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Research Article

Women's education, infant and child mortality, and fertility decline in rural and urban sub-Saharan Africa

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Abstract

BACKGROUND
This paper provides estimates of the contributions of increased women's education and reduced infant and child mortality to fertility declines in urban and rural areas of countries in Sub-Saharan Africa, using individual-level data.

OBJECTIVE
The principal question that the paper addresses is: How much have increased women's schooling and reduced mortality contributed to fertility declines in urban and rural places in each of 30 countries in sub-Saharan Africa? A secondary question is: What have been the changes in women's schooling and mortality in urban and rural areas in these countries?

METHODS
Data from the first and last Demographic and Health Surveys for each country is used, along with a decomposition technique that allows us to quantify how much of the observed fertility decline is attributable to increased education and how much is due to reduced mortality.

RESULTS
In urban places, on average, increased women's schooling accounts for 54% of observed fertility decline while reduced mortality contributes 30%. In rural areas with fertility decline, increased women's education accounts for an average of 30% of the decline while reduced mortality accounts for an average of 35%. Results vary substantially by country and place of residence.

CONCLUSIONS
Accelerating increases in women's schooling and decreases in infant and child mortality have the potential to accelerate fertility decline in sub-Saharan Africa.

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CONTRIBUTION

The paper uses individual-level data to provide quantitative estimates of the importance of increased women's schooling and reduced mortality in contributing to fertility decline in sub-Saharan Africa.

1. Introduction

What are the roles of increasing women's educational attainment and declining infant and child mortality in contributing to fertility decline in sub-Saharan Africa? Sub-Saharan Africa was the last major world region to experience the fertility decline that all industrialized countries have gone through and that much of the developing world has experienced. It has uniquely high fertility: for the period 2015–2020 the United Nations (2015) estimates (medium variant) the total fertility rate (TFR) at 4.75 for sub-Saharan Africa, compared to 2.15 for Asia and 2.05 for Latin America and the Caribbean. The ongoing fertility transition in sub-Saharan Africa has been comparatively slow and subject to stalling (Bongaarts 2008; Bongaarts and Casterline 2013; Shapiro and Gebreselassie 2008; Shapiro et al. 2013). As a consequence of the late onset of fertility transition, the prevalence of stalling of fertility decline, and the slow pace of decline (Bongaarts and Casterline 2013; Shapiro et al. 2013), sub-Saharan Africa has an overall level of fertility that is well over twice the levels in Asia and Latin America.

As we discuss in more detail in the theoretical framework section that follows, there are various pathways by which increased women's education contributes to lower fertility. Likewise, there is evidence that reductions in infant and child mortality also contribute to fertility decline in the region.

Women's schooling is low in sub-Saharan Africa (United Nations 2010; Shapiro 2012), although it has been increasing over time (Garenne 2012), both absolutely and relative to the schooling of men (Schultz 1993; Barro and Lee 2013). These increases should contribute to the ongoing fertility transition in the region: At the aggregate level, within sub-Saharan Africa, countries with comparatively higher levels of women's educational attainment are the countries that tend to have lower levels of fertility (Shapiro 2012) and to be more advanced in their fertility transition (Garenne 2012). However, using aggregated data in a longitudinal perspective, Garenne (2012) finds that the percentage of educated women is low at the onset of the fertility decline (2.2 years of schooling, on average), and he finds no correlation between the speed of fertility decline and the mean level of education at the onset.

Similarly, infant and child mortality is higher in sub-Saharan Africa than in Asia and Latin America (United Nations 2015). In most countries there have been declines in infant and child mortality, which, based on analysis of aggregate data, have contributed to the fertility decline in sub-Saharan Africa (Shapiro and Gebreselassie 2008; Shapiro 2012).

We use individual-level micro data and a decomposition technique for analyzing differences or changes to quantify the importance of increased women's education and reduced infant and child mortality in contributing to the declines in fertility. Data is from the Demographic and Health Surveys, and comes from urban and rural places in all 31 countries that have had at least two surveys. These countries account for 86% of the population of sub-Saharan Africa.

The method entails decomposing observed changes in fertility to identify the magnitudes of those changes that are attributable to changes in different factors, most notably women's education and infant and child mortality. The decompositions control not only for changes in these two variables, but also for changes in the age composition of the population of women. We examine overall changes between the first and the last surveys, beginning in the mid–1980s and up to the present. We provide separate estimates for urban and rural places: Garenne and Joseph (2002) show that the fertility transition in the region began first in urban areas, with a lag prior to the onset of fertility decline in rural places, and Shapiro and Tambashe (2002) emphasize that urban and rural areas in the region differ in terms of both the timing of the onset of fertility decline and the pace of that decline as the fertility transition unfolds.

We first provide a theoretical framework, and then review changes in fertility, education, mortality, and mean age of women in urban and rural sub-Saharan Africa (section 3). We describe the decomposition method and the data in section 4, and proceed to the decomposition analysis in section 5. The conclusion is presented in section 6.

2. Theoretical framework

The underlying theoretical framework for our analyses is the Easterlin framework for fertility analysis (Easterlin 1975; Easterlin and Crimmins 1985). In this framework, fertility is the outcome of the interaction of the demand for children (the number of surviving children that parents would want in the absence of costs of fertility regulation), the supply of children (the number of surviving children that parents would have if they made no effort to control their fertility), and the objective and subjective costs of fertility regulation. If demand exceeds supply there is no motivation for fertility control, while if supply exceeds demand there is such motivation. Whether fertility regulation is used will depend in part on the strength of the motivation for fertility regulation, and in part on the costs of fertility regulation. The proximate determinants of fertility, such as exposure to the risk of conception and use of contraception, will in turn be influenced by the 'basic determinants' of fertility, such as education and infant and child mortality.

In her classic work, *Fertility and education: What do we really know?* (1979), Susan Hill Cochrane explores the various pathways by which education influences fertility, from the perspective of the Easterlin approach. Women's education is associated with demand for fewer numbers of better-educated children (e.g., see Shapiro and Tambashe 2003), reflecting the quality-quantity tradeoff, reduced exposure to the risk of pregnancy through delays in marriage associated with increased schooling (Shapiro and Gebreselassie 2014), greater use of more efficient contraception (Rosenzweig and Schultz 1989; Shapiro and Tambashe 1994), and lower infant and child mortality (Hobcraft 1993; Rutstein 2000).

Reduced infant and child mortality, from the perspective of the Easterlin framework, raises the supply of children and hence, other things being equal, increases the demand for fertility control and thus contributes to declining fertility. In addition, in high-mortality environments the desired number of births may exceed the ideal number of children, which can stem from either a replacement effect following an infant death or an insurance effect in anticipation of such deaths, or both (Bongaarts and Casterline 2013). As noted in the introduction, reduced infant and child mortality contributes to declining fertility in sub-Saharan Africa (Shapiro and Gebreselassie 2008; Shapiro 2012) and elsewhere in the developing world (Shapiro et al. 2013).

As will be seen below, changes in education and mortality on average account for the majority but not the totality of observed fertility changes in the 30 countries with available data to carry out the decompositions, and in some countries these changes contribute relatively little to fertility decline. This implicitly raises the question, what other external factors might contribute to fertility decline? (Proximate determinants like marriage and contraception, which are pathways for education's impact on fertility, are not discussed here but will be addressed below in the discussion of the decompositions.)

Two external factors that have been discussed in the literature are conflict and economic hardship. Blanc (2004) and Woldemicael (2008) argue that Eritrea's rapid fertility decline is most likely conflict-led. While Eritrea is not included in the decompositions because micro data is not publicly available, Rwanda is a country that experienced horrendous conflict between its first and last survey. Romaniuk (2011) and Shapiro (2015), in discussing Kinshasa in the Democratic Republic of the Congo, argue that economic hardship has contributed to the rapid fertility decline in the city, and probably elsewhere in large cities in the region under economic duress. Economic hardship as a contributor to fertility decline has also been emphasized by Eloundou-Enyegue, Stokes, and Cornwell (2000), Antoine (2006), and Gurmu and Mace (2008). In addition, there is some evidence that very high population density, as in Rwanda and Burundi, contributes to a lower ideal number of children and lower fertility (Lutz, Testa, and Penn 2006; Shapiro 2017). Finally, changes in preferences for children (i.e., ideal number of children) that cut across educational groups could be an independent source of fertility decline.

3. Overview of changes in fertility, education, mortality, and mean age of women

Before we examine data for urban and rural places separately, we provide a brief overview of data at the national level, to facilitate comparisons with earlier research. The 31 countries present considerable variation in the pace of decline in fertility (Shapiro and Tenikue 2015). For all of the countries taken together, the average TFR in the first survey (measuring fertility during the three years prior to the survey) was 6.0, while the average TFR in the last survey was 5.2. Thus, over a span that on average was a little more than 16 years, the TFR has declined on average by a little less than 0.05 per year.

This pace is in line with the recent decline in sub-Saharan Africa. Shapiro et al. (2013) find that the average decline in sub-Saharan Africa between the two most recent Demographic and Health Surveys was 0.05 children per year. Going back over a longer time period, Bongaarts (2008) reports an average annual decline in the TFR of 0.07 from about 1992 to 1998 and a lower value (average decline of 0.02 per year) from 1998 to 2004. Using data from 31 sub-Saharan African countries, Garenne (2008) reports that the onset of fertility decline in most of the countries took place between 1960 and 2000 and that the average speed of fertility decline was approximately 0.1 children per woman per year.

We first examine the TFRs in the first and last Demographic and Health Surveys, and their variations. The data is shown in Table 1 for urban and rural places, along with the dates of the first and last survey. For all of these countries taken together, the average TFR in the first survey in urban areas was 4.7, while the average TFR in the last survey was 3.9. Over a span of on average a little more than 16 years, there was a 17% decline in average urban TFRs and the average annual decline in the TFR in urban places was just over 0.05 per year. In rural areas the average TFR in the first survey was 6.5, while in the last survey it was 6.0, corresponding to an 8% overall decline and an average annual decline of a little more than 0.03.

