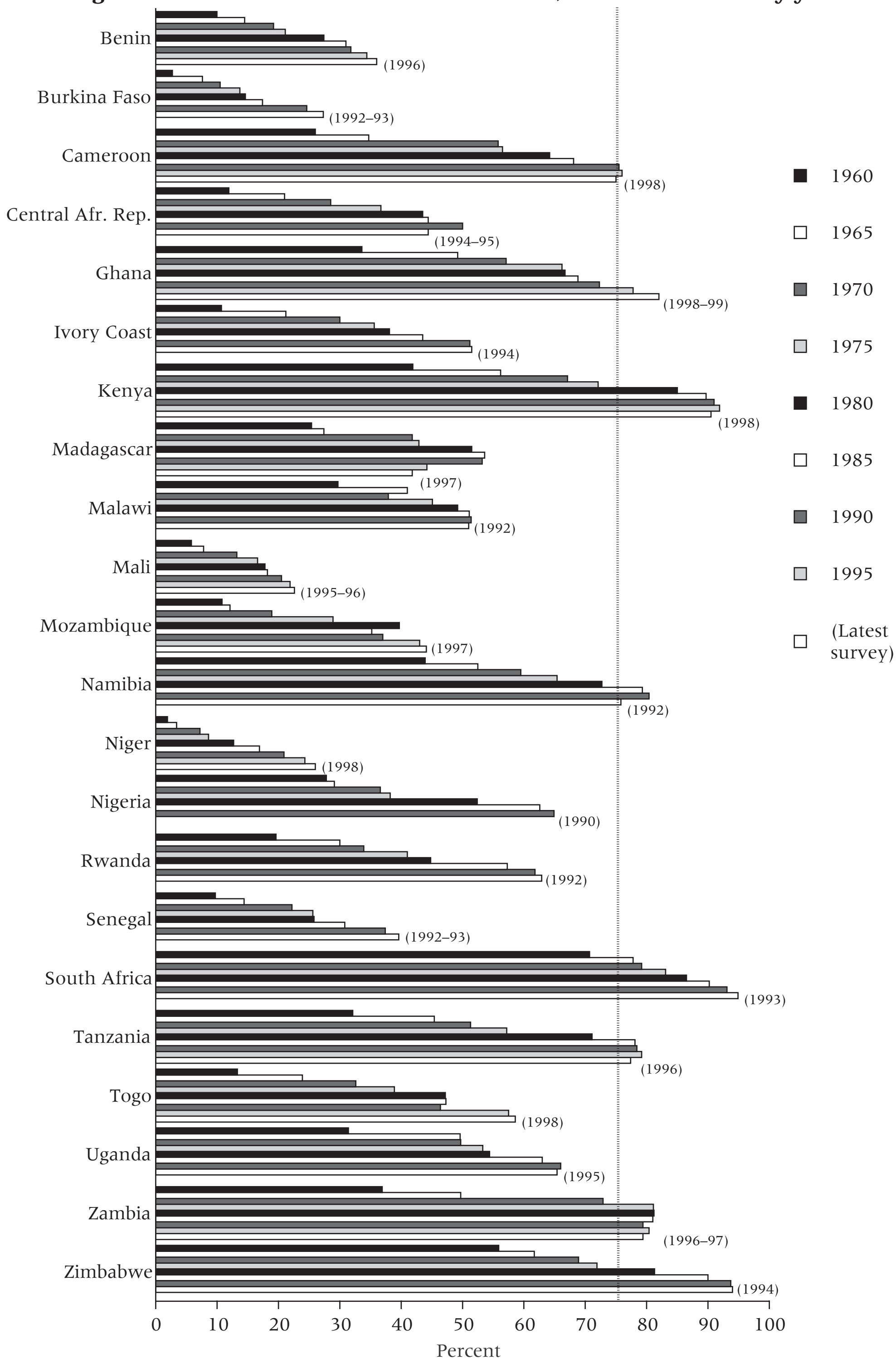
of age rounding are also likely to flatten trends. These biases, although not expected to affect country rankings in schooling levels seriously, will likely overestimate grade attainment in the earliest years of our comparison.

Caldwell defined the achievement of mass schooling as the point at which 90 percent of primary-school-aged children attend school. For these analyses, we use 75 percent of 15–19-year-olds who have completed four or more grades as the cutoff point for marking the achievement of mass schooling. Our designated threshold of 75 percent reflects the fact that we are focusing on a concrete level of grade attainment rather than simply on a measure of school participation.

Since the 1960s when our assessment of trends begins, all countries show clear increases in the percentage of children attaining at least grade 4, but the extent of those increases varies according to state spending patterns and educational strategies influenced considerably by former colonial experiences. Specifically, the levels of school attendance exhibited by the former French, Belgian, and Portuguese colonies are, in general, not as high as those achieved in the former British and German colonies represented here (see Figure 1). This pattern is congruent with British colonial education policies, which were more committed to some minimal education for all, particularly in areas of significant colonial settlement, whereas the French focused instead on educating a small elite (see Lloyd, Kaufman, and Hewett 1999 for discussion of the different colonial traditions). Outliers, nonetheless, exist within each of the major colonial traditions. Within the group of former British colonies represented here, Kenya has seen the percent completing grade 4 grow from 42 percent in 1960 to 91 percent by 1998, while Malawi, starting from a lower base in 1960 (30 percent), has experienced much more limited growth with the percent attaining grade 4 reaching only 51 in 1992. Variations exist as well in countries formerly colonized by the French, but the overall level is much lower and includes extremely poor educational performers such as Burkina Faso, Mali, and Niger—none of which has yet to achieve 30 percent of children completing grade 4. For example, the current percentage attaining grade 4 ranges from 23 percent in Mali to 75 percent in Cameroon (formerly British and French), while levels in 1960 ranged from 2 percent in Niger to 26 percent in Cameroon. In general, countries with an anglophone tradition have achieved higher levels of grade attainment than countries with other colonial traditions.

Nine of the 23 countries in this comparison have surpassed the 75 percent threshold that we define as the achievement of mass schooling, and, with the exception of Cameroon and Ghana, they are all countries from Southern or Eastern Africa.[9] These nine are likely to be the only countries out of the 59 countries in sub-Saharan Africa to have achieved mass schooling. The first country in the region to attain mass schooling was South Africa by 1965, followed by Zambia by 1975, Kenya and Zimbabwe by 1980, Botswana (not shown), Namibia, and Tanzania by 1985, Cameroon by 1990, and Ghana by 1995. While progress remains steady but slow in West Africa, where attainment rates are much lower, progress in Eastern and Southern Africa has slowed or halted, with a number of countries even showing declines in grade attainment in the most recent period. Countries experiencing declines in the percentage of 15–19-year-olds attaining at least grade 4 in the 1990s include Cameroon, Central African Republic, Madagascar, Malawi, Namibia, Tanzania, Uganda, and Zambia. However, declines for Malawi, Uganda, and Zambia are relatively slight. Because of a general slowdown in the growth of grade attainment in the 1990s, only one country—Ghana—has achieved mass schooling according to this indicator during the 1990s.

FIGURE 1 Estimated percentage of children aged 15–19 who have completed 4+ years of schooling: Selected countries of sub-Saharan Africa, 1960 to latest survey year



SOURCE: Authors' calculations from DHS household surveys for all countries but South Africa. For South Africa, estimates are derived from the 1993 Living Standards Survey.

