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Linkages between Education and Fertility in Sub-Saharan Africa

David SHAPIRO[1]

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Contact at AFD: Hélène DJOUFELKIT (djoufelkith@afd.fr)

[1] Pennsylvania State University

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Linkages between Education and Fertility in Sub-Saharan Africa[2]

David Shapiro, Professor Emeritus of Economics, Demography, and Women's, Gender, and Sexuality Studies, Pennsylvania State University, e-mail: dshapiro@psu.edu

Abstract

This paper explores linkages between women's education and fertility in sub-Saharan Africa, using DHS data from about 30 countries. There are three substantive sets of analyses. First, we shed light on several pathways via which fertility is linked to education. We examine how fertility varies by detailed education and place of residence jointly, consider ideal number of children and its relationship to fertility, look at some proximate determinants, and differences in infant and child mortality, all by education and place of residence. The second part identifies, for each country, the importance of changes over time in women's education and in mortality in contributing to observed declines in fertility. We decompose changes in fertility and identify the importance of changes in education and mortality, separately for urban and rural places. The final set of analyses looks at preferences for low fertility, defined as an ideal number of children of three or fewer. The prevalence of such preferences, as well as how they have increased over time, are documented, and the analyses explore their relationship to women's education, place of residence, and other factors including population density and subregion. The conclusion provides some speculation on future fertility decline in the region.

Key Words: Education, Fertility, Sub-Saharan Africa

JEL Codes: I20, J13, O10, O55

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I. Introduction

High fertility in sub-Saharan Africa is a distinguishing characteristic of the region. In the early 1950s, sub-Saharan Africa, Northern Africa, Asia, and Latin America and the Caribbean all had high fertility, with total fertility rates (TFRs) of 6.6, 6.7, 5.8, and 5.9, respectively (United Nations, 2015). Fertility subsequently declined in all four regions, but the declines began first in Asia, Latin America, and Northern Africa, and only subsequently in sub-Saharan Africa. At the outset of decline in each region, the pace of decline was slower in sub-Saharan Africa. Consequently, at present (2015-2020), the Population Division of the United Nations (2015) medium variant estimates of the TFR are 4.75 for sub-Saharan Africa, 3.05 for Northern Africa, 2.15 for Asia, and 2.05 for Latin America and the Caribbean.

The continued high fertility in sub-Saharan Africa, in conjunction with declining mortality (United Nations, 2015), has resulted in a young population with a high dependency burden. This constitutes a real challenge to efforts to invest in the human capital of the population and promote economic growth and development. Numerous studies of fertility and fertility change, in both sub-Saharan Africa and the developing world more broadly, have been carried out, and these studies typically find that increased women's schooling has been an important factor contributing to the observed declines in fertility in sub-Saharan Africa (for example, see Castro Martin, 1995; Jejeebhoy, 1995; Rutstein, 2002; Bongaarts, 2010; Garenne, 2012; Shapiro, 2012; Shapiro and Tenikue, 2017).

This paper explores linkages between women's education and fertility behavior in sub-Saharan Africa. Data used in the paper are from the Demographic and Health Surveys that have been carried out in close to 30 countries in the region since the mid-1980s. There are three substantive sets of analyses reported in the paper. The initial analyses shed light on a number of pathways via which fertility outcomes are associated with women's educational attainment. In addition to examining how fertility varies by detailed educational attainment

and place of residence jointly, these analyses also consider ideal number of children and how this is related to fertility, as well as proximate determinants of fertility such as being in union and use of contraception, and differences in infant and child mortality, all by education and place of residence. Results of regressions analyzing individual data on cumulative fertility (children ever born) as a function of detailed schooling and place of residence, controlling for age and whether the woman is Muslim, are also reported in this first section of analyses.

The second part of the paper focuses on identification, for each country in our analyses, of the importance of changes over time in women's educational attainment and in infant and child mortality (itself influenced in part by changes in women's education) in contributing to observed declines in fertility. We use a well-known technique for decomposing changes or differences in an outcome variable (in this case, fertility) that allows us to identify the importance of changes in key determinants (education and mortality), and analyses are carried out separately for urban and rural places.

The final set of analyses looks at preferences for low fertility, defined as an ideal number of children of three or fewer. The prevalence of such preferences, as well as how they have increased over time, are documented, and the analyses explore their relationship to women's education, place of residence, and other factors including population density and subregion. The conclusion provides some speculation on the future of fertility decline in the region.

II. Pathways Linking Education and Fertility in Sub-Saharan Africa

In *Fertility and Education: What Do We Really Know?* (1979), Susan Hill Cochrane explored numerous pathways linking fertility and education. The underlying theoretical framework for her study was the Easterlin framework for fertility analysis (Easterlin, 1975; Easterlin and

Crimmins, 1985), and in this context, channels through which education could affect fertility included the demand for children, the biological supply of children, and fertility regulation.

At the time that Cochrane's study was done, very little information was available on these different channels for countries in sub-Saharan Africa. However, by the mid-1980s the Demographic and Health Survey (DHS) program had begun, and over the past 30+ years the DHS program has provided a wealth of data, with numerous surveys in a large number of African countries that permit examination of the different pathways through which education is linked to fertility in sub-Saharan Africa.

This first section analyzes relationships between fertility and education for nearly 30 countries in the region. The analyses are carried out for seven detailed education categories, based on number of years of schooling, and corresponding roughly to no schooling, incomplete primary, complete primary, low secondary, medium secondary, upper secondary, and post-secondary schooling. At the same time, we differentiate by place of residence, distinguishing capital cities from other urban places and from rural areas.

Figure 1 shows average TFRs by schooling and place of residence jointly. More precisely, these are unweighted averages of the data for each country, by schooling and place of residence jointly.[3] In almost all cases average fertility declines as educational attainment increases, and in each place of residence. Holding schooling constant, fertility tends to be highest in rural places and lowest in the capital cities. While these patterns are typically true in individual countries, there is considerable diversity of experience (and of general levels of fertility) across countries; for more detail, see Gebreselassie and Shapiro (2017).

[3] Unweighted country averages are used as well in Figures 2 through 7.