Table 1: Fertility and fertility changes between the first and last Demographic and Health Survey, urban and rural places

Country	First demographic and health survey			Last demographic and health survey			Absolute change in total fertility rate			
	year	total fertility rate		year	total fertility rate		total		per year	
		urban	rural		urban	rural	urban	rural	urban	rural
Benin	1996	4.9	6.7	2011–2012	4.3	5.4	–0.6	–1.3	–0.039	–0.084
Burkina Faso	1993	4.6	7.0	2010	3.9	6.7	–0.7	–0.3	–0.041	–0.018
Burundi	1987	5.1	7.0	2010	4.8	6.6	–0.3	–0.4	–0.013	–0.017
Cameroon	1991	5.2	6.3	2011	4.0	6.4	–1.2	0.1	–0.060	0.005
Chad	1996–1997	5.9	6.5	2004	5.7	6.5	–0.2	0.0	–0.027	0.000
Comoros	1996	3.8	5.0	2012	3.5	4.8	–0.3	–0.2	–0.019	–0.013
Congo	2005	3.8	6.1	2011–2012	4.5	6.5	0.7	0.4	0.108	0.062
Ivory Coast	1994	4.4	6.0	2011–2012	3.7	6.3	–0.7	0.3	–0.040	0.017
DRC	2007	5.4	7.0	2013–2014	5.4	7.3	0.0	0.3	0.000	0.046
Eritrea	1995	4.2	7.0	2002	3.5	5.7	–0.7	–1.3	–0.100	–0.186
Ethiopia	2000	3.0	6.0	2011	2.6	5.5	–0.4	–0.5	–0.036	–0.045
Gabon	2000	3.8	6.0	2012	3.9	6.1	0.1	0.1	0.008	0.008
Ghana	1988	5.3	7.0	2008	3.1	4.9	–2.2	–2.1	–0.110	–0.105
Guinea	1999	4.4	6.1	2012	3.8	5.8	–0.6	–0.3	–0.046	–0.023
Kenya	1989	4.5	7.1	2008–2009	2.9	5.2	–1.6	–1.9	–0.082	–0.097
Lesotho	2004	1.9	4.1	2009	2.1	4.0	0.2	–0.1	0.040	–0.020
Liberia	1986	6.0	7.1	2013	3.8	6.1	–2.2	–1.0	–0.081	–0.037
Madagascar	1992	3.8	6.7	2008–2009	2.9	5.2	–0.9	–1.5	–0.055	–0.091
Malawi	1992	5.5	6.9	2010	4.0	6.1	–1.5	–0.8	–0.083	–0.044
Mali	1987	6.3	7.4	2012–2013	5.0	6.5	–1.3	–0.9	–0.051	–0.035
Mozambique	1997	4.6	5.3	2011	4.5	6.6	–0.1	1.3	–0.007	0.093
Namibia	1992	4.0	6.3	2006–2007	2.8	4.3	–1.2	–2.0	–0.083	–0.138
Niger	1992	6.4	7.1	2012	5.6	8.1	–0.8	1.0	–0.04	0.050
Nigeria	1990	5.0	6.3	2013	4.7	6.2	–0.3	–0.1	–0.013	–0.004
Rwanda	1992	4.5	6.3	2010	3.4	4.8	–1.1	–1.5	–0.061	–0.083
Senegal	1986	5.4	7.1	2010–2011	3.9	6.0	–1.5	–1.1	–0.061	–0.045
Tanzania	1991–1992	5.1	6.6	2010	3.7	6.1	–1.4	–0.5	–0.076	–0.027
Togo	1988	4.9	7.3	1998	3.2	6.3	–1.7	–1.0	–0.170	–0.100
Uganda	1988–1989	5.7	7.6	2011	3.8	6.8	–1.9	–0.8	–0.084	–0.036
Zambia	1992	5.8	7.1	2007	4.3	7.5	–1.5	0.4	–0.100	0.027
Zimbabwe	1988	3.8	6.2	2010–2011	3.1	4.8	–0.7	–1.4	–0.031	–0.062
Averages	1993.4	4.7	6.5	2009.7	3.9	6.0.	–0.9	–0.6	–0.053	–0.034

Notes: Countries with at least two Demographic and Health Surveys. TFR data are from DHS webpage http://www.statcompiler.com/en/.

While the average pace of decline is slow in sub-Saharan Africa there is considerable variation across countries, in both urban and rural areas. Only 19 of the 31 countries have had declines in both urban and rural fertility. Of these countries, 11 have experienced more rapid declines in urban areas, while in the other eight the fertility decline has been more rapid in rural places. As mentioned above, the rapid fertility decline in Eritrea, especially in the countryside, may result in part from a border conflict with Ethiopia during the late 1990s (Blanc 2004; Woldemicael 2008).

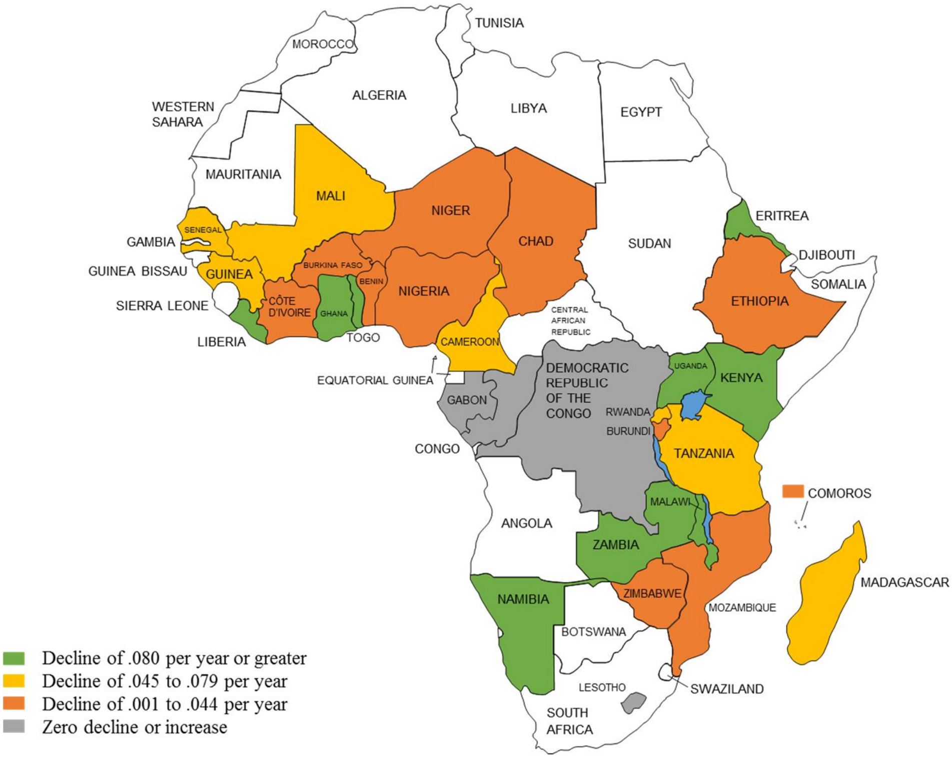
Six countries experienced declines in urban fertility but not in rural fertility: Cameroon, Chad, Ivory Coast, Mozambique, Niger, and Zambia. The Congo Republic and Gabon had increased fertility in both urban and rural places, while the Democratic Republic of the Congo had stable urban fertility and increasing rural fertility. Finally, Lesotho, a low-fertility country, had increased urban fertility and reduced rural fertility.

The most common outcome is for fertility to decline in both urban and rural places, but in nearly 40% of the countries this is not the case. Fertility decline has been more prevalent in urban areas, being present in 28 countries as compared to the 23 countries that experienced rural fertility decline.

Map 1 shows the annual pace of decline in urban areas, and Map 2 does the same for rural places. The greater number of countries with an absence of fertility decline in rural areas is apparent. Rapid fertility decline is evident in both urban and rural places in Western, Eastern, and Southern Africa, while Middle Africa is least likely to have experienced fertility decline (regions are defined following the United Nations 2015 definitions).

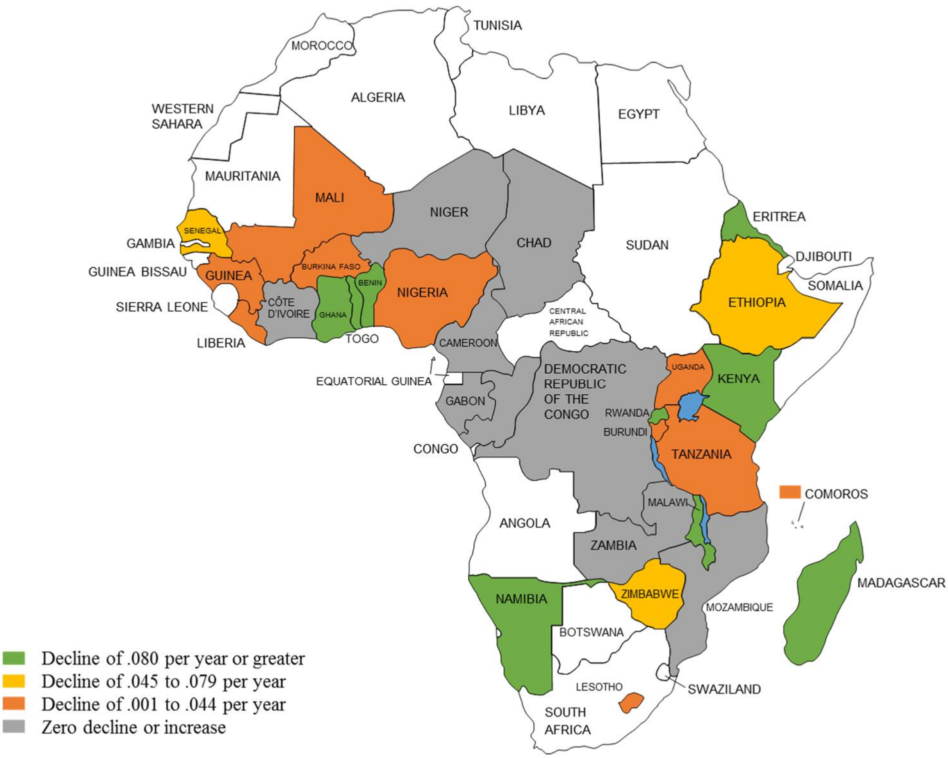
Patterns of fertility decline in urban and rural places as the fertility transition proceeds are shown in Figure 1. Using all pairs of consecutive DHS surveys, the figure shows how average declines in the urban and rural TFRs vary as a function of the corresponding average national TFRs, as of the initial DHS in the pair. At high levels of initial TFR, average urban fertility declines relatively rapidly, while average rural fertility declines distinctly more slowly. At the medium levels of the last TFR, urban fertility declines more slowly than in the high-fertility group, while among rural residents, compared to the high-fertility group, fertility decline is somewhat more rapid in Figure 1a but slightly slower in Figure 1b.

Map 1: Average annual pace of decline in the total fertility rate between the first and last Demographic and Health Survey, urban areas



Notes: N.B. Countries in white are not included in the analysis, either due to lack of two surveys or because they are not part of sub-Saharan Africa.

Map 2: Average annual pace of decline in the total fertility rate between the first and last Demographic and Health Survey, rural areas



Notes: N.B. Countries in white are not included in the analysis, either due to lack of two surveys or because they are not part of sub-Saharan Africa.