The historical growth in the percentage completing four years of education and the recent stagnation of this growth are considered here as background for an evaluation of how these overall trends and patterns differed by sex. Have these countries made gains in achieving gender equity in grades completed? To the extent that overall grade attainment has reached mass-schooling levels, have girls shared equally with boys in this achievement—an issue that is likely to be particularly important in considering the onset and pace of fertility decline? Have the recent stagnation, and in some cases declines, in school completion adversely affected girls? Overall levels of grade attainment can disguise substantial gender differences. As already mentioned, the full achievement of mass schooling should involve the participation of both boys and girls.

Table 3 presents trends in the percentage of children aged 15–19 who have completed grade 4, separately for boys and girls beginning with 1970.[10] The estimates are grouped into one of three categories: (1) countries where girls and (in all but one case) boys have achieved mass schooling by the date of the most recent survey, (2) countries where the gender gap is narrowing but where girls have not yet achieved mass schooling levels, and (3) countries where the gender gap has been sustained over time.[11] Percentages are shown in boldface for each time period in which mass-schooling levels of 75 percent have been met or exceeded by either sex.

Seven of the eight countries that have achieved mass schooling for boys have also achieved mass schooling for girls, although in most cases girls have lagged behind boys in the timing of that achievement, usually by five to ten years. The exception to this is Cameroon, where boys achieved mass schooling in 1980 but girls as of 1998 had not yet achieved mass schooling. In all these countries, gender gaps continue to narrow and in some cases, such as Kenya, Tanzania, Zambia, and Zimbabwe, they have virtually been eliminated, while in a few—Madagascar, Namibia, Rwanda, and South Africa—they have been reversed, with girls' grade 4 completion rates now exceeding boys'. Namibia is an exceptional case because girls achieved mass schooling levels by 1980 while boys did not achieve those levels until a decade later.

In recent years, a more disturbing trend is developing in which continual narrowing in the gender gap is driven as much by declines in boys' grade attainment as by further increases for girls. In earlier years, the narrowing of the gender gap was primarily explained by more-rapid growth in girls' grade attainment relative to boys'. Boys' attainment rates have been declining since 1975 in Malawi and Zambia, since 1980 in Madagascar, Mozambique, and Togo (with some recovery in more recent years in Mozambique and Togo), since 1985 in Nigeria, Tanzania, and Zimbabwe, and since 1990 in Benin, Cameroon, Central African Republic, Kenya, Mali, Namibia, Senegal, and Uganda. Thus, over two-thirds of the countries for which we

TABLE 3 Trends in percentage of children aged 15–19 who have completed four or more years of schooling, by sex, in selected countries of sub-Saharan Africa, 1970–90 and latest survey date

Country and survey date(s)	1970		1975		1980		1985		1990		Latest survey date[a]	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Girls achieved ‡75%												
Ghana 1998–99	68	47	**77**	57	**77**	59	**80**	59	**83**	64	**85**	**79**
Kenya 1998	**80**	54	**85**	61	**91**	**80**	**92**	**88**	**93**	**91**	**91**	**91**
Namibia 1992	61	59	63	68	70	**75**	74	**84**	**76**	**85**	70	**82**
South Africa 1993	**82**	**77**	**85**	**81**	**87**	**86**	**91**	**90**	**92**	**94**	**93**	**96**
Tanzania 1996	67	37	74	43	**82**	61	**83**	74	**82**	**76**	**78**	**77**
Zambia 1996–97	**87**	60	**90**	72	**91**	74	**87**	**75**	**85**	**75**	**81**	**78**
Zimbabwe 1994	**79**	60	**85**	61	**91**	74	**96**	**85**	**95**	**93**	**95**	**93**
Countries narrowing gender gap												
Cameroon 1998	67	45	66	49	**75**	56	**79**	60	**85**	69	**78**	72
Madagascar 1997	44	39	48	39	55	48	54	53	52	55	41	43
Malawi 1992	56	22	67	26	64	35	64	40	60	44	55	46
Nigeria 1990	50	23	56	23	66	42	74	55	71	60	(b)	(b)
Rwanda 1992	46	23	51	32	50	41	59	56	61	63	61	65
Uganda 1995	66	31	66	41	69	42	**75**	53	**75**	59	70	61
Countries with sustained gender gap												
Benin 1996	30	10	36	11	42	16	45	21	46	21	46	25
Burkina Faso 1992–93	13	8	21	9	20	11	24	13	31	19	32	21
Central African Rep. 1994–95	46	13	55	20	58	31	58	32	64	38	55	35
Ivory Coast 1994	42	16	45	26	50	28	53	34	62	41	62	42
Mali 1995–96	18	8	22	13	25	13	25	14	30	14	29	17
Mozambique 1997	34	8	49	13	55	27	48	26	48	30	55	33
Niger 1998	10	5	13	5	18	9	25	12	30	16	36	18
Senegal 1992–93	32	15	34	20	33	22	41	23	47	29	45	34
Togo 1998	48	18	54	24	67	31	62	36	64	32	69	48

[a]Latest survey dates are the years of the survey shown next to country name in the left-hand column. [b]1990 is the latest survey date.
SOURCE: Authors' calculations based on DHS household surveys for all countries but South Africa. For South Africa, estimates are derived from the 1993 Living Standards Survey. DHS household survey data on schooling are not available for Botswana.

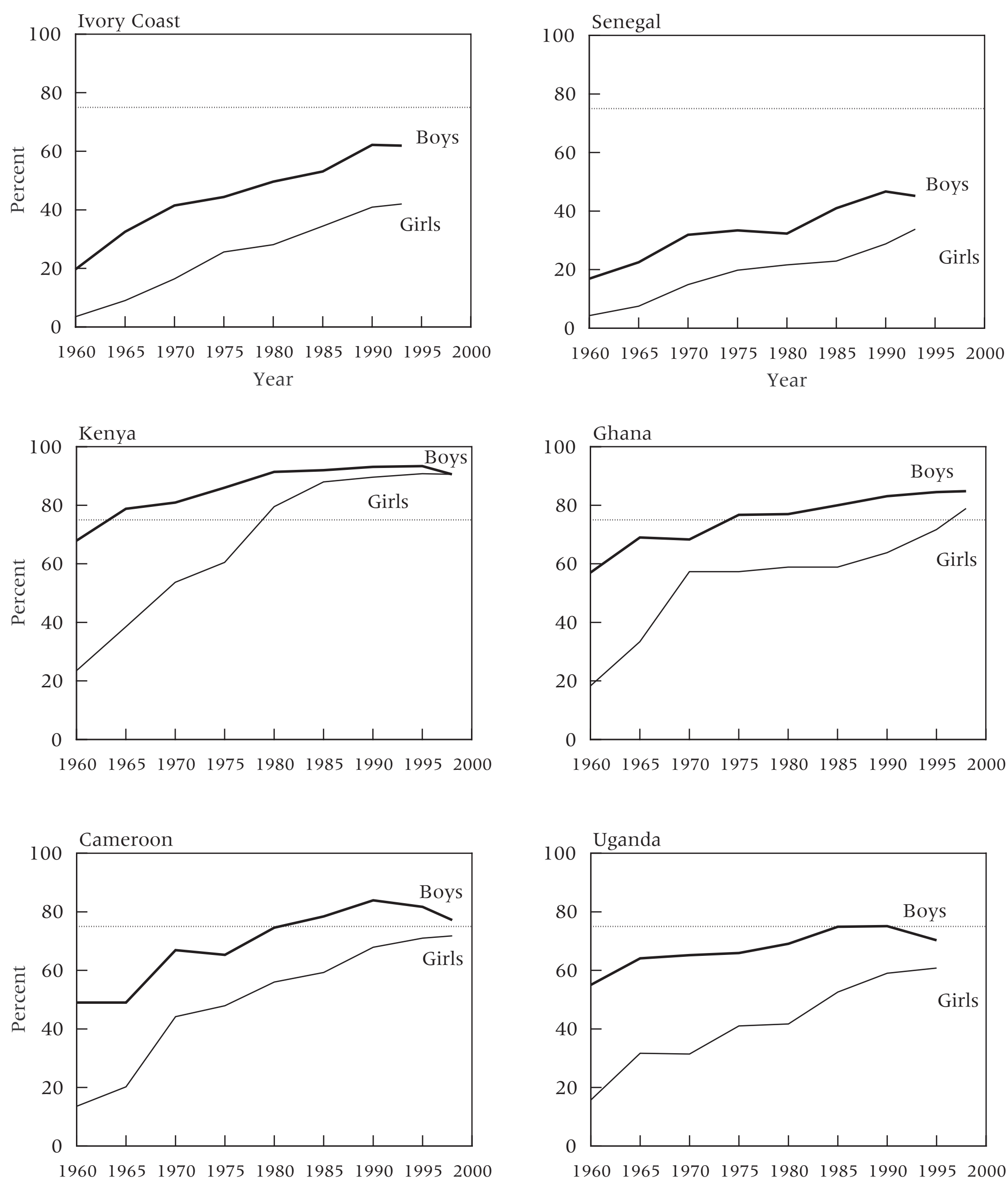
have data have experienced declines in boys' grade attainment.[12] It appears that declines in boys' enrollment have occurred primarily in those countries participating in World Bank–supported structural adjustment programs (Rose 1995).[13] While all the factors underlying these trends are not known, we speculate that, when parents turn to their children for economic contributions to the family during economically difficult times, boys may be more able than girls to make such contributions in the context of persistent cultural constraints and differential treatment of girls.