Figure 1. Average Total Fertility Rates by Schooling and Place of Residence

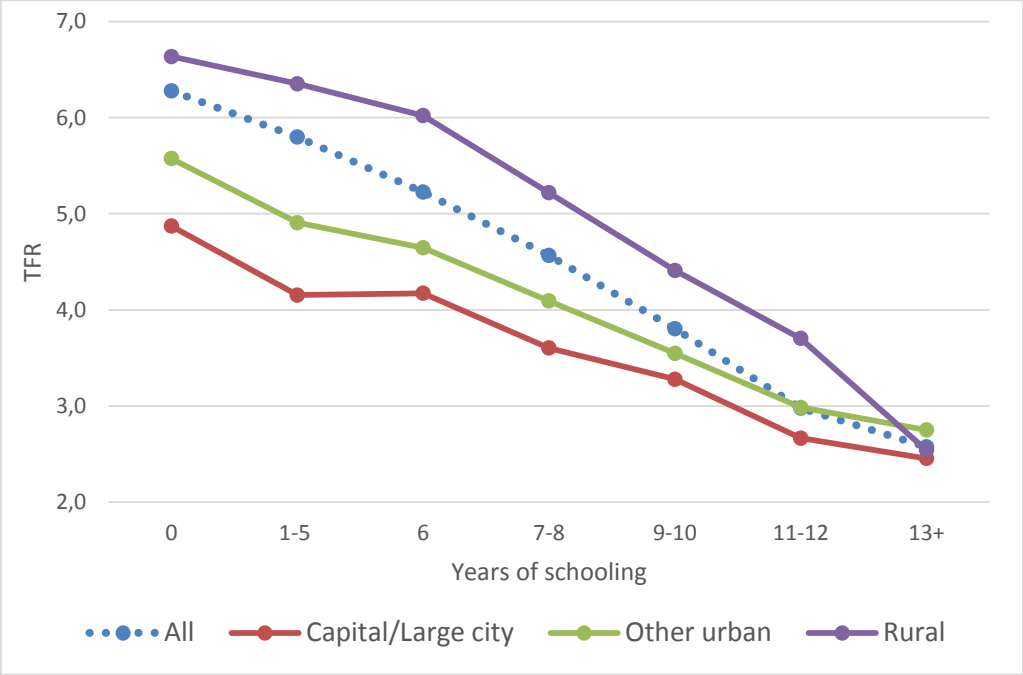
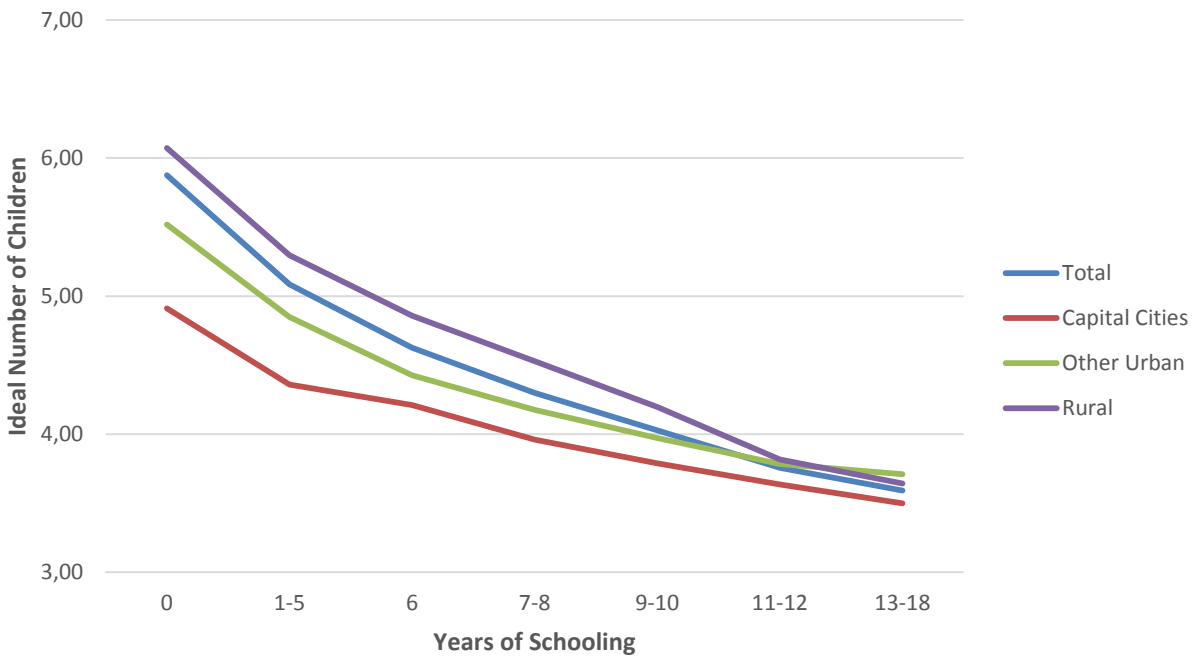


Figure 2 shows average ideal number of children by schooling and place of residence. This is an important indicator of the demand for children (Bongaarts, 2010). There are both similarities and differences between ideal number of children and actual fertility and their relationship between education and place of residence. Greater schooling, even in small increments, is consistently associated with lower ideal number of children, and ideal number of children is lowest in the capitals (this category also includes other very large cities) and highest in rural places. At the same time, as schooling increases, the ideal number of children tends to fall more rapidly than actual fertility, especially at lower levels of education. This suggests the presence of unmet need for effective contraception for women with lesser schooling in particular.

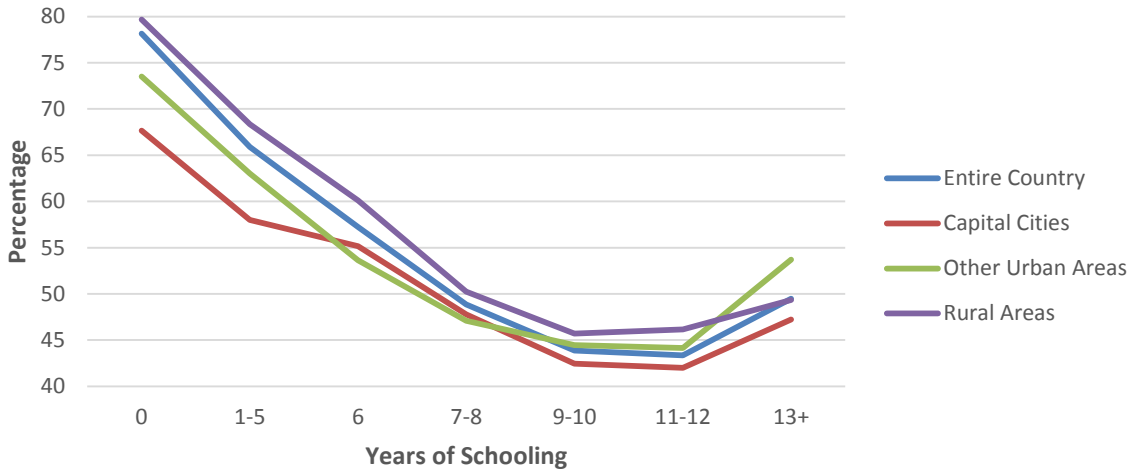
Figure 2. Aerage Ideal Number of Children by Schooling and Place of Residence