Figure 1a: Average relative declines in urban and rural TFRs between pairs of surveys, by initial level of fertility, version a

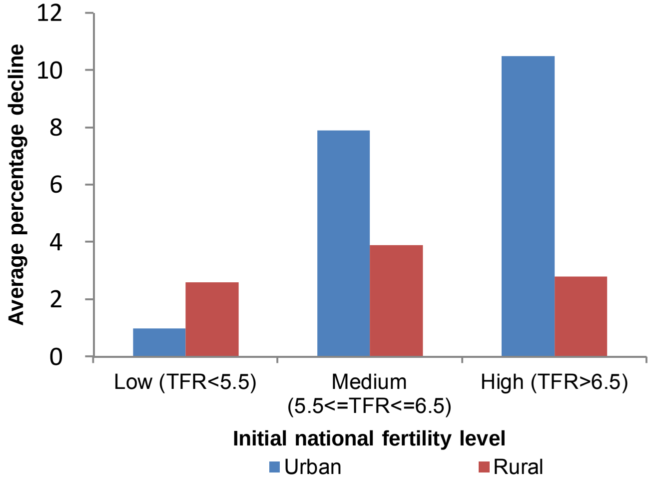
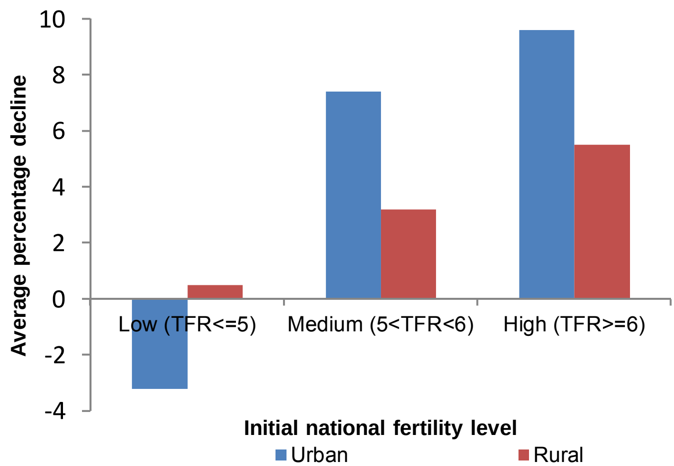


Figure 1b: Average relative declines in urban and rural TFRs between pairs of surveys, by initial level of fertility, version b



In both cases the pace of urban fertility decline remains higher than that of rural fertility decline, but the gap between the two has narrowed. Figures 1a and 1b differ by the cutoffs for distinguishing the three fertility groups, this differentiation serving as a sensitivity analysis. In the low-fertility group, in Figure 1a urban fertility decline has fallen further, to below the pace of rural fertility decline, while in Figure 1b average urban fertility decline is negative – i.e., urban fertility has stalled and increased, while the pace of rural fertility decline has slowed but exceeds that of urban areas. We believe that this is evidence of increasing numbers of African cities having actual fertility close to ideal fertility. In a study of a smaller number of sub-Saharan countries, Shapiro and Tambashe (2002) find a similar pattern of fertility decline being initially more rapid in urban places but eventually reaching a stage where rural fertility decline is faster than that in urban places.

Table 2 shows the mean years of schooling of women of reproductive age, and the percentage who have never been to school. Between the first and last survey, mean years of schooling increased in both urban and rural places in every country. Similarly, the percentage of women with no schooling declined almost everywhere except for urban and rural Lesotho and urban Congo, where the very low percentages with no schooling (1–3%) remained stable.

On average, urban women had 5.3 years of schooling as of the first survey and 7.0 years as of the last survey, an increase of 1.7 years over a period that averaged just over 16 years. Among rural women, mean years of schooling increased from 2.5 as of the first survey to 3.8 at the last survey, an increase of 1.3 years. The average percentage of urban women who had never been to school declined from 29% at the first survey to 19% at the last survey; the corresponding numbers for rural women declined from 55% to 41%. On each measure, then, rural women were worse off by roughly a factor of two.

There is substantial variation in the levels and changes in women's schooling, both across countries and between urban and rural areas. Typically, mean years of schooling increased more rapidly in urban areas, but in five countries (Malawi, Namibia, Rwanda, Senegal, and Zimbabwe) mean schooling increased more rapidly in rural areas, and in two others (the DRC and Gabon) the increase in mean years of schooling was the same in urban and rural places. Of these seven countries with comparatively strong growth in rural schooling, five had rather high educational attainment at the outset. Hence, the strong rural growth presumably reflects the fact that the process of expansion of schooling from urban to rural areas that typically unfolds over time in developing countries is farther along in those countries that already have a high level of schooling. However, for most countries that process is at an earlier stage, and schooling is still increasing more rapidly in urban places.

Table 2: Levels and changes in educational attainment between the first and last Demographic and Health Survey, urban and rural places

Country	First demographic and health survey				Last demographic and health survey				Absolute changes			
	mean years of school		pct. w/ no school		mean years of school		pct. w/ no school		mean years of school		pct. w/ no school	
	urban	rural	urban	rural	urban	rural	urban	rural	urban	rural	urban	rural
Benin	2.9	0.6	51	85	4.7	1.6	42	75	1.8	1.0	–9	–10
Burkina Faso	3.7	0.4	50	91	4.6	0.7	40	87	0.9	0.3	–10	–4
Burundi	4.7	0.7	30	82	7.0	2.6	16	49	2.3	1.9	–14	–33
Cameroon	5.5	2.9	28	50	8.1	4.0	8	34	2.6	1.1	–20	–16
Chad	2.2	0.4	57	86	3.3	0.7	52	81	1.1	0.3	–5	–5
Comoros	4.7	2.2	38	61	8.3	5.3	19	38	3.6	3.1	–19	–23
Congo	8.4	5.5	3	14	8.8	5.8	3	11	0.4	0.3	0	–3
Ivory Coast	3.5	1.6	48	70	4.9	1.9	41	66	1.4	0.3	–7	–4
DRC	7.6	3.4	8	34	8.7	4.5	4	23	1.1	1.1	–4	–11
Eritrea	3.6	0.6	30	83	5.8	1.4	23	71	2.2	0.8	–7	–12
Ethiopia	4.7	0.5	36	86	6.4	1.8	23	61	1.7	1.3	–13	–25
Gabon	7.4	5.1	6	7	8.6	6.3	4	5	1.2	1.2	–2	–2
Ghana	6.5	4.1	27	47	8.2	5.1	11	31	1.7	1.0	–16	–16
Guinea	3.5	0.4	56	93	5.2	1.1	42	82	1.7	0.7	–14	–11
Kenya	7.2	4.8	12	28	9.9	7.1	5	10	2.7	2.3	–7	–18
Lesotho	8.6	6.9	1	2	9.3	7.5	1	2	0.7	0.6	0	0
Liberia	4.2	1.4	46	76	5.9	2.3	24	52	1.7	0.9	–22	–24
Madagascar	6.6	3.0	7	27	7.3	3.6	4	23	0.7	0.6	–3	–4
Malawi	5.4	2.2	23	52	7.8	4.8	7	18	2.4	2.6	–16	–34
Mali	2.4	0.3	65	93	4.5	1.0	48	85	2.1	0.7	–17	–8
Mozambique	4.1	1.4	19	55	6.2	2.6	14	42	2.1	1.2	–5	–13
Namibia	7.6	4.8	9	19	10.1	7.8	4	10	2.5	3.0	–5	–9
Niger	2.2	0.2	65	95	4.0	0.6	47	88	1.8	0.4	–18	–7
Nigeria	5.8	2.2	31	66	9.0	4.0	16	54	3.2	1.8	–15	–12
Rwanda	6.3	3.2	20	41	6.4	4.1	8	19	0.1	0.9	–12	–22
Senegal	3.9	0.3	54	94	4.6	1.3	38	78	0.7	1.0	–16	–16
Tanzania	5.5	3.8	20	39	7.4	5.1	8	24	1.9	1.3	–12	–15
Togo	3.9	1.5	38	70	4.2	1.6	28	61	0.3	0.1	–10	–9
Uganda	6.4	2.9	13	41	8.7	5.0	4	16	2.3	2.1	–9	–25
Zambia	6.6	3.8	7	28	8.4	4.9	3	16	1.8	1.1	–4	–12
Zimbabwe	7.7	5.2	6	17	10.2	8.3	1	3	2.5	3.1	–5	–14
Averages	5.3	2.5	29	55	7.0	3.8	19	41	1.7	1.3	–10	–14

Notes: Countries with at least two Demographic and Health Surveys.

Table 3 shows $_5q_0$, the infant and child mortality rate, calculated over the past 10 years prior to the survey. As with increased educational attainment, reduced infant and child mortality between the first and last survey in both urban and rural places is close to universal. Only rural Chad, urban and rural Lesotho, and urban Zimbabwe did not show declining mortality, and, except for Zimbabwe, the increases in mortality were trivial. In every country except for Tanzania, mortality is higher in rural areas, but in some cases the urban-rural difference in mortality is modest (for example, Gabon, Kenya, Namibia) while in others it is substantial (for example, Burkina Faso, Cameroon, Guinea, and Niger).

Among urban women the average rate of infant and child mortality fell by 38% between the first and last survey. Among rural women, $_5q_0$ declined by 36%. Mortality is higher in rural areas by a little more than 30% on average. There is considerable diversity of experience across countries. Reflecting the larger average absolute declines in rural mortality, in 19 of the countries the decline in the rural mortality rate exceeded the decline in the urban mortality rate. However, in 11 countries the decline in the mortality rate was greater in urban places.

In the decompositions that we carry out, the age composition of women of reproductive age is an important control variable. This is because the dependent variable is children ever born, and the value of this variable increases with age, other things being equal. Here we examine the mean age of these women and how it changes between the first and last survey. Since we know from stable population theory that given the level of mortality, higher-fertility populations are younger than lower-fertility populations, in places experiencing fertility decline the population of women of reproductive age will tend to get older over time. This phenomenon will presumably be more common in urban places than in rural ones, given the lower urban fertility. At the same time, the age pattern of female rural-urban migration will also influence age distributions in both locations.

To the extent that the population of reproductive age gets older over time, this will partially mask fertility decline, since the aging will result in increased numbers of children ever born. Consequently, we control for the woman's age in the regressions in order to take account of this factor.