Eight West African countries and Mozambique showed sustained gender gaps as well as relatively low levels of grade attainment even for boys. These countries have experienced no significant narrowing of the gender gap, with the possible exception of Central African Republic.

We choose six countries to illustrate patterns of educational differentials by sex: two countries that have achieved mass schooling for boys and girls (Ghana and Kenya), two countries with narrowing gender gaps (Cameroon and Uganda), and two countries with sustained gender gaps and lower overall levels of grade attainment (Ivory Coast and Senegal). In Ivory Coast and Senegal, a gender gap of 20 and 11 percentage points, respectively, has been sustained in the percentage with at least four years of schooling (see Figure 2), although in both countries grade 4 attainment stands at well below the 75 percent mark for both boys and girls. Interestingly, the gap is larger in Ivory Coast even though the country's overall attainment levels are higher and the proportion of its government expenditures for primary education is greater than in Senegal (for expanded discussion see Lloyd, Kaufman, and Hewett 1999). Recent observations indicate that, in both countries, girls continue a slow trend upward for this measure. In Ivory Coast, however, the measure for boys has reached a plateau, and in Senegal the percentage of 15–19-year-old boys completing at least four years of school has declined slightly to just over 45 percent.

In Eastern Africa, the gender gap has closed completely in Kenya with remarkable progress for both boys and girls. The percentage of 15–19-year-olds now completing four or more years of schooling stands at roughly 90 percent and appears to have reached a plateau at that level, with perhaps a slight decline for boys. Ghana has experienced improvement from a lower base, after some stagnation during the 1980s. The gender gap, which had narrowed considerably by the 1970s, has narrowed further in recent years and now stands at 6 percentage points. Progress in Cameroon appears very similar to that in Ghana up until the most recent period, when Cameroon experienced a substantial setback in grade 4 attainment for boys, leading to a sharp narrowing in the gender gap. While there has been a substantial increase in girls' grade attainment in Uganda, the attainment of boys has stagnated since 1985, and previous gains in the early 1980s were reversed in the early 1990s.

FIGURE 2 Estimated percentage of children aged 15–19 who have completed four or more years of schooling, by sex, selected countries of sub-Saharan Africa, 1960–98



SOURCE: See Table 3.

Disparities in educational patterns and trends across urban and rural sectors also reveal a government's commitment or a country's capacity to achieve primary schooling for all of its school-aged population.[14] Although

the majority of the population in all countries under review still live in rural areas (as shown in Table 1), all countries have become more urban over time, and in six of them, Botswana, Cameroon, Ivory Coast, Senegal, South Africa, and Zambia, at least 40 percent of the population was living in urban areas by 1990. Trends in rural–urban educational attainment are illustrated in Table 4. Analogous to Table 3, this table provides estimates of the percent of children aged 15–19 who have completed four or more years of schooling by urban–rural residence for years spaced five years apart beginning with 1970 up to 1990 and for the most recent year for which data are available. Urban and rural estimates are based on residence at the time of the survey. To the extent that better-educated rural dwellers tend to migrate to urban areas over time, the estimates of grade attainment derived from the current distribution of grade attainment among household members in the DHS will increasingly understate educational levels for rural areas at successively earlier dates and, thus, increase the estimated gap between rural and urban areas.

In Table 4, countries are grouped into one of three categories: (1) countries where mass schooling appears to have been attained in both rural and urban areas, (2) countries in which the urban–rural gap is narrowing although the size of the gap in absolute terms is still large, and (3) countries where large gaps have been sustained over time. In no country has the gap between rural and urban areas been fully closed, although Kenya comes close to that state with a 2 percentage point gap between rural and urban areas. Moreover, the gains shown in narrowing urban–rural disparities do not appear to be as impressive as the gains in narrowing differences in education by sex. This result is all the more striking given the tendency for the urban–rural gap in earlier years to be overestimated. Only six countries—Botswana, Ghana, Kenya, South Africa, Tanzania, and Zimbabwe—have attained mass-schooling levels in both urban and rural areas. In three of these, the urban–rural gap has essentially been eliminated. While four additional countries have shown a narrowing of the gap between rural and urban areas, none has yet achieved mass schooling in rural areas. In more than half the countries in our sample, on the other hand, wide gaps in grade attainment have been sustained between urban and rural areas, and, given possible biases in our estimates of rural attainment rates in earlier years, may imply widening urban–rural gaps. In roughly half the countries we are also witnessing the beginning of a decline in urban grade attainment rates. These include Cameroon, Central African Republic, Ivory Coast, Kenya, Madagascar, Mozambique, Rwanda, Tanzania, Uganda, and Zambia and possibly Benin and Ghana. In most countries, however, a substantial gap between rural and urban schooling has been sustained for three decades, regardless of level of educational attainment.