The average percentage of women of reproductive age who are in union, by schooling and place of residence, is shown in Figure 3. This is an important indicator of the supply of children, and it shows that, on average, the percentage of women in union declines as years of schooling increase, up to 9-10 years of schooling. Beyond that, the percentage in union first remains stable and then increases for the highest schooling group. The failure to control for age undoubtedly exaggerates the inverse relationship between schooling and being in union, since the long-term trend toward increased schooling means that better-educated women are likely to be younger than their lesser-educated counterparts. However, multivariate analyses of being in union that take age into account still show that, other things equal, increased educational attainment is for the most part associated with a lower likelihood of being in union. In addition, controlling for schooling, being in union is most prevalent in rural places and least likely in capital cities.

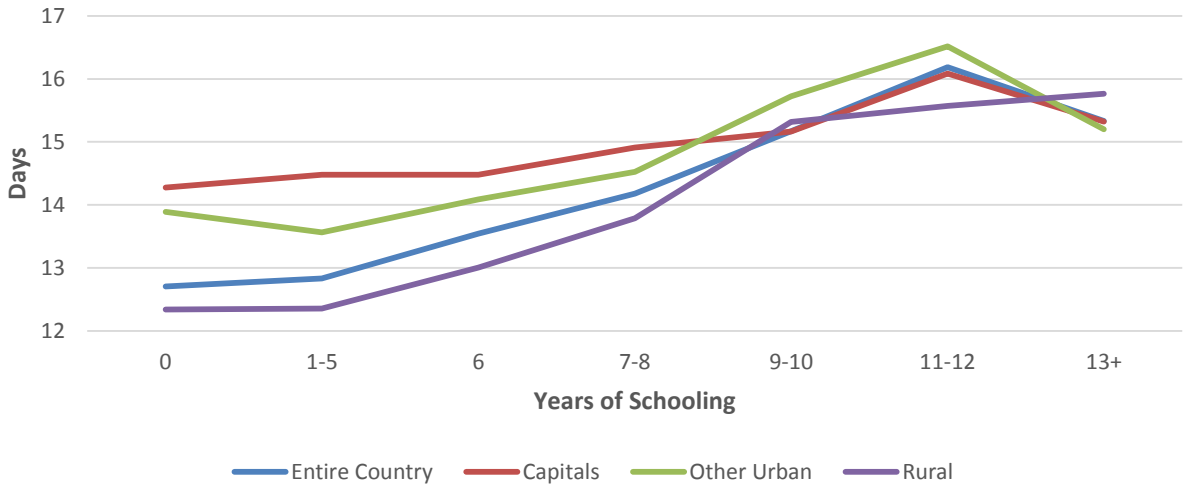
More generally, the data shown in these graphs, focused on only two variables linked to fertility, show correlations pertinent to fertility. While suggestive, these data cannot be taken as evidence of causality.

Figure 3. Percentage in Union by Schooling and Place of Residence



Data on the frequency of sexual intercourse are shown in Figure 4. This is a proximate determinant of the supply of children. Beyond the first two schooling groups, intercourse becomes a little less frequent as schooling increases, up through 11-12 years, before becoming somewhat more frequent in the highest group. Up through 7-8 years of schooling, intercourse is most frequent in rural areas and least frequent in the capitals. At higher schooling levels there is no clear pattern by place of residence, holding schooling constant.

Figure 4. Average Number of Days Since Last Intercourse by Educational Attainment and Place of Residence



Average age at first birth by educational attainment and place of residence is shown in Figure 5. Up through eight years of school, there is little variation of this measure as schooling increases, but beyond this the average age at first birth increases, and especially so for the two highest schooling groups. Of course, since pregnancy of girls enrolled in school is often followed by dropping out of school, there is clearly an endogenous aspect in the relationship between age at first birth and educational attainment. Holding schooling constant, average age at first birth tends to be lowest in rural places and highest in capital cities, although the differences by place of residence are modest compared to the differences by years of schooling.

Figure 5. Average Age at First Birth by Educational Attainment and Place of Residence