Table 3: Mortality and mortality changes between first and last Demographic and Health Survey, urban and rural places

Country	First demographic and health survey			Last demographic and health survey			Absolute change in 5q0			
	year	5q0		year	5q0		total		per year	
		urban	rural		urban	rural	urban	rural	urban	rural
Benin	1996	150	200	2011–2012	62	83	–88	–117	–5.7	–7.5
Burkina Faso	1993	148	214	2010	104	156	–44	–58	–2.6	–3.4
Burundi	1987	163	186	2010	79	131	–84	–55	–3.7	–2.4
Cameroon	1991	120	159	2011	93	153	–27	–6	–1.4	–0.3
Chad	1996–1997	190	204	2004	179	208	–11	4	–1.5	0.5
Comoros	1996	81	123	2012	28	58	–53	–65	–3.3	–4.0
Congo	2005	108	136	2011–2012	77	88	–31	–48	–4.8	–7.4
Ivory Coast	1994	120	165	2011–2012	100	125	–20	–40	–1.2	–2.3
DRC	2007	122	177	2013–2014	96	118	–26	–59	–4.0	–9.1
Eritrea	1995	129	160	2002	86	117	–43	–43	–6.1	–6.1
Ethiopia	2000	149	193	2011	83	114	–66	–79	–6.0	–7.1
Gabon	2000	88	100	2012	61	77	–27	–23	–2.3	–1.9
Ghana	1988	131	163	2008	75	90	–56	–73	–2.8	–3.6
Guinea	1999	149	211	2012	87	148	–62	–63	–4.7	–4.8
Kenya	1989	89	91	2008–2009	74	86	–15	–5	–0.8	–0.3
Lesotho	2004	87	105	2009	89	110	2	5	0.4	1.0
Liberia	1986	216	239	2013	106	120	–110	–119	–4.1	–4.4
Madagascar	1992	142	183	2008–2009	63	84	–79	–99	–4.8	–6.0
Malawi	1992	205	244	2010	113	130	–92	–114	–5.1	–6.3
Mali	1987	203	303	2012–2013	64	113	–139	–190	–5.5	–7.5
Mozambique	1997	150	237	2011	100	111	–50	–126	–3.6	–9.0
Namibia	1992	86	94	2006–2007	60	76	–26	–18	–1.8	–1.3
Niger	1992	210	347	2012	83	163	–127	–184	–6.4	–9.2
Nigeria	1990	130	208	2013	100	167	–30	–41	–1.3	–1.8
Rwanda	1992	155	163	2010	81	105	–74	–58	–4.1	–3.2
Senegal	1986	135	250	2010–2011	62	102	–73	–148	–3.0	–6.0
Tanzania	1991–1991	159	152	2010	94	92	–65	–60	–3.5	–3.3
Togo	1988	131	169	1998	101	157	–30	–11	–3.0	–1.1
Uganda	1988–1989	164	191	2011	77	111	–87	–80	–3.9	–3.5
Zambia	1992	151	201	2007	132	139	–19	–62	–1.3	–4.1
Zimbabwe	1988	55	99	2010–2011	77	78	22	–21	1.0	–0.9
Averages	1993.4	139	183	2009.7	87	116	–53	–66	–3.2	–4.1

Notes: Countries with at least two DHSs. Data on infant and child mortality are for the 10–year period preceding the survey. They are extracted from the webpage http://www.statcompiler.com/en/.

Table 4 shows that in urban areas, consistent with the observed declines in fertility, 25 of the countries experienced increasing mean age of women. In rural places, mean age of women of reproductive age increased in 20 countries. The general pattern, then, is increased mean age, but somewhat more so for urban women.

Table 4: Total fertility rate and mean age of women, first and last Demographic and Health Survey, urban and rural places

Country	First demographic and health survey					Last demographic and health survey					Absolute changes in mean age			
	year	mean age		TFR		year	mean age		TFR		total		per year	
		urban	rural	urban	rural		urban	rural	urban	rural	urban	rural	urban	rural
Benin	1996	27.8	29.8	4.9	6.7	2011–2012	28.5	29.2	4.3	5.4	0.7	–0.6	0.045	–0.039
Burkina Faso	1993	26.7	28.5	4.6	7.0	2010	27.3	29.3	3.9	6.7	0.6	0.8	0.035	0.047
Burundi	1987	27.9	28.5	5.1	7.0	2010	26.5	27.9	4.8	6.6	–1.4	–0.6	–0.06	–0.026
Cameroon	1991	27.0	28.2	5.2	6.3	2011	27.4	28.5	4	6.4	0.4	0.3	0.020	0.015
Chad	1996–1997	27.5	28.0	5.9	6.5	2004	27.5	28.5	5.7	6.5	0.0	0.5	0.000	0.067
Comoros	1996	26.9	27.4	3.8	5.0	2012	28.0	27.5	3.5	4.8	1.1	0.1	0.069	0.006
Congo	2005	27.6	28.2	3.8	6.1	2011–2012	28.0	29.9	4.5	6.5	0.4	1.7	0.062	0.262
Ivory Coast	1994	26.5	28.3	4.4	6.0	2011–2012	27.4	29.5	3.7	6.3	0.9	1.2	0.051	0.069
DRC	2007	27.6	28.9	5.4	7.0	2013–2014	27.5	28.5	5.4	7.3	–0.1	–0.4	–0.02	–0.062
Eritrea	1995	NA	NA	4.2	7.0	2002	NA	NA	3.5	5.7	NA	NA	NA	NA
Ethiopia	2000	26.5	28.5	3.0	6.0	2011	26.5	28.1	2.6	5.5	0.0	–0.4	0.000	–0.036
Gabon	2000	27.0	28.6	3.8	6.0	2012	28.2	30.2	3.9	6.1	1.2	1.6	0.100	0.133
Ghana	1988	28.3	28.8	5.3	7.0	2008	28.6	29.3	3.1	4.9	0.3	0.5	0.015	0.025
Guinea	1999	27.6	29.8	4.4	6.1	2012	27.1	29.2	3.8	5.8	–0.5	–0.6	–0.04	–0.046
Kenya	1989	26.2	28.9	4.5	7.1	2008–2009	27.9	28.7	2.9	5.2	1.7	–0.2	0.087	–0.010
Lesotho	2004	28.5	28.3	1.9	4.1	2009	28.6	28.0	2.1	4.0	0.1	–0.3	0.020	–0.060
Liberia	1986	26.6	28.9	6.0	7.1	2013	27.7	29.9	3.8	6.1	1.1	1.0	0.041	0.037
Madagascar	1992	27.8	27.9	3.8	6.7	2008–2009	28.7	29.0	2.9	5.2	0.9	1.1	0.055	0.067
Malawi	1992	27.3	28.7	5.5	6.9	2010	27.2	28.2	4.0	6.1	–0.1	–0.5	–0.01	–0.028
Mali	1987	28.7	30.1	6.3	7.4	2012–2013	27.5	29.0	5.0	6.5	–1.2	–1.1	–0.05	–0.043
Mozambique	1997	27.3	28.9	4.6	5.3	2011	27.8	29.0	4.5	6.6	0.5	0.1	0.036	0.007
Namibia	1992	28.5	27.7	4.0	6.3	2006–2007	28.6	28.1	2.8	4.3	0.1	0.4	0.007	0.028
Niger	1992	27.2	27.9	6.4	7.1	2012	28.3	28.9	5.6	8.1	1.1	1.0	0.055	0.050
Nigeria	1990	27.4	28.6	5.0	6.3	2013	28.9	28.7	4.7	6.2	1.5	0.1	0.065	0.004
Rwanda	1992	27.0	28.4	4.5	6.3	2010	27.6	28.6	3.4	4.8	0.6	0.2	0.033	0.011
Senegal	1986	27.0	28.2	5.4	7.1	2010–2011	27.9	27.9	3.9	6	0.9	–0.3	0.037	–0.012
Tanzania	1991–1991	26.9	28.1	5.1	6.6	2010	27.5	29.0	3.7	6.1	0.6	0.9	0.032	0.049
Togo	1988	26.8	28.8	4.9	7.3	1998	27.6	29.2	3.2	6.3	0.8	0.4	0.080	0.040
Uganda	1988–1989	25.5	27.6	5.7	7.6	2011	26.6	28.3	3.8	6.8	1.1	0.7	0.049	0.031
Zambia	1992	26.2	27.6	5.8	7.1	2007	27.3	28.6	4.3	7.5	1.1	1.0	0.073	0.067
Zimbabwe	1988	27.2	28.1	3.8	6.2	2010–2011	27.8	28.4	3.1	4.8	0.6	0.3	0.027	0.013
Averages	1993.4	27.23	28.47	4.74	6.52	2009.7	27.73	28.77	3.88	5.97	0.5	0.3	0.031	0.018

We have used the TFR as our measure of fertility to this point. However, the TFR is a measure based on aggregated data, and for this study we use micro data for our decomposition analyses. For each individual, then, our measure of fertility is the number of children ever born, or cumulative fertility, and mean number of children ever born is a key variable in the analyses. The mean number of children ever born is sensitive to even small changes in the average age of women of reproductive age.

It is useful to compare the levels of the TFR and the mean number of children ever born. In urban areas the levels of these two measures are very highly correlated, with the correlation being about +0.9 for both the first and last surveys. In rural areas the correlation coefficient is about +0.7 for the first survey and +0.8 for the last survey. Given these high correlations, the analyses below of changes in the determinants of fertility and their consequences for fertility behavior, using children ever born as the measure of fertility, are useful for understanding the ongoing fertility transition in sub-Saharan Africa.

4. Decomposition method and data

4.1 Decomposing changes in fertility over time

Oaxaca (1973) introduced a procedure for analyzing differences in wages between two groups. Consider wages as a consequence of earnings functions that reflect both endowments of factors that influence wages and the payoffs to those factors. From this perspective, two groups may have different wages as a consequence of different endowments of wage-relevant factors (such as schooling and work experience) and/or different payoffs to given factors (as might occur with labor market discrimination). The Oaxaca decomposition procedure allows the assessment of the importance of different endowments of relevant factors in accounting for the observed difference in wages between two groups.

The procedure developed by Oaxaca (1973) and subsequently refined (Oaxaca and Ransom 1994) has been used in many studies of wage differences between groups. However, it may also be applied to analysis of differences in fertility (Bundervoet 2014). Here we are interested in changes in fertility over time, and in the importance of changes in the educational attainment of women and in mortality in accounting for the fertility changes.

The number of children ever born to a woman in period i, Yi (i=1,2), is considered as a linear function of a set of women's characteristics X_i (i=1,2), a vector of parameters (β_i) and an error term (e_i).

$$Y_i = X_i \beta_i + e_i$$

The average number of children ever born to a woman in the sample is on the regression line and can be written as

$$\overline{Y_i} = \overline{X_i}\ \hat{\beta}_i$$

where $\overline{X_i}$ is the vector of average values of X_i and $\hat{\beta}_i$ is the vector of estimated values of β_i.

For any arbitrary vector β* we have that

$$\overline{Y_2} - \overline{Y_1} = (\overline{X_2} - \overline{X_1})\beta^* + \overline{X_2}(\widehat{\beta_2} - \beta^*) + \overline{X_1}(\beta^* - \widehat{\beta_1}) \qquad (1)$$

Equation 1 is a decomposition equation of the linear regression model. It expresses the change in the means of the dependent variable over two periods as a function of changes in means of the set of women's characteristics (first term on the right-hand side) and changes in the regression coefficients (two last terms on the right-hand side). We can then compute the contribution of each of these factors (as well as the contributions of changes in other characteristics that influence fertility) to overall fertility decline. The literature has considered various values for β* and some of them display some weaknesses (Oaxaca and Ransom 1994; Sinning, Hahan, and Bauer 2008). Following Oaxaca and Ransom (1994), this paper sets β* to be parameters estimated on the pooled sample. It reflects the set of parameters that should prevail irrespective of the time period.