In Figure 3, the same six countries as in Figure 2 are used to detail patterns in urban–rural differentials. For these six countries, rural grade 4

TABLE 4 Trends in percentage of children aged 15–19 who have completed four or more years of schooling, by urban–rural residence, in selected countries of sub-Saharan Africa, 1970–90 and latest survey date

Country and survey date(s)	1970		1975		1980		1985		1990		Latest survey date[a]	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Urban and rural achieved ‡ 75%												
Ghana 1998–99	72	50	**82**	58	**83**	58	**85**	60	**82**	66	**88**	**79**
Kenya 1998	**89**	62	**87**	68	**92**	**83**	**96**	**87**	**95**	**89**	**92**	**90**
South Africa 1993	**89**	64	**91**	72	**92**	**79**	**94**	**87**	**95**	**92**	**97**	**93**
Tanzania 1996	72	46	**76**	52	**84**	67	**87**	**76**	**89**	**75**	**87**	**75**
Zimbabwe 1994	**89**	58	**89**	62	**94**	72	**96**	**87**	**97**	**92**	**97**	**93**
Countries narrowing urban–rural gap												
Cameroon 1998	68	50	72	50	**80**	56	**82**	61	**87**	70	**86**	68
Nigeria 1990	64	27	68	29	**80**	42	**86**	54	**86**	58	(b)	(b)
Rwanda 1992	61	32	69	39	72	42	**79**	56	**76**	61	**76**	62
Uganda 1995	**79**	46	**77**	50	**80**	50	**86**	58	**86**	62	**83**	62
Countries with sustained urban–rural gap												
Benin 1996	36	10	40	10	45	16	51	18	49	20	50	25
Burkina Faso 1992–93	36	4	40	6	41	7	46	8	59	12	63	15
Central African Rep. 1994–95	39	21	56	26	63	30	63	29	69	33	65	24
Ivory Coast 1994	41	22	48	27	51	30	57	34	65	39	64	42
Madagascar 1997	60	33	65	34	**76**	43	74	46	71	46	66	32
Malawi 1992	72	34	74	39	**75**	44	**76**	46	**76**	47	**77**	47
Mali 1995–96	32	6	35	8	40	8	40	8	41	8	45	9
Mozambique 1997	38	13	52	23	67	29	72	24	70	27	66	34
Namibia 1992	**76**	47	**79**	55	**84**	64	**89**	73	**92**	**75**	**93**	69
Niger 1998	25	3	29	4	35	6	45	10	53	13	61	15
Senegal 1992–93	42	8	47	10	49	8	54	11	63	17	66	20
Togo 1998	57	21	61	28	67	37	70	34	67	33	74	49
Zambia 1996–97	**85**	63	**94**	71	**93**	72	**95**	69	**93**	69	**92**	69

[a] Latest survey dates are the years of the survey shown next to country name in the left-hand column. [b] 1990 is the latest survey date.
SOURCE: Authors' calculations based on DHS household surveys for all countries but South Africa. For South Africa, estimates are derived from the 1993 Living Standards Survey. DHS household survey data on schooling are not available for Botswana.

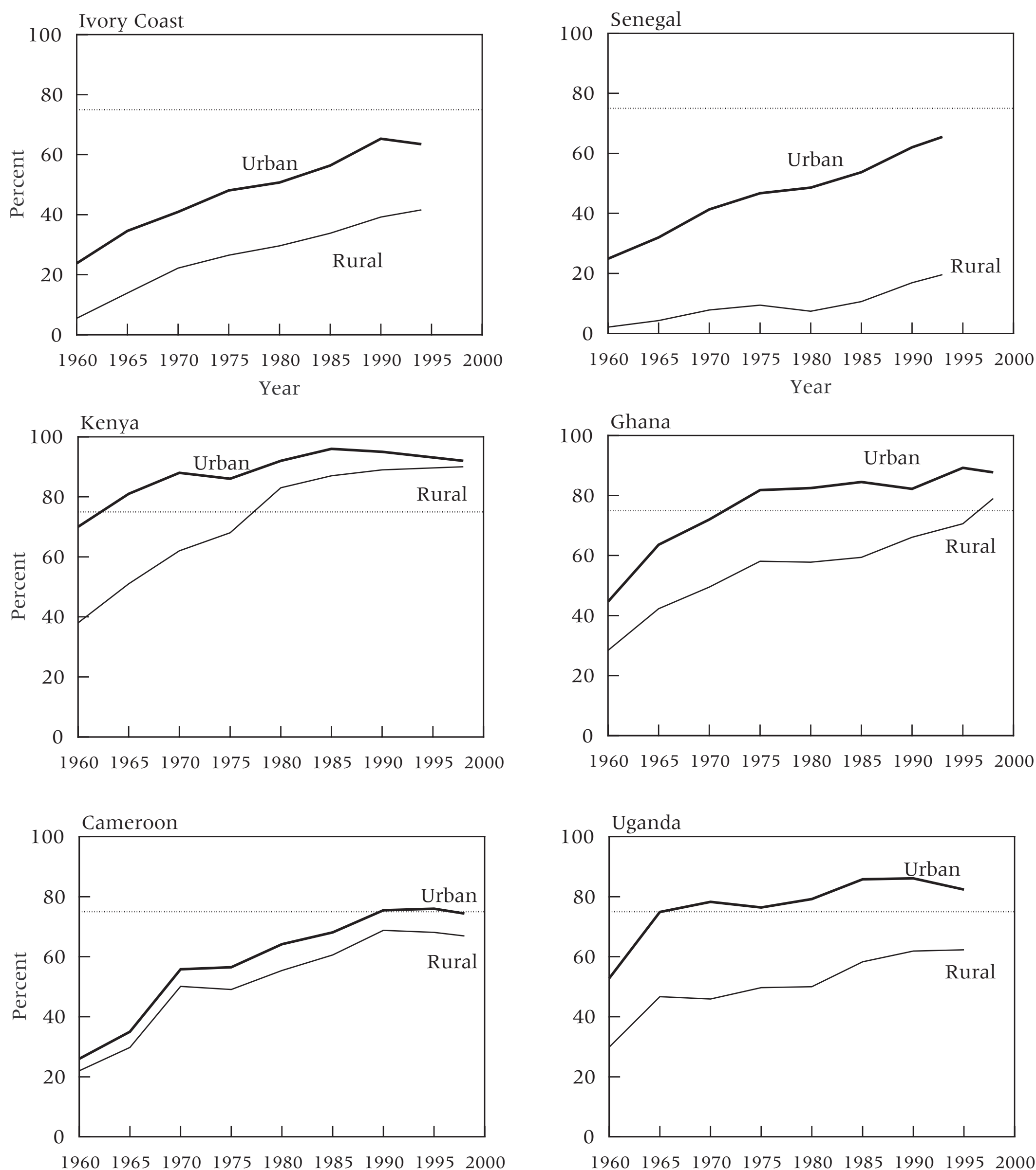
completion rates range from a low of 20 percent in Senegal to a high of 90 percent in Kenya, with the other four countries showing a range of 42 percent in Ivory Coast to 79 percent in Ghana. Trends in levels of 15–19-year-olds completing at least four years of schooling are strikingly dissimilar across the six countries. While all countries have shown some progress in increasing these levels for both urban and rural areas, in the case of Kenya the levels are approaching parity whereas in Senegal the absolute gap is widening. In Ivory Coast, a gap of 20 percentage points has been more or less sustained over time, while in Ghana a gap of 30 percentage points in 1970 had narrowed to 9 percentage points by 1998. Recent observations suggest a slight decline in urban areas in all countries except Senegal. The figure also shows that patterns are not necessarily a function of the overall level of education. The percentage of those completing four or more years of schooling, for example, is lower for Senegal than for Ivory Coast (see Figure 1). But while Ivory Coast has managed to sustain similar increases in education in both rural and urban areas, Senegal appears to have directed the bulk of educational resources to urban areas.