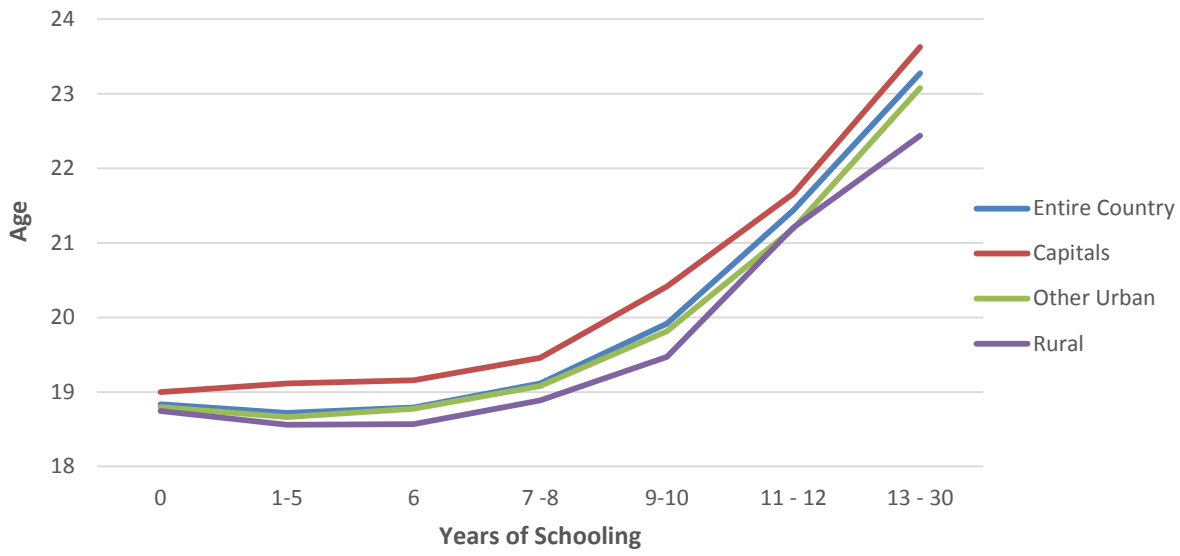
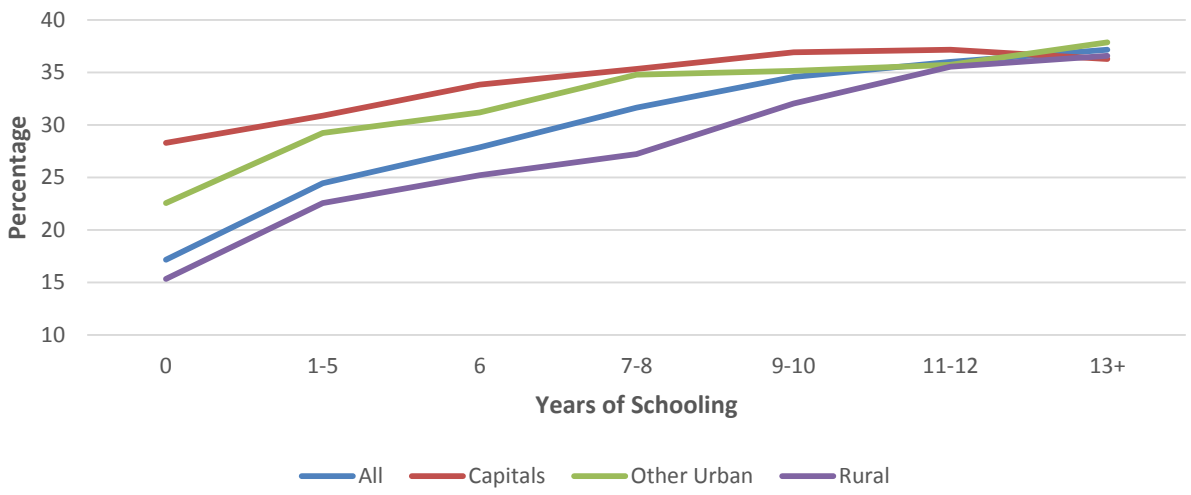
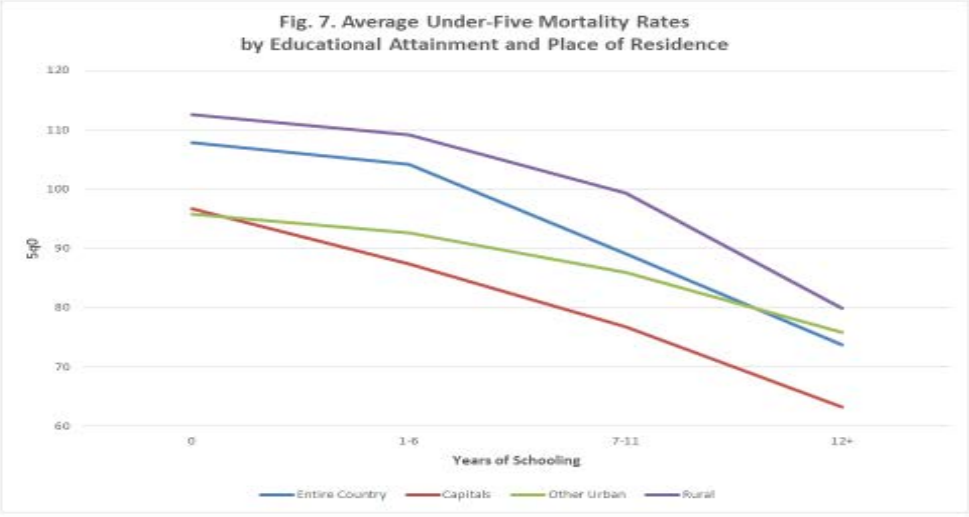


Figure 6 shows the average percentage of women in union who are using modern contraception. Fertility regulation is clearly much more widely practiced by better-educated women, and this presumably contributes to their lower fertility. Also of note is the fact that differences by place of residence in modern contraceptive use are substantial among women with lower levels of schooling while being quite modest among women with greater educational attainment. In conjunction with the higher average fertility as compared to the ideal number of children of women with lower levels of schooling noted above, which is evident for rural places, this suggests that improved contraceptive service delivery in rural areas might well contribute to more rapidly declining rural fertility.

Figure 6. Modern Contraceptive Use by Educational Attainment and Place of Residence



Infant and child mortality rates by mother's schooling and place of residence are shown in Figure 7. Because of the comparative infrequency of mortality, we have compressed the number of schooling groups from seven to four. Mortality declines as schooling increases, and especially so in rural places. This implies greater supply of children for better-educated women, other things equal, and hence a greater motivation for fertility control in the Easterlin framework.



The preceding figures document several pathways by which increased education appears to contribute to lower fertility in sub-Saharan Africa. The final part of this first section reports results of multivariate analyses of micro data on fertility, using children ever born as the dependent variable. Given the existence of cultural differences among countries that may influence fertility, the regressions were estimated separately for each country. They control for age and whether the woman is Muslim, as well as detailed education and place of residence. Table 1 shows the mean values of the estimated coefficients from these equations, the vast majority of which were highly significant, overall and separately by place of residence.

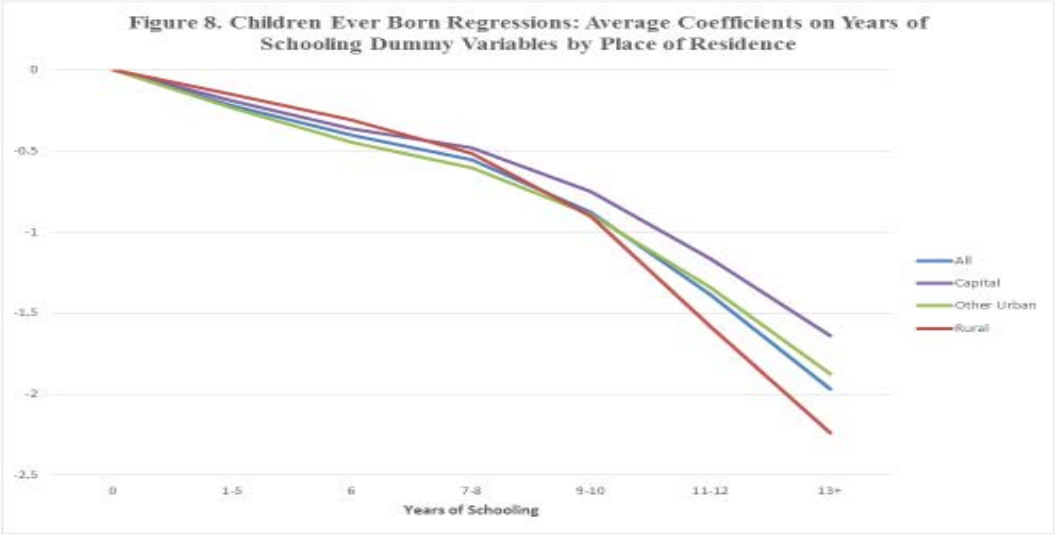
Table 1. Multivariate Analyses: Mean Regression Coefficients
Dependent variable = children ever born