We first estimate the effects of educational attainment, mortality, and age on cumulative fertility (children ever born), using data from the first and last Demographic and Health Surveys for each country. We estimated the β_1 coefficients using the first survey for each country, the β_2 coefficients using the last survey, and the β* coefficients using the pooled data. The estimated coefficients from the pooled data are then used in conjunction with changes in the means of the explanatory variables to identify the consequences for fertility of the changes in age, mortality, and education between the first and last survey.

Educational attainment is measured by a series of dummy variables indicating the number of years of schooling completed (0, 1–6, 7–8, 9–10, 11–12, 13+). The reference category is those with 1–6 years of schooling, representing primary schooling in a system with six years of primary school. However, there is variation across countries in grades per level; for example, in some countries, there are seven years to primary school. For this reason we use years of schooling rather than level. In addition, we break up what would be secondary schooling in a 6–6 system into three groups, as previous research (Shapiro and Tambashe 2003; Shapiro 2012) shows that these three secondary-school groups have distinctly different fertility.

Infant and child mortality is proxied by the percentage of children born to women in the respondent's sample cluster who have died. This is a measure of mortality that pertains to the small area in which each woman resides. It is not a measure of the infant and child mortality rate, but since most of the deaths it counts are likely to be of infants and children under five, our mortality measure should be highly correlated with the local area's infant and child mortality rate. The correlation between levels of our measure of mortality and the reported infant and child mortality rate exceeds +0.96 in both urban and rural places as of the first survey, and exceeds +0.92 in both places of residence as of the last survey. Our measure should thus be a good indicator of women's perceptions of the level of mortality.

4.2 Changes in mean values of the variables

Appendix Table A-1 shows the detailed results for individual countries with respect to changes in the mean values of the variables between the first and last surveys, for the variables used in the regressions. Micro data is not available for Eritrea, so the Appendix tables cover 30 countries.

Consider first the education dummy variables. In nearly every country the proportion of women with no schooling declined between the first and last survey in both urban and rural places. On average, the decline was about 35% in urban areas and 25% in rural areas. The pace of decline varied substantially across countries and was considerably slower in relative terms among the countries that had particularly low educational attainment at the outset.

For example, of the seven countries with more than 50% of urban women of reproductive age with no schooling as of the first survey, the average decline in this percentage as of the last survey was 13 percentage points, a 23% decline; while among the 23 countries with fewer than 50% of urban women with no schooling at the first survey, the average decline was 10 percentage points, more than 45% of the initial level. Among rural women, when 50% or more had no schooling at the first survey, there was a 15-point decline in that percentage at the last survey, or nearly a 20% decline, while in rural places with fewer than 50% with no schooling at the outset, the average decline was 11 points, almost 45%.

At the other end of the education distribution, the general tendency for each of the three education groups with nine or more years of schooling was for the proportion to increase over time, with this being the case for 90% of the 180 feasible comparisons. However, particularly in rural areas, these high-education groups remained small. More broadly, these changes in educational attainment reflect the increased access to both primary and (especially in urban places) secondary schooling that women have experienced during the past 20–30 years.

Declines in mortality, based on our measure reflecting mortality of children in each cluster of residence in urban and rural places, were universal within this group of countries, with one exception: urban Zimbabwe, which had the lowest mortality of all countries as of the first survey and, despite a slight increase, the fifth-lowest level as of the last survey. In some cases these declines were substantial and in others quite modest. The correlations between infant and child mortality rates reported in Table 3 and the mortality measures reported in Table A-1 are greater than +0.9 in both urban and rural areas and for both first and last surveys.

Changes in mean age of women aged 15–49 were mostly increases, but sometimes there were decreases. In some cases the changes were modest and in others more substantial. All of these changes influence the decompositions.

4.3 Regression results

The first step in the decomposition procedure is to estimate regressions with the dependent variable, the number of children ever born to each woman, regressed on variables indicating her educational attainment, the extent of mortality locally, and the woman's age. The data from the first and last Demographic and Health Survey is pooled, regressions are estimated using weighted data, and the resulting coefficients indicate the effects of each variable on the number of children ever born. The samples for each of these regressions consist of all urban women and all rural women aged 15–49, respectively.

Regression results for each country are in Appendix Table A-2. The estimated coefficients differ across countries, and the vast majority of these coefficients are highly significant. There are some consistent similarities in the results for the different countries. Consider the coefficients for the education dummy variables. Compared to women with 1–6 years of schooling (the reference group), women with no schooling tend to have significantly higher fertility, a little more so in urban places than in rural areas. Women with higher levels of schooling tend to have significantly lower numbers of children ever born, and typically the negative impact of schooling gets larger in absolute value as schooling level increases, in urban and especially in rural places.

These results may be seen more easily in Table 5, which shows the (unweighted) average values of the urban and rural coefficients across the 30 countries for which micro data are available.

Controlling for a woman's age and the level of mortality of children in her cluster of residence, on average urban women with no schooling have had nearly a third of a child more than women with 1–6 years of schooling; among rural women the corresponding differential is only half as large. Both urban and rural women with 7–8 years of schooling have lower fertility than their counterparts with 1–6 years of education, other things being equal, by close to 0.3 children, on average. As educational attainment increases beyond this level the magnitudes of the negative coefficients for the schooling groups rise in absolute value and at an increasing rate, especially among rural residents. Similar evidence of increasingly stronger negative effects of schooling on fertility as schooling increases is reported in Shapiro (2012).

Table 5: Mean values of regression coefficients, children-ever-born regressions, urban and rural places

Variable	Average values	
	urban	rural
Age	0.292	0.438
Age^2	–0.0017	–0.0034
ED0	0.318	0.156
ED1–6	–	–
ED7–8	–0.29	–0.279
ED9–10	–0.567	–0.676
ED11–12	–1.041	–1.295
ED13+	–1.642	–2.06
Mortality	0.023	0.018

Notes: ED0=dummy variable=1 if years of schooling=0; otherwise =0.
ED1–6=dummy variable=1 if 1<=years of schooling<=6; otherwise=0.
ED7–8=dummy variable=1 if 7<=years of schooling<=8; otherwise=0.
ED9–10=dummy variable=1 if 9<=years of schooling<=10; otherwise=0.
ED11–12=dummy variable=1 if 11<=years of schooling<12; otherwise=0.
ED13+=dummy variable=1 if years of schooling>=13.
Mortality=percentage of children born to women in respondent's cluster who have died.

The coefficients of the mortality variable typically have a small, positive value, slightly higher in urban places, on average, indicating that where mortality is higher, fertility tends to be higher, as anticipated. And finally, the number of children ever born increases with age, other things being equal, but at a decreasing rate.

5. Decomposition analysis

Appendix Table A-3 provides results of the decompositions that assess the contributions of different variables to the changes in fertility (children ever born) between the first and last Demographic and Health Surveys. Effects of the changes in means of the different education dummy variables, evaluated using the individual regression coefficients, are aggregated so that we see the consequences of changes in the group of education variables. The effects of changes in age and age squared are reported as the effect of the change in age.

Consider some examples to illustrate the interpretation of the numbers in the table. The increased educational attainment in urban Benin accounts for just over a third of the decline in the average number of children ever born between 1996 and 2012. By contrast, the reduction in mortality experienced in urban Benin implies a decline in the number of children ever born equivalent to more than 80% of the actual decline of 0.47 children. The increase in the mean age of urban women aged 15–49 of 0.7 years, by itself, would have increased fertility by almost 30% of the observed decline, and hence has a negative value. The three variables, taken together, account for 91% of the change in the number of children ever born between the first and last survey.

In urban Cameroon, increased education accounts for almost two-thirds of the fertility decline between 1991 and 2011 of more than 0.6 children in the average number of children ever born. The decline in mortality in Cameroon accounts for only 11% of the reduction in fertility. Finally, the slight increase in mean age of women of reproductive age between 1991 and 2011, since it would imply an increase in the number of children ever born, gets a minus sign for its influence, given that fertility declined.

In rural Namibia, increased schooling accounted for almost 90% of the decline in fertility, while reduced mortality had only a very small impact on fertility. By contrast, in rural Senegal more than two-thirds of the fertility decline reflected declining mortality, and increased education only contributed modestly to the decline in fertility.

These different examples illustrate that in some countries increased women's schooling accounts for the lion's share of changes in urban and rural fertility, while in other countries it is reductions in mortality that are predominant in accounting for declines in fertility. Before going into detail on this point, however, consider some peculiarities of the table.

The decompositions shown in Table A-3 omit results for a few urban locations and a substantial number of rural locations. In particular, when there is an increase in our measure of fertility (as in urban Congo and in the rural areas of nine countries), factors contributing to lower fertility will have negative signs, since their effect is to run counter to the observed fertility increase. In addition, in urban areas of three countries

(Chad, the DRC, and Lesotho) and in rural areas of six countries there was a decline in the mean number of children ever born, but the decline was quite small. Since that decline is the denominator in the decomposition calculations, the result of having small values of the denominator is inordinately high values for the impact of individual variables. The table thus includes decompositions only for those places that experienced a decline in the mean number of children ever born between the first and last survey of at least 0.10. This constituted 26 of the 30 urban areas, but, reflecting the slower pace of rural fertility decline, only 15 of the 30 rural areas showed reduced fertility of at least 0.10.

For the 26 countries whose urban areas experienced a decline in mean number of children ever born of at least 0.1, the unweighted mean contribution of increased women's schooling accounts for 54% of the fertility decline, while the corresponding figure for improvements in mortality is 30%. In 17 of those countries, education plays a more important role than mortality in contributing to reduced urban fertility, while in seven other countries mortality is more important for urban fertility, and in two countries they have about the same impact.

Among the 15 countries with a rural fertility decline of at least 0.1 children, the mean contribution of increased education represented 30% of the fertility decline, while reduced mortality accounted for 35% of the decline. Mortality had a greater impact than education on reducing rural fertility in eight countries, while the reverse was true in six countries, and in rural Rwanda the two factors had equal weight. Rwanda is a country in which education and mortality only contribute modestly to fertility decline, as is also the case for neighboring Burundi. These two countries have the highest population density by far in the region, and this high density appears to contribute to preferences for low fertility (Lutz, Testa, and Penn 2006; Shapiro 2017).

Because our goal was to carry out these decompositions for as many countries as possible, we included all countries that met the minimum requirement of having had at least two surveys. We used the first and last surveys for each country so as to maximize the duration of the period of observation. These durations ranged from five years for Lesotho, one of the five countries that only initiated DHSs in the 2000s (Congo, the DRC, Ethiopia, and Gabon are the others), up to 27 years for Liberia, one of nine countries that initiated DHSs during the 1980s. One consequence is that the 'first survey' takes place in some countries in the 1980s and in other countries not until the 2000s. In the presence of this diversity in the timing of first and last surveys, it is possible that there may be period effects that go undetected in our approach, which, by including all countries with at least two surveys without taking account of the timing of those surveys, cannot be identified.[3] Pursuit of the Millennium Development Goals (MDGs) is an example of a policy with the capability to create a period effect. With the

[3] We thank two reviewers and the editor for their comments raising this issue.