Even as we recall that improvements in grade attainment may be slightly underestimated given the possibility of overestimated grade attainment for earlier years, we feel confident in concluding that most countries in this review have made progress in expanding primary education for both boys and girls. However, at the same time that seven of the 23 countries reviewed here have achieved mass schooling for both boys and girls, there are still some francophone countries—including Benin, Burkina Faso, Mali, and Niger—where grade 4 attainment for girls has not yet surpassed 25 percent. Although gaps in education for boys and girls are narrowing, most countries are facing stagnating or declining levels of boys' educational achievement, even while girls continue to lag behind boys educationally. Furthermore, children in rural areas continue to lag substantially behind their urban counterparts in grade attainment despite substantial improvements in rural school accessibility (Filmer and Pritchett 1999). Most countries in sub-Saharan Africa are far from achieving mass schooling for their populations, and some have witnessed stagnation or erosion of the educational gains of earlier decades. We now pose the question: Is there a connection between the patterns and trends of education for children and fertility trends?

Implications of educational changes for fertility transitions

Although United Nations projections would imply that most countries in sub-Saharan Africa had begun a fertility transition by the late 1990s (United Nations 1999; for a discussion see Casterline 1999), firm evidence to support many of these projections is lacking. If we rely instead on fertility esti-

FIGURE 3 Estimated percentage of children aged 15–19 who have completed four or more years of schooling, urban–rural comparisons, selected countries of sub-Saharan Africa, 1960–98



SOURCE: See Table 4.

mates from censuses and surveys, particularly the recent Demographic and Health Surveys, fertility decline is apparently beginning to spread beyond the demographic leaders in Southern Africa and Kenya, but the spread is

by no means universal. In particular, evidence suggests the beginnings of a fertility transition in Botswana, Kenya, and Zimbabwe by the late 1980s and, in the case of South Africa, probably well before then (Cohen 1998; Kirk and Pillet 1998). Although another Southern African country—Namibia—is likely to have embarked on a fertility transition during the 1980s as well, data gathered at various points in time to track that transition are not available. Furthermore, there is now firm evidence from surveys conducted in the mid-to-late 1990s of moderate to larger fertility declines beginning in that decade for Cameroon, Ghana, Ivory Coast, Rwanda, and Senegal—the first countries in West Africa for which such evidence has been found (Cohen 1998; Kirk and Pillet 1998). In addition, Cohen (1998) presents evidence for small declines in total fertility rates for Malawi, Nigeria, Tanzania, and Zambia.[15]

If we assume that all countries in our sample were pretransitional in the early 1960s, we can develop reasonably comparable estimates of the percent decline in fertility from its pretransitional level by comparing the most recent TFR as estimated by DHS and the UN estimate of fertility for 1960–65 (see Table 5). If a fertility decline of 10 percent is used as a marker for the beginning of the transition (Bongaarts and Watkins 1996), this indicator would identify as still pretransitional ten of the 23 countries in this survey: Benin, Burkina Faso, Central African Republic, Madagascar, Malawi, Mali, Niger, Nigeria, Uganda, and Zambia. If we use, instead, current contraceptive prevalence as a marker (fewer than 10 percent of currently married women using contraception as pretransitional), we would include five of the previously named ten—Burkina Faso, Central African Republic, Mali, Niger, and Nigeria[16]—and also Mozambique and Senegal in the pretransitional category.

For the transition to diffuse widely throughout a population, fertility must begin to fall in rural areas. With the possible exception of South Africa, the majority of people in the countries of sub-Saharan Africa are rural dwellers. Furthermore, rates of urban growth vary greatly, from the striking cases of Botswana and Mozambique where there has been a near tripling in the case of Botswana and a doubling in the case of Mozambique in the proportion urban between 1980 and 1990, to the cases of Ghana and Rwanda where urban growth has been negligible during the same period. Levels and trends in urbanization matter greatly for the fertility transition; in some cases, such as Botswana and Mozambique, rapid trends in urbanization may be driving the transition.

Among the 23 countries considered in this article, eight had rural fertility rates lower than six children per woman: Botswana (5.4 in 1988), Cameroon (5.8 in 1998), Central African Republic (5.5 in 1995), Ghana (5.4 in 1998), Kenya (5.2 in 1998), Mozambique (5.8 in 1997), South Africa (3.9 in 1998), and Zimbabwe (5.1 in 1994) (see Table 6).[17] Among the

TABLE 5 Percentage decline in total fertility rate from 1960–65 to latest survey, and percentage of married women aged 15–49 currently using contraception, by country and date of most recent survey, selected countries of sub-Saharan Africa

Country	Survey date(s)	Decline in TFR, 1960–65 to present (percent)	Currently using any contraception (percent)
Benin	1996	9	16
Botswana	1988	29	32
Burkina Faso	1992–93	1	8
Cameroon	1998	13	19
Central African Rep.	1994–95	5	9
Ghana	1998–99	34	22
Ivory Coast	1994	22	11
Kenya	1998	42	39
Madagascar	1997	6	19
Malawi	1992	4	13
Mali	1995–96	1	7
Mozambique	1997	12	6
Namibia	1992	13	29
Niger	1998	–1	8
Nigeria	1990	3	6
Rwanda	1992	16	21
Senegal	1992–93	11	7
South Africa	1998	55	56
Tanzania	1996	15	18
Togo	1998	18	14
Uganda	1995	0	15
Zambia	1996–97	8	26
Zimbabwe	1994	43	48

SOURCE: Authors' calculations using individual DHS country surveys for all countries; "present" total fertility rate is TFR calculated for the five-year time interval preceding the survey; 1960–65 TFR from United Nations (1999).

other countries, where some evidence suggests a fertility transition, direct evidence is available from at least two independent surveys of slight declines in rural fertility in Ivory Coast, Senegal, Tanzania, Uganda, and Zambia. Most of these same countries, however, show greater declines in urban than in rural fertility. All countries in the sample have urban TFRs below six children per woman, and 12 of the 23 have urban fertility rates below five children.

In order to explore more systematically the relationship between mass schooling and fertility change, we have regressed the percentage of 15–19-year-olds having completed four or more years of schooling on two indicators of the fertility transition presented in Table 5: (1) the percentage decline in total fertility from its pretransitional base (1960–65) and (2) the

TABLE 6 Trends in total fertility rates by urban–rural residence according to estimates from available DHS and WFS surveys in selected countries of sub-Saharan Africa[a]

Country	Most recent DHS			Earlier DHS			WFS		
	Survey date	Urban	Rural	Survey date	Urban	Rural	Survey date	Urban	Rural
Benin	1996	5.2	7.0	na	na	na	1981–82	6.2	7.4
Botswana	1988	3.9	5.4	na	na	na	na	na	na
Burkina Faso	1992–93	5.0	7.3	na	na	na	na	na	na
Cameroon	1998	3.9	5.8	1991	5.3	6.5	1978	6.0	6.5
Central African Rep.	1994–95	5.2	5.5	na	na	na	na	na	na
Ghana[b]	1998–99	3.0	5.4	1988	5.3	7.0	1979	5.8	6.8
Ivory Coast	1994	4.7	6.4	na	na	na	1980	6.6	7.7
Kenya[c]	1998	3.1	5.2	1988–89	4.9	7.1	1977	6.0	8.5
Madagascar	1997	4.2	6.7	1992	3.9	6.7	na	na	na
Malawi	1992	5.5	6.9	na	na	na	na	na	na
Mali	1995–96	5.7	7.6	1987	6.2	7.2	na	na	na
Mozambique	1997	5.1	5.8	na	na	na	na	na	na
Namibia	1992	3.9	6.1	na	na	na	na	na	na
Niger	1998	5.9	7.9	1992	6.6	7.4	na	na	na
Nigeria	1990	5.0	6.3	na	na	na	1982	6.2	6.4
Rwanda	1992	4.7	6.6	na	na	na	na	na	na
Senegal	1992–93	5.2	7.0	1986	5.6	7.3	1978	6.5	7.5
South Africa	1998	2.3	3.9	na	na	na	na	na	na
Tanzania	1996	4.3	6.3	1991–92	5.1	6.5	na	na	na
Togo	1998	3.3	6.5	na	na	na	na	na	na
Uganda	1995	5.2	7.2	1988–89	5.7	7.5	na	na	na
Zambia	1996–97	5.3	6.7	1992	5.6	7.1	na	na	na
Zimbabwe	1994	3.2	5.1	1988–89	4.2	6.5	na	na	na