Averages	All	Capital	Other Urban	Rural
Age	.367	.223	.293	.429
Age²	-.0027	-.0011	-.00180	-.00341
0	---	---	---	---
1-5	-.219	-.190	-.237	-.152
6	-.401	-.361	-.449	-.308
7-8	-.555	-.480	-.607	-.517
9-10	-.878	-.751	-.895	-.905
11-12	-1.386	-1.165	-1.343	-1.580
13+	-1.971	-1.642	-1.876	-2.242
Muslim	.088	.118	.126	.021
Capital	-.690	---	---	---
Other Urban	-.368	---	---	---
Constant	-4.610	-2.828	-3.706	-5.705
R^2	.626	.566	.603	.624

The mean values of the estimated schooling coefficients are all negative, indicating that the reference group, women with no schooling, tends to have the highest fertility. Over all, and for each place of residence, the average estimated schooling difference in fertility compared to the reference group becomes larger in absolute value as years of schooling

increase. Further, there is a tendency for the differences in fertility between adjacent groups to widen as years of schooling increase. This may be seen in Figure 8 below, particularly beyond eight years of schooling. Interestingly, at the higher schooling levels, fertility differences by education, other things equal, are widest among rural residents and narrowest among those from capital cities.

In the results for all women, those in capital cities average about 0.7 children fewer than those in rural places, other things equal, while the corresponding differential for women in other urban places is just over half that size. Fertility increases with age, but at a decreasing rate, and most rapidly in rural areas and least rapidly in the capitals. Finally, other things equal, Muslim women living in capitals and other urban places tend to have slightly higher fertility than their non-Muslim counterparts.



What we would like to do ideally is to quantify the different pathways by which women's educational attainment influences fertility. For example, one might think of the ideal number of children as the primary determinant of a woman's desired fertility. The ability to reach and not exceed that target will be influenced by multiple factors: time spent in union,

partner's preferences and the woman's weight in the couple's decision making, frequency of intercourse, use of contraception and recourse to abortion, and infant and child mortality. All of these aspects, of course, are linked to women's education, as we've seen here for some of them. Quantifying these elements should be helpful in identifying effective policies designed to accelerate fertility decline.

III. Contributions of Increased Women's Schooling and Reduced Infant and Child Mortality to Observed Declines in Fertility

Over time, women's educational attainment in sub-Saharan Africa has been increasing (Barro and Lee, 2013), while infant and child mortality has been decreasing (United Nations, 2015). From the perspective of the Easterlin framework, both of these changes should have contributed to fertility decline in the region. Using aggregated data, Shapiro and Gebreselassie (2008) and Shapiro (2012) have shown that these changes indeed appear to have made important contributions to the ongoing sub-Saharan fertility decline.

This second part of the paper reports on analyses of micro data from 30 countries, all of which have had at least two DHS surveys, that seek to quantify the contributions of increased schooling and reduced mortality to observed declines in fertility between the first and last survey in each country. Oaxaca (1973) introduced a technique for decomposing changes in wages to link them to changes in key determinants of wages. This decomposition procedure shows how an outcome variable (wages) is linked to changes in key determinants (e.g., schooling and work experience). Here, a refined version of the procedure (Oaxaca and Ransom, 1994) is used, with fertility as the outcome variable and education and mortality as the key determinants (cf., Bundervoet, 2014).

These analyses entail using data from the first and last survey in each country to estimate regressions of children ever born on a series of variables representing multiple

education groups, infant and child mortality, and controlling for age. The regression coefficients are then used to assess the contribution of increased schooling and declining mortality to the observed declines in fertility. Regressions are carried out separately for urban and rural places within each country. For further details on the methodology and detailed results by country, see Shapiro and Tenikue (2017).

Fertility is typically lower and has been declining more rapidly in urban areas than in rural areas. On average, the total fertility rate in urban places fell from just over 4.7 in the first survey to just under 3.9 in the last survey, representing a decline of 0.9 children or 19 percent. By contrast, in rural places the average TFR fell from just over 6.5 in the first survey to just under 6.0 in the last survey, a decline of 0.6 children or 9 percent. On average, the duration between the first and last survey was a little more than 16 years, but for individual countries this duration ranged from five years to 27 years.

There was considerable heterogeneity in the experience of individual countries. Map 1 shows the average annual pace of decline of the total fertility rate in urban areas, and Map 2 is the counterpart for rural places. Countries with comparatively rapid declines in urban fertility are in Western, Eastern, and Southern Africa; Middle Africa has slow declines or increases in urban fertility, and slow declines are also found in Western and Eastern Africa.

Map 1. Average Annual Pace of Decline in the TFR, Urban Places

With respect to rural areas, a greater prevalence of absence of decline in fertility is particularly evident. This is especially the case in Middle Africa, but absence of decline is also present in Western and Eastern Africa. Conversely, countries with rapid rural fertility decline are found in Western, Eastern, and Southern Africa.