MDGs being pursued between 2000 and 2015, it is plausible to suggest (as did one of the reviewers) that countries with all surveys in the period 2000 or later might have benefited in terms of fertility decline, presumably from more rapid education increases and mortality declines.

To test for period effects, we compared our preferred decomposition results, for all countries taken together, to results from alternative scenarios. These comparisons are reported in Table 6.

Table 6: Decomposition results with alternative sample selection scenarios

Scenario	Criteria	Decomposition results				Comments
		urban		rural		
		education	mortality	education	mortality	
Preferred:	**all countries 2+ surveys**	57	29	30	36	30 countries
1	FS–1986–1995; LS–2000+	52	24	32	35	eliminates 11 countries
2	FS–1986–1999; LS–2000+	58	28	32	40	eliminates 6 countries
3a	FS–1986–1991	53	23	20	34	divides countries into two groups
3b	FS–1992+	60	33	39	38	
4a	FS–1986–1992	53	24	30	34	4 is a sensitivity analysis to compare
4b	FS–1993+	64	39	32	42	with 3

Notes: N.B. FS=First Survey; LS=Last Survey. Figures in the table show the average percentage of fertility decline attributable to increased education and reduced mortality, by place of residence.

To avoid an MDG effect, the first scenario, proposed by a reviewer, limited the sample to countries with a first survey no later than the mid-1990s and a last survey in 2000 or later. This removed 11 countries from the decompositions, and the average contributions of education and mortality to fertility decline in urban places were reduced somewhat. This indicates, consistent with an MDG effect, that the contributions among the late-starting countries were greater. In rural areas the results were essentially unchanged. Scenario 2 extends the first-survey limit to 1999, resulting in 6 countries being removed. Results for urban places are essentially the same as those for all 30 countries; the contribution of mortality is a little greater in rural places.

Scenarios 3 and 4 each divide the full sample into two groups differentiated by the year of the first survey, with 1991–1992 and 1992–1993 being the respective dividing lines (these close dividing lines represent a sensitivity analysis, and move six countries from the late to the early group). It is clear in each case that the later-starting countries show a greater impact of education and mortality on urban fertility decline, and while results for rural areas are somewhat variable there is evidence of greater impact on rural fertility decline as well.

A few conclusions emerge from the decompositions. First, both increased schooling and reduced mortality have contributed to fertility declines in urban and rural places. In urban areas increased educational attainment is more often the dominant factor, while in rural areas mortality decline is slightly more likely to be more important for fertility decline. Over all, on average these two factors account for almost 85% of urban fertility decline and nearly two-thirds of the slower rural fertility decline.

Two important proximate determinants of fertility, age at first union and contraceptive use, have not been included in the analyses. There are two major problems with using these variables. First, endogeneity with respect to education: these variables are related to education, so including them would reduce the estimated impact of education by attributing its consequences (later marriage, more and better contraception) to these other variables. The analysis here is essentially very close to a reduced form. Even here, there is an endogenous component to mortality: better-educated women experience lower infant and child mortality. If we omit mortality from the regressions, the impact of women's education in contributing to explaining fertility decline increases in all countries and locations where mortality had previously had some relevance. The increases are small, presumably because there is also a substantial exogenous component to mortality decline reflecting improvements in medical technology and in the delivery of health care services, but omitting mortality shows that including a partially endogenous variable reduces the estimated contribution of women's education.

Having noted our preferred analytical strategy, we also estimated regression equations for children ever born, including age at first union and modern contraceptive use. More specifically, to avoid endogeneity we used the average age at first marriage in the respondent's cluster of residence, and current use of modern contraception in the cluster. As anticipated, explicitly controlling for these proximate determinants reduces the estimated contribution of education per se. At the same time, it highlights the roles of these two pathways.

Results of the decompositions controlling for these two proximate determinants of fertility are shown in Appendix Table A-3, beneath the reduced-form results for each country. The average contribution of education per se to fertility decline falls by almost seven percentage points in urban places and by just over five percentage points in rural places. Declines are even larger for the average contribution to fertility decline of mortality decreases. We believe that this reflects correlations at the cluster level among mortality, age at marriage, and contraception, such that the mortality effects in the reduced form are biased upward. Finally, we note that, on average, inclusion of mean age at marriage in the cluster accounted for 40% of urban fertility decline and 30% of rural fertility decline, while current use of modern contraception represented another 11% of the urban and 15% of the rural fertility decrease.

6. Conclusion

Analyses of changes in urban and rural fertility in 31 countries in sub-Saharan Africa, in many cases going back to the mid- or late-1980s, show that the changes are typically but not exclusively declines, and vary substantially in magnitude and pace. Using individual-level data, we decompose the fertility changes into portions due to increasing women's schooling and declining infant and child mortality, while controlling for changes in the mean age of women of reproductive age as an additional factor influencing changes in our measure of fertility, children ever born.

The analyses document that fertility decline is more rapid in urban areas than in rural places. While both increased women's schooling and reduced mortality contribute to fertility decline, in urban areas the importance of women's education tends more frequently to be greater, while in rural places reduced mortality tends, on average, to play a modestly more important role than increased schooling in contributing to fertility decline. We note that the increases in educational attainment tend to be greater in urban places, while the declines in infant and child mortality are greater in rural areas.

We estimate the impact of educational attainment and mortality on cumulative fertility using a six-category scheme to represent educational attainment rather than the trichotomy (none/primary/secondary+) that is often used to characterize schooling. This more detailed representation of education shows that as educational attainment increases through the secondary level and beyond, fertility differences by education tend to widen. This suggests that as educational attainment rises to the secondary level and beyond for many women, the pace of fertility decline may well accelerate.

Fertility transition in sub-Saharan Africa, late in getting started relative to elsewhere in the developing world, has been comparatively slow and subject to stalling. As continued high fertility in the region is an obstacle to efforts to promote socioeconomic development and economic growth, policies seeking to encourage lower fertility constitute efforts to facilitate growth and development. The analyses here suggest that continued and augmented efforts to increase women's schooling and reduce infant and child mortality will generate more rapid fertility decline. We believe that such fertility decline will contribute to more rapid socioeconomic development.

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References

Antoine, P. (2006). Analyse biographique de la transformation des modèles matrimoniaux dans quatre capitales africaines: Antananarivo, Dakar, Lomé et Yaoundé. *Cahiers québecois de démographie* 35(2): 5–38. doi:10.7202/018591ar.

Barro, R.J. and Lee, J.W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics* 104: 184–198. doi:10.1016/j.jdeveco.2012.10.001.

Blanc, A. (2004). The role of conflict in the rapid fertility decline in Eritrea and prospects for the future. *Studies in Family Planning* 35(4): 236–245. doi:10.1111/j.0039-3665.2004.00028.x.

Bongaarts, J. (2008). Fertility transitions in developing countries: Progress or stagnation? *Studies in Family Planning* 39(2): 105–110. doi:10.1111/j.1728-4465.2008.00157.x.

Bongaarts, J. and Casterline, J. (2013). Fertility transition: Is sub-Saharan Africa different? *Population and Development Review* 38 (Supplement 1): 153–168. doi:10.1111/j.1728-4457.2013.00557.x.

Bundervoet, T. (2014). What explains Rwanda's drop in fertility between 2005 and 2010? Washington, D.C.: World Bank Group (Policy Research working paper WPS 6741.). doi:10.1596/1813-9450-6741.

Cochrane, S.H. (1979). *Fertility and education: What do we really know?* Baltimore: Johns Hopkins University Press.

Easterlin, R.A. (1975). An economic framework for fertility analysis. *Studies in Family Planning* 6(1): 54–63. doi:10.2307/1964934.

Easterlin, R.A. and Crimmins, E.M. (1985). *The fertility revolution: A supply–demand analysis.* Chicago: University of Chicago Press.

Eloundou-Enyegue, P., Stokes, C.S., and Cornwell, G. (2000). Are there crisis-led fertility declines? Evidence from central Cameroon. *Population Research and Policy Review* 19(1): 47–72. doi:10.1023/A:1006423527473.

Garenne, M. (2008). Fertility changes in sub-Saharan Africa. Calverton: Macro International (DHS Comparative Report 18).

Garenne, M. (2012). Education and fertility in sub-Saharan Africa: A longitudinal perspective. Calverton: ICF International (DHS Analytical Studies 33).

Garenne, M. and Joseph, V. (2002). The timing of the fertility transition in sub-Saharan Africa. *World Development* 30(10): 1835–1843. doi:10.1016/S0305-750X(02)00069-4.

Gurmu, E. and Mace, R. (2008). Fertility decline driven by poverty: The case of Addis Ababa, Ethiopia. *Journal of Biosocial Science* 40(3): 339–358. doi:10.1017/S002193200700260X.

Hobcraft, J. (1993). Women's education, child welfare, and child survival: A review of the evidence. *Health Transition Review* 3(2): 159–175.

Lutz, W., Testa, M.R., and Penn, D.J. (2006). Population density is a key factor in declining human fertility. *Population and Environment* 28(2): 69–81.

Oaxaca, R. (1973). Male–female wage differentials in urban labor markets. *International Economic Review* 14(3): 693–709. doi:10.2307/2525981.

Oaxaca, R. and Ransom, M. (1994). On discrimination and the decomposition of wage differentials. *Journal of Econometrics* 61(1): 5–21. doi:10.1016/0304-4076(94)90074-4.

Romaniuk, A. (2011). Persistence of high fertility in tropical Africa: The case of the Democratic Republic of the Congo. *Population and Development Review* 37(1): 1–28. doi:10.1111/j.1728-4457.2011.00388.x.

Rosenzweig, M. and Schultz, T.P. (1989). Schooling, information, and nonmarket productivity: Contraceptive use and its effectiveness. *International Economic Review* 30(2): 457–477. doi:10.2307/2526657.

Rutstein, S. (2000). Factors associated with trends in infant and child mortality in developing countries during the 1990s. *Bulletin of the World Health Organization* 78(10): 1256–1270. doi:10.1590/S0042-96862000001000011.

Schultz, T.P. (1993). Investments in the schooling and health of women and men: Quantities and returns. *Journal of Human Resources* 28(4): 694–734. doi:10.2307/146291.

Shapiro, D. (2012). Women's education and fertility transition in sub-Saharan Africa. *Vienna Yearbook of Population Research* 10: 9–30. doi:10.1553/populationyearbook2012s9.

Shapiro, D. (2015). Enduring economic hardship, women's education, marriage, and fertility transition in Kinshasa. *Journal of Biosocial Science* 47(2): 258–274. doi:10.1017/S0021932014000091.