DHS = Demographic and Health Survey. WFS = World Fertility Survey. na = not available.
[a] 1–60 months before survey, except where otherwise indicated. [b]1993 data: 4.0 urban, 6.4 rural. [c]1993 data: 3.4 urban, 5.8 rural.
SOURCES: Most recent DHS: see Table 1. Earlier DHS: See Appendix. WFS: See WFS (1984).

percentage of all married women aged 15–49 currently practicing contraception. Both education and fertility indicators are measured as of the same survey date, keeping in mind that parental decisions about the schooling of children aged 15–19 at the date of the survey would have been made roughly ten years prior to the time at which fertility and use of contraception were measured. This time lag allows parental decisionmaking about family-building strategies to be influenced by overall societal levels of children's schooling.

Because Caldwell's hypothesis implies that the relationship between education and fertility decline will become much stronger once the mass-schooling threshold has been reached, we employ a Spline regression technique (Greene 1993). Spline regression allows us to estimate a piecewise linear function, such that the estimated slope of the regression line changes after a specified level of the independent variable has been reached.[18] In this instance we specify grade 4 attainment by 75 percent of 15–19-year-olds as the point at which we expect the strength of the relationship to change.[19]

The Spline regression results for our sample of 23 sub-Saharan African countries are presented in Table 7. The estimated relationship between education and fertility change is clearly consistent with expectations. The size and significance levels of the estimated slope coefficients reveal a markedly stronger relationship between education and the fertility transition above the 75 percent threshold, relative to the coefficients before the threshold has been reached. This provides compelling evidence that education has a much greater impact on fertility change and use of contraception once the mass-schooling threshold has been met. For instance, focusing on the average effect of education on fertility change indicates that for every 10 percent increase in grade 4 attainment prior to levels of mass schooling, total fertility declines by about 1.1 percent. By contrast, after mass schooling has been achieved the same increase in grade 4 attainment leads to a 17

TABLE 7 Results of Spline regression analysis of fertility change and current contraceptive use as a function of grade 4 attainment, selected countries of sub-Saharan Africa

	b	SE(b)	t-value	p-value
Fertility change 1965 to present				
Education < threshold (75%)	–.11	.10	–1.08	.292
Education ‡ threshold (75%)	–1.72	.27	–6.48	.000
Adjusted R^2 = .77				
Currently using any contraception				
Education < threshold (75%)	.15	.08	1.95	.065
Education ‡ threshold (75%)	1.53	.20	7.74	.000
Adjusted R^2 = .84				

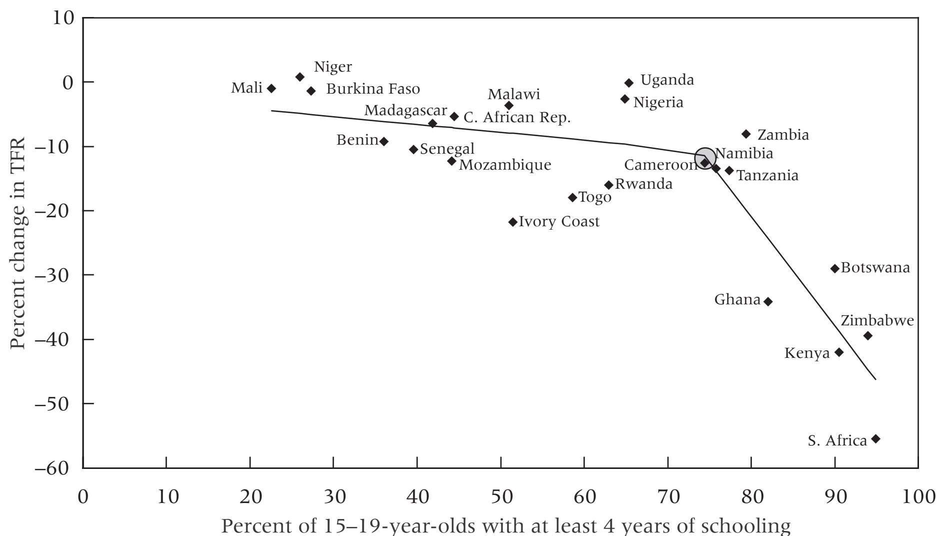
percent decline in fertility. These patterns are paralleled in the results for current use of contraception.

The overall fit of each of the Spline regression models is exceptionally good. The model estimation for fertility change has an adjusted R^2 of .77, while the model estimation for contraceptive practice has an adjusted R^2 of .84.[20] This indicates, respectively, that 77 percent and 84 percent of the variance in the dependent variables are explained by the cross-country variance in the percentage of 15–19-year-olds who have completed at least grade 4. The better fit of education and contraceptive practice could reflect the fact that the contraceptive measure has less measurement error, since the calculated percentage decline in the total fertility rate depends on the accuracy of estimates of fertility for two separate time periods. Furthermore, contraceptive prevalence is a more recent expression of deliberate fertility control, while the TFR reflects a five-year average that is sometimes subject to date shifting and timing and recall error.

Figures 4 and 5 present the estimated regression lines for the fertility and contraceptive practice regressions. The threshold or "knot" of the fertility regression line (the point in Figure 4 represented by the shaded circle at which grade 4 attainment reaches 75 percent) falls precisely at the point where fertility decline reaches 10 percent—a marker of the beginning of fertility transition. This is consistent with Caldwell's general argument and the discussion throughout this analysis.