Map 2. Average Annual Pace of Decline in the TFR, Rural Places

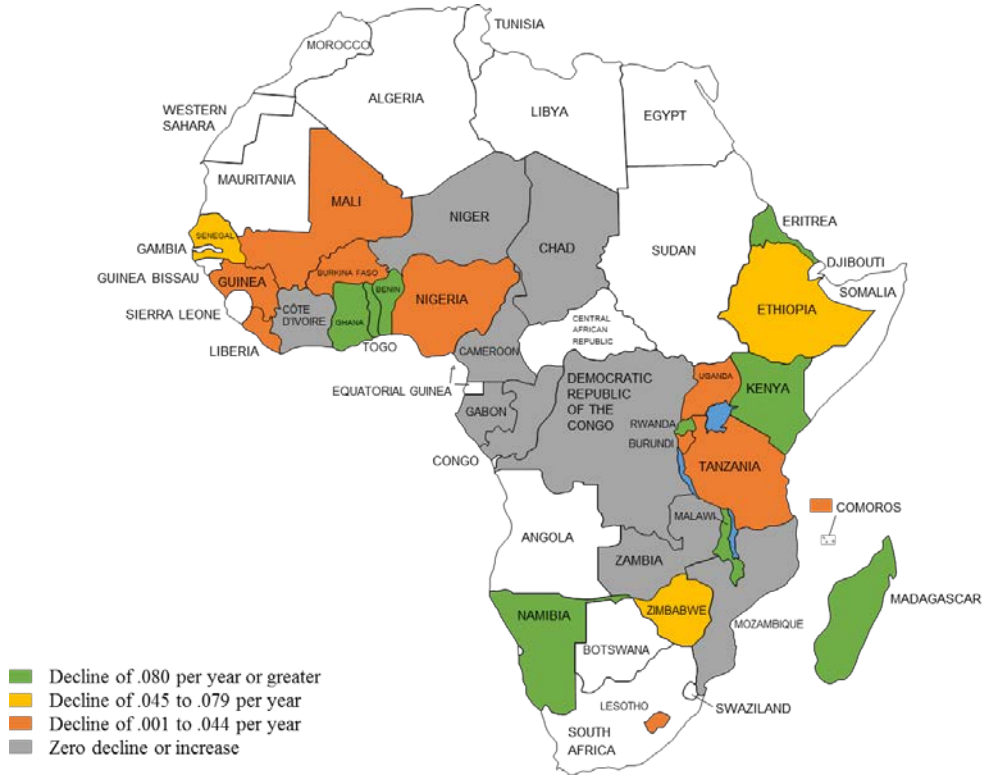


Table 2 shows how educational attainment and infant and child mortality have changed among the countries in this analysis. More specifically, the table gives the average number of years of schooling and the percentage of women with no schooling, as well as the average infant and child mortality rate, as of the first and last DHS, for urban and rural places. Absolute and percentage changes in these indicators are also provided. Urban places had greater schooling and lower infant and child mortality as of the first survey, and absolute increases in years of schooling between the first and last survey were greater for urban places. By contrast, absolute declines in infant and child mortality were somewhat greater in rural areas.

Table 2. Average Levels and Changes in Schooling and Infant & Child Mortality between First and Last Survey

Indicator	First survey		Last survey		Absolute change		Percentage change	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Avg. yrs. of schooling	5.3	2.5	7.0	3.8	1.7	1.3	32	52
Pct. with no schooling	29	55	19	41	-10	-14	-34	-25
Infant & child mortality	139	183	87	116	-53	-66	-38	-36

Table 3 shows the mean values of the estimated children-ever-born regression coefficients (these coefficients were typically highly significant in the country-specific regressions). The table is similar to Table 1 in the preceding section, but with six instead of seven education categories, a measure of mortality of infants and children in the respondent's sample cluster, without a Muslim variable, and for only two places of residence.

Table 3: Mean Values of Regression Coefficients, Children Ever Born Regressions, Urban and Rural Places

Variable	Average values	
	Urban	Rural
Age	0.292	0.438
Age2	-0.0017	-0.0034
ED0	0.318	0.156
ED1-6	--	--
ED7-8	-0.290	-0.279
ED9-10	-0.567	-0.676
ED11-12	-1.041	-1.295
ED13+	-1.642	-2.060
Mortality	0.023	0.018

As in Table 1, fertility is typically highest among those with no schooling, and declines as schooling increases, with the declines accelerating in moving to the two highest schooling groups. Greater mortality is associated with higher fertility, as anticipated. And as before, fertility increases with age but at a decreasing rate, and more rapidly in rural places.

For each country and place of residence, changes in educational attainment and in mortality are evaluated for their impact on observed fertility. These evaluations examined places in which fertility decline of more than a trivial amount was found, representing 26 of the 30 countries in the case of urban places and – reflecting the lesser prevalence of fertility decline in rural areas – only 15 of the rural places. As a consequence of differences among countries and by place of residence in rates of increase of schooling and rates of decrease of infant and child mortality, there was considerable variation among the countries in the decomposition results (Shapiro and Tenikue, 2017). In some cases, increased schooling was the major contributor to the observed fertility decline, in others reduced mortality was distinctly more important, and in still others both factors were pertinent.

In urban places, increased women's schooling accounted for an average of 57 percent of the observed declines in fertility, while reductions in infant and child mortality accounted for an average of 29 percent of the observed fertility declines. In rural places where fertility declined, increased women's schooling accounted for an average of 30 percent of the decline while declining mortality accounted for an average of 36 percent of the observed decline. This analysis of individual data thus confirms earlier analyses of aggregate data, indicating that both increased women's schooling and reduced infant and child mortality are important factors contributing to fertility decline in sub-Saharan Africa, and that, on average, they account for a substantial portion of observed fertility declines.

IV. Emerging Preferences for Low Fertility

As noted at the outset, sub-Saharan Africa is very much a high-fertility region, with an overall total fertility rate more than twice that of either Asia or Latin America and more than 55 percent higher than in Northern Africa. At the same time, however, that earlier overview and the previous section document that fertility in the region has been declining. In this final

substantive section, we examine emerging preferences for low fertility in the region. Sub-Saharan Africa has traditionally been a place where preferences for large families are widespread. But this is changing, and here we analyze evidence of the emergence of preferences for low fertility.

More specifically, we examine ideal number of children, and women who indicate that their ideal number of children is three or less are categorized as having a preference for low fertility. Ideal number of children is strongly correlated with actual fertility, as may be seen in Figure 9, which compares the two using data from the most recent survey in each country covered in this part of the study. In fact, apart from the two countries with very high ideal number of children (Niger and Chad), the other countries show actual fertility that is either very close to mean ideal number of children or somewhat higher than the average ideal number of children.