Shapiro, D. (2017). *Emerging preferences for low fertility in sub-Saharan Africa: An exploratory study*. Revised version of paper presented at the 2016 Annual Meeting of the Population Association of America, Washington, D.C., March 31 – April 02, 2016.

Shapiro, D. and Gebreselassie, T. (2008). Fertility transition in sub-Saharan Africa: Falling and stalling. *African Population Studies* 23(1): 3–23.

Shapiro, D. and Gebreselassie, T. (2014). Marriage in sub-Saharan Africa: Trends, determinants, and consequences. *Population Research and Policy Review* 33(2): 229–255. doi:10.1007/s11113-013-9287-4.

Shapiro, D., Kreider, A., Varner, C., and Sinha, M. (2013). Stalling of fertility transitions and socioeconomic change in the developing world: Evidence from the Demographic and Health Surveys. In: Tabutin, D. and Masquelier, B. (eds.). *Ralentissements, résistances et ruptures dans les transitions démographiques, Actes de la Chaire Quetelet 2010*. Louvain-la-Neuve: Presse de l'Université de Louvain: 47–64.

Shapiro, D. and Tambashe, B.O. (1994). The impact of women's employment and education on contraceptive use and abortion in Kinshasa, Zaire. *Studies in Family Planning* 25(2): 96–110. doi:10.2307/2138087.

Shapiro, D. and Tambashe, B.O. (2002). Fertility transition in urban and rural sub-Saharan Africa: Preliminary evidence of a three-stage process. *Journal of African Policy Studies* 8(2 and 3): 103–127.

Shapiro, D. and Tambashe, B.O. (2003). *Kinshasa in transition: Women's education, employment, and fertility*. Chicago: University of Chicago Press.

Shapiro, D. and Tenikue, M. (2015). *Women's education, infant and child mortality, and fertility decline in sub-Saharan Africa: A quantitative assessment*. Paper presented at the Annual Meeting of the Population Association of America, San Diego, California, April 30 – May 02, 2015. doi:10.2139/ssrn.2717490.

Sinning, M., Hahan, M., and Bauer T.K. (2008). The Blinder–Oaxaca decomposition for nonlinear regression models. *The Stata Journal* 8(4):480–493.

United Nations (2010). The world's women 2010: Trends and statistics. New York: Department of Economic and Social Affairs, Population Division. http://unstats.un.org/unsd/demographic/products/Worldswomen/WW2010pub.htm.

United Nations (2015). World population prospects: The 2015 revision*,* DVD edition. New York: Department of Economic and Social Affairs, Population Division.

Woldemicael, G. (2008). Recent fertility decline in Eritrea: Is it a conflict-led transition? *Demographic Research* 18(2): 27–58. doi:10.4054/DemRes.2008.18.2.

Appendix

Table A-1 a: Mean values of the variables used in the regressions, first and last surveys, by country, urban places

Variable/	Benin		Burkina Faso		Burundi		Cameroon		Chad	
Year	1996	2012	1993	2010	1987	2010	1991	2011	1997	2004
Age	27.8	28.5	26.7	27.3	27.9	26.5	27	27.4	27.5	27.5
Age2	860.4	895.4	792.9	830.9	861.2	781.5	801.8	838.6	840.7	845.5
ED0	0.508	0.419	0.501	0.403	0.305	0.161	0.277	0.082	0.569	0.521
ED1–6	0.301	0.229	0.248	0.249	0.413	0.388	0.301	0.288	0.311	0.265
ED7–8	0.074	0.08	0.071	0.098	0.112	0.099	0.14	0.135	0.05	0.064
ED9–10	0.069	0.126	0.103	0.139	0.081	0.094	0.167	0.221	0.038	0.065
ED11–12	0.032	0.061	0.037	0.058	0.041	0.102	0.084	0.145	0.022	0.047
ED13+	0.016	0.085	0.04	0.053	0.048	0.156	0.031	0.129	0.01	0.038
Mortality	16.3	6.4	15.8	12.1	14.9	9.3	13.5	10	20.6	18.6
CEB	2.695	2.227	2.632	2.05	2.821	1.913	2.788	2.147	3.286	3.219

Variable/	Comoros		Congo		Ivory Coast		Democratic Republic of the Congo		Ethiopia	
Year	1996	2012	2005	2011	1994	2012	2007	2013	2000	2011
Age	26.9	28	27.6	28	26.5	27.4	27.6	27.5	26.5	26.5
Age2	808.6	871.4	843.5	866	780.4	829.3	844.3	839.3	787.7	775.3
ED0	0.381	0.192	0.03	0.034	0.483	0.411	0.075	0.039	0.364	0.233
ED1–6	0.246	0.144	0.205	0.174	0.293	0.247	0.292	0.225	0.229	0.249
ED7–8	0.134	0.107	0.232	0.206	0.078	0.058	0.207	0.191	0.182	0.167
ED9–10	0.131	0.159	0.328	0.321	0.09	0.125	0.189	0.212	0.093	0.149
ED11–12	0.059	0.143	0.112	0.126	0.035	0.059	0.187	0.248	0.109	0.068
ED13+	0.049	0.255	0.093	0.14	0.021	0.1	0.05	0.085	0.023	0.134
Mortality	8.9	4.4	10.1	8.2	13.6	10.8	13	10.3	16.8	9.8
CEB	2.161	1.872	1.965	2.095	2.472	1.947	2.554	2.494	1.934	1.643

Variable/	Gabon		Ghana		Guinea		Kenya		Lesotho	
Year	2000	2012	1988	2008	1999	2012	1989	2009	2004	2009
Age	27	28.2	28.3	28.6	27.6	27.1	26.2	27.9	28.5	28.6
Age2	813.7	881	889.9	906.8	850.5	815.5	750.1	850.2	899.1	903.6
ED0	0.062	0.045	0.267	0.111	0.555	0.418	0.123	0.047	0.008	0.007
ED1–6	0.349	0.214	0.15	0.165	0.211	0.19	0.186	0.091	0.17	0.124
ED7–8	0.232	0.229	0.095	0.118	0.067	0.09	0.302	0.283	0.31	0.286
ED9–10	0.19	0.265	0.385	0.344	0.061	0.102	0.143	0.094	0.289	0.266
ED11–12	0.094	0.103	0.053	0.172	0.037	0.082	0.211	0.308	0.195	0.205
ED13+	0.073	0.144	0.05	0.09	0.069	0.118	0.035	0.177	0.028	0.112
Mortality	9.9	7.2	14.5	8.9	17.2	10.4	8.7	6.4	8.9	8.3
CEB	2.354	2.114	2.687	1.768	2.686	2.039	2.324	1.676	1.429	1.377

Table A-1 a: (Continued)

Variable/	Liberia		Madagascar		Malawi		Mali		Mozambique	
Year	**1986**	**2013**	**1992**	**2009**	**1992**	**2010**	**1987**	**2012**	**1997**	**2011**
Age	26.6	27.7	27.8	28.7	27.3	27.2	28.7	27.5	27.3	27.8
Age2	779.2	853.2	852.8	918.2	821.9	815	900.5	832.4	833.3	860.6
ED0	0.465	0.237	0.073	0.044	0.232	0.073	0.649	0.485	0.19	0.145
ED1–6	0.203	0.315	0.438	0.368	0.309	0.278	0.183	0.147	0.582	0.365
ED7–8	0.095	0.14	0.212	0.221	0.251	0.202	0.068	0.114	0.142	0.204
ED9–10	0.102	0.118	0.076	0.135	0.108	0.175	0.06	0.091	0.057	0.16
ED11–12	0.108	0.138	0.149	0.154	0.089	0.207	0.019	0.089	0.022	0.093
ED13+	0.027	0.052	0.052	0.078	0.011	0.065	0.021	0.074	0.007	0.033
Mortality	21.7	15.2	14	8.1	20.6	13.5	21.8	7.8	17.1	11.8
CEB	2.82	2.346	2.342	1.868	3.018	2.369	3.573	2.526	2.645	2.337

Variable/	Namibia		Niger		Nigeria		Rwanda		Senegal	
Year	**1992**	**2007**	**1992**	**2012**	**1990**	**2013**	**1992**	**2010**	**1986**	**2011**
Age	28.5	28.6	27.2	28.3	27.4	28.9	27	27.6	27	27.9
Age2	895.8	903.1	815.4	886.2	824.8	927	804.2	842.4	807.5	863.5
ED0	0.09	0.038	0.655	0.469	0.312	0.155	0.202	0.078	0.541	0.378
ED1–6	0.231	0.101	0.196	0.228	0.267	0.168	0.328	0.508	0.245	0.311
ED7–8	0.267	0.124	0.07	0.098	0.06	0.055	0.149	0.153	0.001	0.085
ED9–10	0.229	0.346	0.052	0.121	0.106	0.11	0.08	0.089	0.026	0.108
ED11–12	0.142	0.279	0.014	0.043	0.216	0.347	0.156	0.109	0.075	0.061
ED13+	0.041	0.112	0.013	0.041	0.039	0.165	0.085	0.063	0.112	0.057
Mortality	9.4	6.1	20.7	11.9	13.3	10.9	15.4	11	16.4	8.2
CEB	2.185	1.657	3.328	2.998	2.752	2.509	2.236	1.829	2.738	1.951

Variable/	Tanzania		Togo		Uganda		Zambia		Zimbabwe	
Year	**1992**	**2010**	**1988**	**1998**	**1989**	**2011**	**1992**	**2007**	**1988**	**2011**
Age	26.9	27.5	26.8	27.6	25.5	26.6	26.2	27.3	27.2	27.8
Age2	807	840.2	792.1	846.4	719.5	776.5	763	830.5	818.8	852.8
ED0	0.195	0.078	0.376	0.283	0.134	0.037	0.074	0.033	0.065	0.008
ED1–6	0.175	0.091	0.39	0.444	0.357	0.263	0.272	0.197	0.204	0.045
ED7–8	0.52	0.552	0.095	0.16	0.188	0.199	0.479	0.273	0.272	0.144
ED9–10	0.046	0.126	0.101	0.097	0.128	0.157	0.089	0.241	0.181	0.208
ED11–12	0.056	0.093	0.03	0	0.148	0.142	0.057	0.152	0.244	0.489
ED13+	0.008	0.06	0.008	0.016	0.045	0.202	0.029	0.104	0.034	0.106
Mortality	15.8	11	13.2	12.1	14.2	8.9	14.1	13.6	6	6.7
CEB	2.58	1.987	2.277	2.014	2.611	2.19	2.785	2.355	2.288	1.571

Notes: ED0=dummy variable=1 if years of schooling=0; otherwise =0.
ED1–6=dummy variable=1 if 1<=years of schooling<=6; otherwise=0.
ED7–8=dummy variable=1 if 7<=years of schooling<=8; otherwise=0.
ED9–10=dummy variable=1 if 9<=years of schooling<=10; otherwise=0.
ED11–12=dummy variable=1 if 11<=years of schooling<12; otherwise=0.
ED13+=dummy variable=1 if years of schooling>=13.
Mortality=percentage of children born to women in respondent's cluster who have died.
CEB=Children ever born.