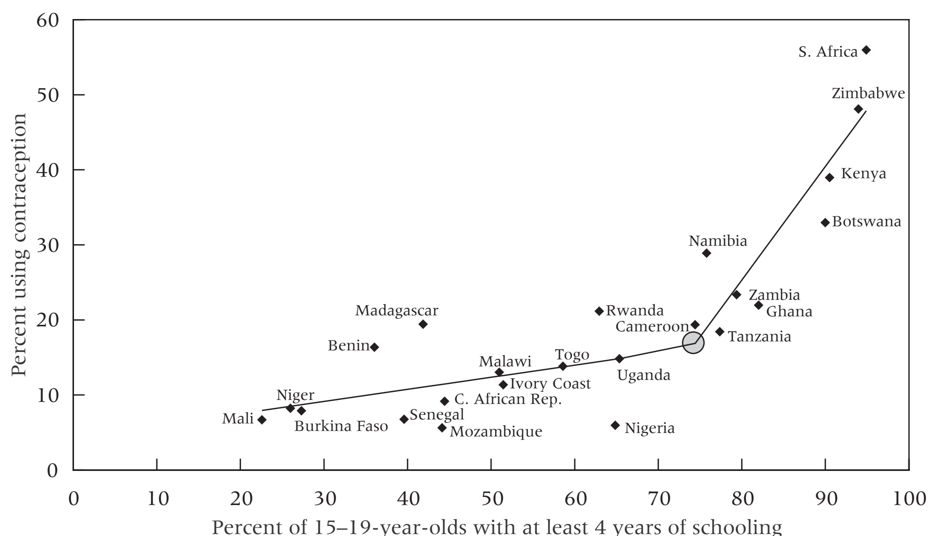
Although the expected relationship between educational attainment and the timing of the fertility transition is apparent from Figures 4 and 5, some deviations of the observed measures from the estimated regression line are worth noting. For example, in Figure 4, Ivory Coast, Mozambique, Rwanda, Togo, and possibly Senegal appear to have started a fertility transition despite the failure to attain mass schooling. The most extreme case in this group is Ivory Coast, which has apparently experienced a 22 percent decline in fertility despite only slightly more than 50 percent of 15–19-year-olds having attained a minimum of grade 4. On the other hand, Zambia does not appear to have started a fertility transition despite the achievement of mass schooling. Using 15 percent contraceptive practice as an alternative threshold for measuring the start of the fertility transition, it would appear from Figure 5 that Madagascar and Rwanda are the only countries that have started the fertility transition without attaining mass-schooling levels.[21] On the other hand, all countries that have achieved mass schooling show evidence of deliberate family-building behavior. Given the likelihood that contraceptive practice is measured more accurately than fertility change, Figure 5 may be a better guide to possible outliers. Indeed, we note the possibility that inconsistencies between Figures 4 and 5 may be as likely to suggest inaccurate estimates of fertility decline as they are to suggest early fertility transitions in the absence of mass schooling.

FIGURE 4 Spline regression line showing fit of percentage change in the TFR from the pretransition level as a function of educational attainment, selected countries of sub-Saharan Africa



NOTE: Variables measured at the most recent survey date (see Table 5 and Figure 1).

FIGURE 5 Spline regression line showing fit of percentage of married women practicing contraception as a function of educational attainment, selected countries of sub-Saharan Africa



NOTE: Variables measured at the most recent survey date (see Table 5 and Figure 1).

Concluding comments

In most of sub-Saharan Africa, the promise embodied in early postindependence progress in education, namely that the next generation would be universally exposed to basic levels of formal schooling, has yet to be realized. Countries that have achieved mass-schooling levels—Botswana, Cameroon, Ghana, Kenya, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe—are the exceptions rather than the rule, and most of these countries had achieved mass schooling by the early 1980s. In Nigeria and Uganda, roughly 65–70 percent of children have attained grade 4 or higher. The rest of Africa has even farther to go to achieve mass schooling, and in a few countries— Burkina Faso, Mali, and Niger—less than a quarter of girls and scarcely a third of boys have completed grade 4.

Since 1980, growth rates in grade attainment have slowed or halted; in some countries, these rates have even begun to decline in response to mounting economic difficulties. In countries at all levels of educational attainment, gender gaps are narrowing; in some, they have been largely eliminated and, in a few cases, reversed. In earlier years, this trend could be explained by relatively more rapid growth in educational attainment rates for girls than for boys. More recently, this trend has been accentuated by a cessation in growth rates for boys and, in a number of countries, a decline in these rates. In many cases, the narrowing of the gender gap is occurring at a point well below the achievement of mass schooling for either girls or boys.

Knodel and Jones (1996) have raised questions about the current international policy emphasis on closing the gender gap in schooling when much rapid progress has already been made on this front while the gap in education between rich and poor remains wide and neglected.[22] The data presented here appear to confirm their conclusions, at least with respect to the gap between rural and urban educational attainment compared with the gap in education between boys and girls. An exploration of the interaction between gender and socioeconomic status or gender and urban–rural residence would be a useful next step in assessing the full import of Knodel and Jones's argument. Moreover, not only do gender gaps in enrollment and attainment persist in the majority of sub-Saharan countries but also, when boys and girls attend school for the same number of years, their experiences are likely to be very different. Growing evidence in the education literature suggests that discriminatory attitudes and behaviors of teachers and fellow students toward girls can have long-term negative effects (for example, see Lloyd, Mensch, and Clark 2000). The narrowing of the gender gap in educational attainment or enrollment tells us little about the degree of gender equity within schools.

Our empirical results strongly support Caldwell's original hypothesis about the link between the achievement of mass schooling and the onset of

the fertility transition. If we rely on contraceptive practice as a more accurate marker of that stage of the transition than perhaps imperfectly estimated fertility change, we find that all countries that have achieved mass schooling also show evidence of having entered the fertility transition. Only Madagascar and Rwanda appear to have begun the transition prior to the achievement of mass schooling.

In light of recent setbacks in the increase in educational participation rates at primary-school levels, the key question remaining is: What are the prospects for future fertility decline in a context of educational stagnation both for countries that have already begun the fertility transition and for those that have not? Once begun, are future fertility declines inevitable, even in the absence of further educational progress? Can we expect Africans to limit their fertility even if they see no prospect that their children will have a chance to complete primary school or, in some places, attend school at all? Will there be a "quantity" transition without a "quality" transition? Will the emergence of national languages and cultures through the influence of the mass media transform the role of education in fertility transitions as suggested by Watkins (1991)? To answer these questions, we can draw a few insights from past experience. A cautionary note is in order, however. Development in the past has been experienced as a steady and irreversible process; contemporary African experience has no historical analog, not just because of the economic reversals of the 1990s but also because of the escalating AIDS crisis in many parts of Eastern and Southern Africa.

Although relatively few sub-Saharan countries were included in Bongaarts and Watkins's (1996) analysis of the timing and pace of the fertility transition in developing countries, they found that, for Asia, Latin America, and parts of Africa, the more recent the fertility transition, the lower the level of development at the time it began, a finding that supports a hypothesis of social interaction and diffusion across frontiers. Although the human development index (HDI) does not contain a measure of children's schooling—it records only adult literacy—Bongaarts and Watkins also found that the lower the level of the HDI at the beginning of the transition, the less rapid the subsequent fall in fertility. This finding might imply that, although fertility transitions are likely to begin in Africa at lower levels of development than were necessary in the past, the pace of decline will be slower if mass schooling has not been achieved. This is because the mechanisms in place for social interaction and diffusion, including a common national language, will be more limited. Furthermore, high rates of population growth and the youthful age structure of the population are likely to make achievement of mass schooling in the presence of high fertility an even more daunting task than it might have been in the early days of independence, thus providing a likely further brake on the pace of the transition. Indeed, Casterline (1999), in a review of the pace of fertility decline, finds that recent declines are proceeding more slowly than earlier ones.

We conclude that formal schooling will remain an important mechanism of "demographic integration" (Watkins 1991: 45) in sub-Saharan Africa, even as other forms of mass communication spread. The enormous linguistic diversity still prevalent throughout Africa, with 1,250 languages currently in use across the continent, reinforces this view. The appearance of recent fertility change in a few countries that have yet to achieve mass schooling does suggest that, in the future, mass schooling may be tied more closely to the pace than to the onset of fertility decline. We predict, however, that in countries where mass schooling has yet to be attained or where recent setbacks have occurred, fertility declines will proceed much more slowly and demographic diversity will persist across regional and socioeconomic groups.