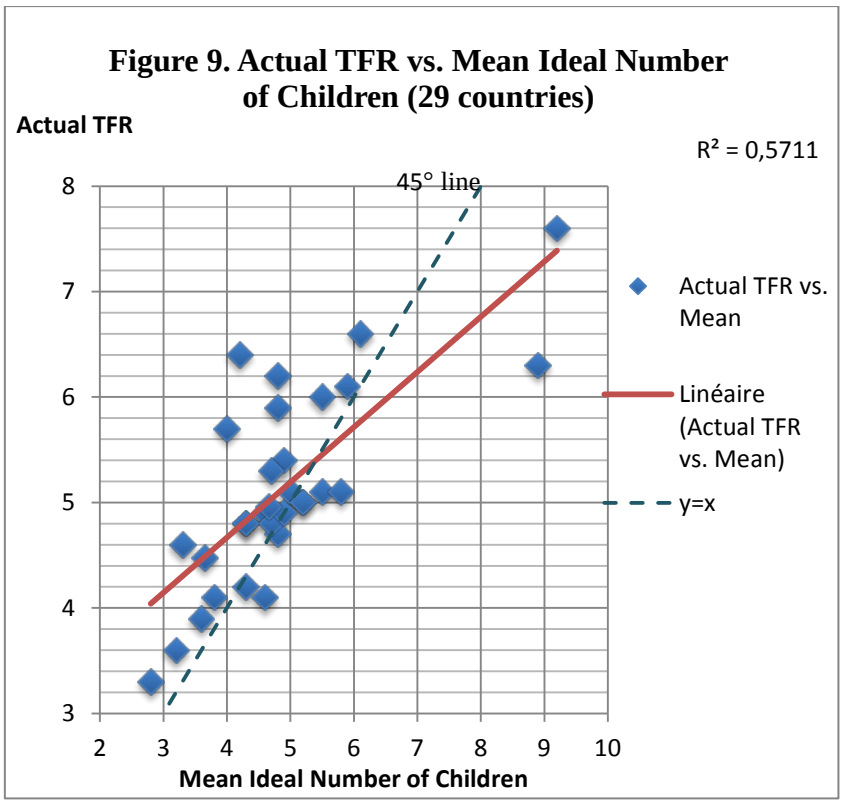


Figure 9. Actual TFR vs. Mean Ideal Number of Children (29 countries)

Within our sample of nearly 30 countries, the average percentage of women expressing a preference for low fertility increased from 16 to 27 between the first and last DHS.[4] Primarily, this was a consequence of increasing numbers of women indicating two or three children as ideal. The corresponding means for the average ideal number of children declined from 5.7 to 4.9. Details on outcomes for individual countries may be found in Shapiro (2016).

Greater preferences for low fertility by women with more schooling were noted by Bongaarts (2010) as an important factor contributing to the inverse association between women's schooling and fertility. This reflects the quantity-quality tradeoff in fertility. As shown in Table 4, increased schooling tends on average to be associated with a growing preference for low fertility and a decline in the ideal number of children. Using data from the most recent DHS in each country, on average, only about one in seven women with no schooling and one in five women with 1-5 years of schooling had a preference for low fertility, while more than 40 percent of women with 11-12 years of schooling and almost half of those with 13 or more years had a preference for low fertility. Corresponding figures for mean ideal number of children were nearly six and five for the two low-education groups and under four for the two high-education groups.

Table 4. Average Percentage Preferring Low Fertility and Mean Ideal Number of Children, By Years of Schooling

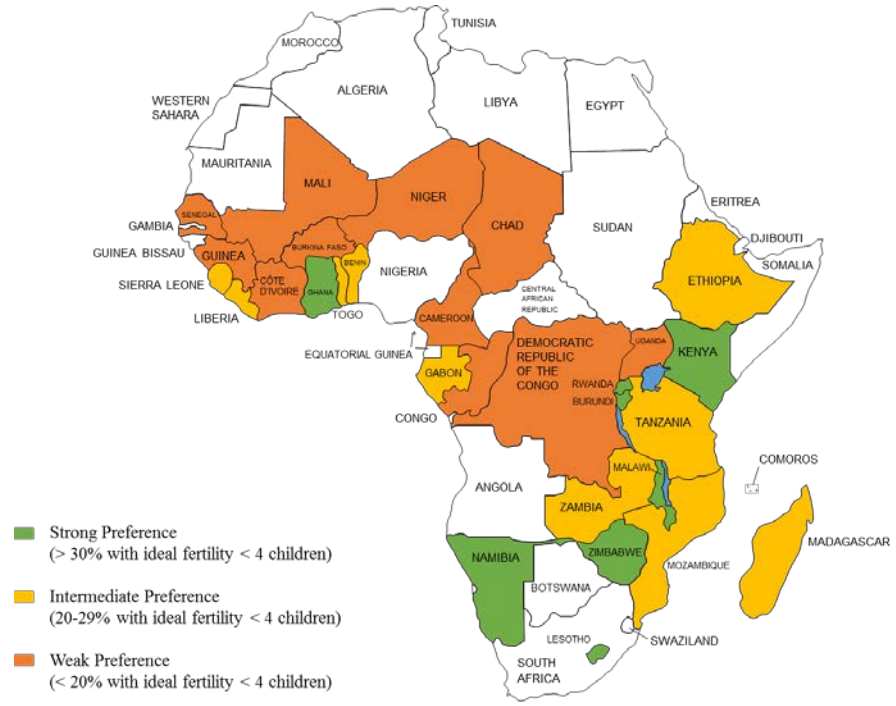
	Years of Schooling						
	0	1-5	6	7-8	9-10	11-12	13+
Pct. with Preference for Low Fertility	14	21	26	31	37	43	48
Mean Ideal Number of Children	5.9	5.0	4.6	4.3	4.0	3.8	3.6

[4] These and subsequent averages are unweighted means. If means are weighted by population, then because both Nigeria and the Democratic Republic of the Congo, two of the three most populous countries in the region, tend to have somewhat high ideal numbers of the children and hence comparatively weak preferences for low fertility, the average percentage of women with preferences for low fertility increases from 11 percent to 22 percent between the first and last survey.

Place of residence also mattered: on average 40 percent of women in capital cities expressed a desire for three or fewer children, while the corresponding figure for rural women was only 21 percent, and other urban women were in between at 32 percent. Of course, part of these gross differences by place of residence reflects the fact that women's schooling is highest in the capitals and lowest in rural areas, on average, but as we'll see below in the multivariate analyses, there are net differences in preferences for low fertility by place of residence, even after controlling for women's schooling.

We also categorized countries according to whether they had strong, intermediate, or weak preferences for low fertility. Map 3 shows these three groups. Countries with strong preferences typically were in Eastern and Southern Africa, had the highest average level of schooling, and were Anglophone, except for two Francophone countries, Rwanda and Burundi, with extremely high population density. Countries with intermediate preferences for low fertility were primarily in Eastern and Western Africa, had lower average education, and were linguistically mixed, and those with the weakest preferences were almost all in Middle and Western Africa, had the lowest average schooling level, and were predominantly Francophone, with Uganda being the notable exception.

Map 3. Countries by Preference for Low Fertility



The next step in the analyses entailed analysis of aggregate data at the country level. The dependent variable was the percentage of women of reproductive age with a preference for low fertility (three or fewer children). Independent variables included mean years of schooling of these women, two alternative measures of mortality (expected to be inversely related to preferences for low fertility), two alternative measures of population density, a dummy variable identifying Francophone countries, dummy variables for subregion, and a variable measuring the percentage of women of reproductive age who were Muslim. Table 5 shows results of alternative specifications of these multivariate regressions for the variables that were significant plus the mortality variables.