Appendix Earlier DHS publications providing data included in Table 6

Note: Order of entries below corresponds to sequence of countries listed under the column headed "Earlier DHS" in Table 6.

Direction Nationale du Deuxième Recensement Général and Macro International Inc. 1992. *Enquête Démographique et de Santé Cameroun 1991.* Columbia, MD.

Ghana Statistical Service and Institute for Resource Development/Macro Systems, Inc. 1989. *Ghana Demographic and Health Survey 1988.* Columbia, MD.

National Council for Population and Development and Institute for Resource Development/Macro Systems, Inc. 1989. *Kenya Demographic and Health Survey 1989.* Columbia, MD.

Centre National de Recherches sur l'Environnement [Madagascar] and Macro International Inc. 1994. *Enquête Nationale Démographique et Sanitaire 1992.* Calverton, MD.

Centre d'Etudes et de Recherches and Institute for Resource Development/Westinghouse. 1989. *Enquête Démographique et de Santé au Mali 1987.* Columbia, MD.

Direction de la Statistique et des Comptes Nationaux and Macro International Inc. 1993. *Enquête Démographique et de Santé Niger 1992.* Columbia, MD.

Ministère de l'Economie et des Finances and Institute for Resource Development/Westinghouse. 1988. *Enquête Démographique et de Santé au Sénégal 1986.* Columbia, MD.

Bureau of Statistics and Macro International Inc. 1993. *Tanzania Demographic and Health Survey 1991/1992.* Columbia, MD.

Ministry of Health, Ministry of Planning and Economic Development, and Institute for Resource Development/Macro Systems Inc. 1989. *Uganda Demographic and Health Survey 1988/1989.* Columbia, MD.

University of Zambia, Central Statistical Office and Macro International Inc. 1993. *Zambia Demographic and Health Survey 1992.* Columbia, MD.

Central Statistical Office and Institute for Resource Development/Macro Systems, Inc. 1989. *Zimbabwe Demographic and Health Survey 1988.* Columbia, MD.

Notes

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1 While Senegal had its most recent Demographic and Health Survey in 1997, this survey did not include data on educational attainment as part of the household survey. Therefore, the most recent education data for Senegal come from the 1992–93 survey.

2 Axinn (1993) also explored the relationship between children's schooling and fertility in one village in Nepal. He found that whether parents sent their oldest child to school had a statistically significant positive effect on parents' ever use of contraception and a significant negative effect on their desire for more children. He found similar results for the proportion of children sent to school. Because the study was conducted in only one village, however, it cannot be viewed as a test of Caldwell's mass-schooling hypothesis. Furthermore, in light of the endogenous nature of fertility and schooling at the household level, problems are encountered in interpreting causality.

3 The Convention on the Rights of the Child became legally binding in September 1990 and committed its signatories (which included all sub-Saharan African countries except Somalia) to making primary education compulsory, available, and free to all (UNESCO 1999). Despite that fact, many of the individual country essays published in the 1994 issue of the *International Encyclopedia of Education* (Husén and Postlethwaite 1994) assert that schooling is not yet compulsory.

4 For all countries participating in the DHS 2 or DHS 3 survey programs, data on educational attainment of the adult population by age and sex are available from the household survey. For 21 of the 23 countries included in this analysis, the data are based on these household surveys. Because of South Africa's overall importance to the region, we added data for South Africa from a representative survey collected by the University of Cape Town and the World Bank in 1993—the South Africa Living Standards Survey. While South Africa participated in the DHS program, those data were not available in time for this analysis. In addition, for Botswana, data for women only are taken from the DHS survey of reproductive-aged women conducted in 1988. The 23 countries in our sample include a good representation of francophone and anglophone countries, all countries with some evidence of fertility decline, and a range of countries in terms of phase of development and form of government.

5 The measure suggested by Coale (1969) and quoted by Caldwell (1980) was the proportion of school-aged children currently enrolled.

6 Some evidence suggests that enrollment as reported by school systems reflects opening-day numbers rather than enrollments in mid-year or year-end; the latter two measures would reflect school attendance more accurately (Behrman and Rosenzweig 1994).

7 A decline in UNESCO's gross primary-school enrollment ratio could reflect a decline in enrollment or, alternatively, could imply improvements in the efficiency of the system through reductions in grade repetition rates or a shift toward more appropriate ages at entry. Similarly, a rise in the ratio could imply a rise in enrollment rates or, alternatively, a deterioration in the efficiency of the system resulting from rising repetition rates or delayed ages of entry. More typically, trends probably reflect simultaneous changes in a variety of underlying factors, some of which may be favorable and some not so. While, in principle, the net primary-school enrollment ratio, which only includes children of primary-school age in the numerator of the ratio, might be a more reasonable alternative, it is not available for some countries in our sample (UNESCO 1999).

8 In a study of primary schooling in Kenya, Lloyd, Mensch, and Clark (2000) found that 54 percent of 17–18-year-olds still enrolled in school were attending primary school.

9 These nine include Botswana, which achieved mass schooling for girls by 1985 but is not included in Figure 1 because data are available only for girls.

10 While data are available from 1960, space considerations preclude gender comparisons for the full time period. Examples of grade completion by sex back to 1960 are provided for six countries in Figure 2.

11 Gender differences in this third group of countries range from 11 to 22 percentage points at the date of the most recent surveys.

12 Our data for Botswana come from the individual DHS questionnaire addressed to women of reproductive age only. Therefore data on boys' grade attainment are not available.

13 The only countries in our sample of sub-Saharan African countries that have not undergone structural adjustment programs are Botswana, Cameroon, and South Africa.

14 One serious problem with such a comparison is that definitions of "urban" vary by country. Most urbanites in sub-Saharan Africa live in settlements with fewer than half a million inhabitants, and a large minority live in very small settlements that are essentially rural centers. Furthermore, the extent of urban primacy, or the concentration of wealth and public resources in the largest agglomeration, is more pronounced in sub-Saharan Africa than in any other region of the world. Thus, the category "urban" may encompass a huge range of living conditions (Martin Brockerhoff, personal communication, 1999).

15 Moreover, Kirk and Pillet (1998) use birth histories from the most recent DHS to demonstrate evidence of fertility decline among younger women (aged 15–34) in Madagascar, Malawi, Tanzania, and Uganda.

16 The most recent national data for Nigeria are from 1990.

17 Cameroon and Central African Republic are known for high rates of childlessness and subfertility (Larsen 1994).

18 This is represented by the following regression equations:

$$\hat{Y} = a_0 + b_0(X_0) \qquad \text{if } X_0 < \text{threshold}$$
$$\hat{Y} = a_1 + b_1(X_0) \qquad \text{if } X_0 \ddagger \text{threshold}$$

19 We tested other potential thresholds to determine the appropriateness of the 75 percent marker, e.g., 65, 70, 80, and 85 percent. We found that the R^2 of the regression is maximized when the 75 percent threshold is designated.

20 The fit of the model, represented by the adjusted R^2, is higher in the Spline regression than in either a simple linear model or a quadratic model. In modeling fertility change, the adjusted R^2 is .54 for the linear model and .65 for the quadratic model. In modeling current contraceptive use, the adjusted R^2 is .63 for the linear model and .80 for the quadratic model.

21 Data for Rwanda were collected prior to the recent ethnic massacre.

22 The existence of large gaps in educational attainment between rich and poor has recently been documented by Filmer and Pritchett (1999) using DHS data. These gaps are particularly striking in West and Central Africa.

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