The variables included in the different specifications accounted for close to 80 percent of the overall variation across countries in the preference for low fertility. Years of schooling were strongly and significantly related to this preference, while mortality was not. The high-density dummy variable identified Rwanda and Burundi, both of which have population

density that is well over 400 people per square kilometer, more than twice as high as the third most densely populated country, Uganda, and close to five times the average over all of the countries. The significance as well of population density squared indicates that higher density contributes to preferences for low fertility for more than just the two highest-density countries (cf., Lutz et al., 2006). And other things equal, the two countries in Southern Africa have significantly stronger preferences for low fertility while the countries from Middle Africa have significantly weaker preferences for low fertility. Presumably, these differences reflect cultural differences between the countries in these two subregions.

Table 5. Factors Influencing Aggregate Preferences for Low Fertility (regression coefficients)

Variable	(1)	(2)	(3)	(4)
Mean years of schooling	4.356**	4.653**	4.144**	4.468**
${}_5q_0$ – under-5 mortality	0.017	--	0.082	--
${}_1q_0$ – infant mortality	--	0.118	--	0.103
High density dummy	27.987**	28.165**	--	--
Population density^2	--	--	.000142**	.000143**
Southern Africa	25.292**	22.779**	26.965**	24.535**
Middle Africa	-14.609**	-15.424**	-13.050*	-13.979**
Intercept	2.297	-3.959	2.840	-3.550
adjusted R^2	0.787	0.797	0.798	0.806

Dependent variable: Percentage of women with ideal no. of children <4.
Sample size = 29 countries.

Francophone countries did not differ significantly from other countries in the strength of preferences for low fertility, despite their predominance among the countries with the weakest preferences in Map 3 and their absence (apart from the two high-density countries) from the group with the strongest preferences. This is due to the fact that the Francophone countries have lower levels of schooling, on average, and once this factor is taken into account, language per se becomes irrelevant. The percentage of women who were Muslim, although with positive coefficients, was not significant in these equations.

In addition to these aggregate regressions at the country level, we also carried out country-specific regressions using individual data, both with ideal number of children and the preference for low fertility as dependent variables. A summary of those regressions, showing mean values of estimated coefficients, is in Table 6. The importance of detailed level of schooling and place of residence, as well as age and being Muslim, as factors associated with the ideal number of children and the preference for low fertility, is evident from the average coefficients in the table.

Table 6. Mean Values of Coefficients, Regressions for Ideal Number of Children and Preference for Low Fertility

Variable	Ideal no. of children	Preference for low fertility
Age	0.055	-0.046
Years of schooling		
0	---	---
1-5	-0.519	0.273
6	-0.760	0.422
7-8	-0.972	0.621
9-10	-1.138	0.816
11-12	-1.370	1.073
13+	-1.615	1.361
Place of residence		
Rural	---	---
Other urban	-0.528	0.401
Capital	-0.882	0.813
Muslim	0.452	-0.465
Intercept	4.174	-0.532

Dependent variables are ideal number of children and a binary variable identifying ideal number of children of fewer than four children, respectively.

The mean coefficients indicate that the ideal number of children declines monotonically with years of schooling, while the preference for low fertility increases with educational attainment. It is of interest to note, however, that for ideal number of children, there is not the widening of schooling differentials at higher levels of education that we saw earlier in the actual fertility regressions. Controlling for schooling, place of residence also

matters: ideal number of children is lowest in the capitals and highest in rural places, and correspondingly, preferences for low fertility are strongest in the capitals and weakest in rural areas. The mean age coefficients suggest that, other things equal, younger cohorts of women have lower fertility preferences and lower ideal number of children than their older counterparts, and Muslim women tend to have higher fertility preferences than non-Muslim women.

V. Summary, Conclusions, and Implications

The first part of the analyses in this paper showed that education is linked to fertility in sub-Saharan Africa through multiple mechanisms or pathways. Better-educated women have preferences for smaller number of children, or lower demand for quantity of children. They are less likely to be in union, contributing to lower supply of children, and initiate childbearing at higher ages. They experience lower infant and child mortality than their lesser-educated counterparts, and they are more likely to use modern contraception.

The second part of the paper showed that both increased educational attainment of women over time and reduced infant and child mortality have contributed substantially to the observed fertility declines in countries throughout the region. While results varied considerably across countries, on average increased schooling was somewhat more important than reduced mortality in urban places, while mortality declines on average were slightly more important than education increases in rural places.

The final set of analyses focused on emerging preferences for low fertility, documenting their growth over time and their strong link to women's schooling. Aggregate analyses also indicated that population density and subregion were related to these preferences. And analyses of micro data confirmed that holding age and schooling constant,

preferences for low fertility were strongest in capitals and other large cities, and weakest in rural areas.

A distinguishing characteristic of the analyses in this paper is the use of a detailed specification of educational attainment in examining education and fertility. Throughout the paper, we see that even with a comparatively large number of schooling groups, behaviors differ consistently across groups. Hence, use of broad groups, like primary and especially secondary, is likely to mask a lot of differences in behaviors that are relevant to fertility outcomes. In addition, we emphasize the importance of taking place of residence into account as well, and note that among urban places, capitals (and other large cities) often see behavior that is different from that in smaller urban centers.

There are several implications of interest in our findings. The divergence between actual fertility and ideal number of children, particularly for women with no or limited schooling and in rural areas, is suggestive of unmet need for contraception for these women. The longer-term trends toward increased schooling and reduced infant and child mortality suggest that fertility decline in the region will be ongoing; accelerating the pace of increase of women's schooling and the pace of decrease in mortality would presumably accelerate the fertility decline. Continuing urbanization will also contribute to the ongoing fertility decline.

In addition, the estimated coefficients from fertility equations that show widening of educational differentials in fertility at higher levels of schooling suggest that continued increases in women's schooling may well lead to more rapid declines in fertility in the future. However, the absence of widening differentials in the regressions for ideal number of children may limit any such compositional effect of higher levels of women's schooling. Indeed, there is evidence that among the best-educated women in the region, it is often the case that their fertility falls short of their ideal number of children (Shapiro, 2017).

The United Nations (2015) estimate of fertility in sub-Saharan Africa by mid-century is approximately three children per woman. While this is well below the current level, it is expected to be associated with population growth in the region of close to two percent per year. Challenges in educating growing populations and promoting economic growth and development will thus persist throughout much of this century. At the same time, improved opportunities for schooling and greater access to modern contraception, especially in rural places, have the potential to accelerate fertility decline in the coming decades.

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