Table A-1 b: Mean values of the variables used in the regressions, first and last surveys, by country, rural places

Variable/	Benin		Burkina Faso		Burundi		Cameroon		Chad	
Year	1996	2012	1993	2010	1987	2010	1991	2011	1997	2004
Age	29.8	29.2	28.5	29.3	28.5	27.9	28.2	28.5	28	28.5
Age2	980.4	934	898.7	949.2	893.3	870.8	891.6	904.8	871.9	906.8
ED0	0.852	0.75	0.915	0.866	0.824	0.488	0.5	0.344	0.859	0.812
ED1–6	0.127	0.134	0.07	0.096	0.167	0.439	0.33	0.434	0.135	0.172
ED7–8	0.014	0.045	0.006	0.021	0.004	0.037	0.098	0.09	0.005	0.013
ED9–10	0.004	0.055	0.007	0.013	0.003	0.02	0.052	0.095	0.001	0.002
ED11–12	0.002	0.01	0.001	0.003	0.002	0.012	0.013	0.025	0	0.001
ED13+	0.001	0.006	0.001	0.001	0	0.004	0.007	0.012	0	0
Mortality	22.9	9	24	17.3	19.5	16.2	19.3	15.8	22	21.8
CEB	3.926	3.179	3.715	3.76	3.03	2.807	3.484	3.408	3.571	3.84

Variable/	Comoros		Congo		Ivory Coast		Democratic Republic of the Congo		Ethiopia	
Year	1996	2012	2005	2011	1994	2012	2007	2013	2000	2011
Age	27.4	27.5	28.2	29.9	28.3	29.5	28.9	28.5	28.5	28.1
Age2	846.7	837.7	882	987.2	890.8	956.6	930.1	897.3	907.3	879.7
ED0	0.607	0.376	0.135	0.115	0.7	0.663	0.335	0.232	0.855	0.614
ED1–6	0.278	0.221	0.462	0.449	0.238	0.266	0.477	0.484	0.124	0.294
ED7–8	0.048	0.109	0.204	0.226	0.032	0.024	0.094	0.151	0.014	0.056
ED9–10	0.048	0.112	0.154	0.164	0.021	0.031	0.056	0.079	0.003	0.024
ED11–12	0.014	0.073	0.034	0.03	0.007	0.007	0.037	0.052	0.002	0.002
ED13+	0.005	0.109	0.011	0.017	0.002	0.009	0.001	0.002	0.002	0.01
Mortality	15.1	6.6	14.1	10.4	18.2	14.1	18.2	13.9	22.9	16.3
CEB	2.779	2.322	2.926	3.324	3.539	3.46	3.332	3.402	3.348	3.271

Variable/	Gabon		Ghana		Guinea		Kenya		Lesotho	
Year	2000	2012	1988	2008	1999	2012	1989	2009	2004	2009
Age	28.6	30.2	28.8	29.3	29.8	29.2	28.9	28.7	28.3	28
Age2	914.5	1016.1	911.3	956	979.2	945.9	922.5	919.3	901.5	882.1
ED0	0.067	0.049	0.465	0.313	0.927	0.816	0.279	0.104	0.025	0.017
ED1–6	0.703	0.523	0.169	0.249	0.053	0.115	0.296	0.219	0.355	0.293
ED7–8	0.136	0.202	0.102	0.137	0.01	0.03	0.284	0.412	0.373	0.375
ED9–10	0.068	0.156	0.237	0.234	0.005	0.025	0.07	0.096	0.175	0.204
ED11–12	0.019	0.043	0.018	0.052	0.002	0.008	0.064	0.13	0.064	0.087
ED13+	0.007	0.027	0.009	0.015	0.003	0.006	0.007	0.039	0.008	0.024
Mortality	11.5	8.4	17.5	11.3	24.5	17.3	10.2	9.3	10.9	10.2
CEB	3.342	3.259	3.417	2.848	3.781	3.515	3.955	3.019	2.249	2.015

Table A-1 b: (Continued)

Variable/	Liberia		Madagascar		Malawi		Mali		Mozambique	
Year	1986	2013	1992	2009	1992	2010	1987	2012	1997	2011
Age	28.9	29.9	27.9	29	28.7	28.2	30.1	29	28.9	29
Age2	921.4	995.2	865.3	935.1	919.2	881.3	992.3	920.5	929.1	937.5
ED0	0.757	0.524	0.268	0.23	0.517	0.181	0.927	0.851	0.553	0.418
ED1–6	0.163	0.357	0.61	0.589	0.368	0.483	0.065	0.08	0.425	0.468
ED7–8	0.037	0.069	0.079	0.104	0.095	0.203	0.007	0.036	0.016	0.068
ED9–10	0.023	0.027	0.02	0.037	0.013	0.08	0.001	0.017	0.006	0.037
ED11–12	0.018	0.019	0.021	0.031	0.007	0.047	0	0.012	0	0.008
ED13+	0.002	0.004	0.002	0.009	0	0.006	0	0.004	0	0.001
Mortality	25.3	17.6	19.1	10.4	27.1	16.3	33.7	11.8	23.3	15.3
CEB	3.347	3.732	3.415	3.063	3.546	3.231	4.101	3.552	3.176	3.204

Variable/	Namibia		Niger		Nigeria		Rwanda		Senegal	
Year	1992	2007	1992	2012	1990	2013	1992	2010	1986	2011
Age	27.7	28.1	27.9	28.9	28.6	28.7	28.4	28.6	28.2	27.9
Age2	860.8	887.7	863.9	914.8	903	917.4	892.8	909.3	877	863.2
ED0	0.189	0.095	0.948	0.88	0.659	0.541	0.407	0.189	0.937	0.779
ED1–6	0.477	0.241	0.049	0.096	0.229	0.181	0.405	0.644	0.056	0.149
ED7–8	0.194	0.211	0.002	0.014	0.029	0.046	0.128	0.105	0	0.036
ED9–10	0.103	0.307	0.001	0.007	0.032	0.067	0.019	0.031	0.002	0.027
ED11–12	0.032	0.107	0	0.002	0.043	0.131	0.034	0.025	0.002	0.006
ED13+	0.005	0.039	0	0.001	0.008	0.034	0.007	0.006	0.003	0.003
Mortality	10.1	8.2	32.8	20.7	21.4	17.6	19.6	15	27.4	12.6
CEB	2.592	2.152	3.961	4.461	3.499	3.466	3.125	2.521	3.625	3.052

Variable/	Tanzania		Togo		Uganda		Zambia		Zimbabwe	
Year	1992	2010	1988	1998	1989	2011	1992	2007	1988	2011
Age	28.1	29	28.8	29.2	27.6	28.3	27.6	28.6	28.1	28.4
Age2	882.4	933.3	918.8	941.7	848.7	896.4	852.6	905.2	885.8	896.1
ED0	0.386	0.24	0.702	0.61	0.41	0.162	0.282	0.16	0.173	0.035
ED1–6	0.205	0.163	0.239	0.335	0.448	0.526	0.442	0.464	0.41	0.157
ED7–8	0.387	0.522	0.028	0.04	0.099	0.172	0.247	0.258	0.259	0.303
ED9–10	0.009	0.046	0.027	0.015	0.029	0.073	0.016	0.09	0.088	0.224
ED11–12	0.012	0.02	0.004	0	0.013	0.036	0.008	0.02	0.066	0.249
ED13+	0.001	0.009	0	0	0.001	0.031	0.005	0.008	0.004	0.032
Mortality	16.9	12.3	19.5	17.5	19.2	13.7	19.5	15.2	10.7	7.9
CEB	3.279	3.236	3.718	2.483	3.607	3.726	3.443	3.525	3.288	2.433

Notes: ED0=dummy variable=1 if years of schooling=0; otherwise =0.
ED1–6=dummy variable=1 if 1<=years of schooling<=6; otherwise=0.
ED7–8=dummy variable=1 if 7<=years of schooling<=8; otherwise=0.
ED9–10=dummy variable=1 if 9<=years of schooling<=10; otherwise=0.
ED11–12=dummy variable=1 if 11<=years of schooling<12; otherwise=0.
ED13+=dummy variable=1 if years of schooling>=13.
Mortality=percentage of children born to women in respondent's cluster who have died.
CEB=Children ever born.

Table A-2 a: Regression coefficients, children ever born, by country, urban places

Variable	Benin	B.F.	Bur.	Cam.	Chad	Com.	Congo	C.I.	DRC
Age	0.3	0.232	0.331	0.315	0.582	0.175	0.266	0.235	0.396
Age2	–0.002	0	–0.002	–0.002	–0.006	0.000ns	–0.002	–0.001	–0.003
ED0	0.614	0.555	–0.005ns	0.825	0.175	0.865	0.075ns	0.392	–0.039ns
ED1–6	–	–	–	–	–	–	–	–	–
ED7–8	–0.225	–0.143*	–0.070ns	–0.307	–0.290*	–0.327	–0.208	–0.129ns	–0.277
ED9–10	–0.453	0.557	–0.668	–0.574	–0.69	–0.736	–0.536	–0.507	–0.588
ED11–12	–0.594	–1.011	–0.984	–1.048	–1.219	–0.987	–0.945	–0.75	–1.304
ED13+	–1.047	–1.575	–1.751	–1.575	–2.054	–1.597	–1.384	–1.366	–2.357
Mortality	0.04	0.031	0.022	0.02	0.010*	0.018*	0.012	0.033	0.017
Constant	–4.743	–4.153	–0.509	–4.386	–8.104	–2.583	–3.471	–3.963	–5.516
R2	0.567	0.692	0.65	0.58	0.601	0.566	0.553	0.565	0.606
N	8889	8104	2727	9953	5.893	3.145	8426	8441	23184

Variable	Ethiopia	Gab.	Ghana	Guinea	Kenya	Lesotho	Lib.	Mad.	Malawi
Age	0.191	0.247	0.237	0.253	0.367	0.117	0.304	0.305	0.329
Age2	0.000ns	–0.001	–0.001	–0.001	–0.003	0.000ns	–0.002	–0.002	–0.002
ED0	0.313	–0.292	0.37	0.354	0.419	0.004ns	0.139*	0.652	0.431
ED1–6	–	–	–	–	–	–	–	–	–
ED7–8	–0.226	–0.361	–0.194ns	–0.303	–0.481	–0.181	–0.317	–0.475	–0.382
ED9–10	–0.447	–0.625	–0.636	–0.371	–0.591	–0.391	–0.526	–0.707	–0.758
ED11–12	–1.001	–1.027	–1.147	–0.754	–1.156	–0.675	–1.071	–1.169	–1.361
ED13+	–1.097	–1.558	–1.651	–1.26	–1.922	–0.845	–1.654	–1.683	–2.104
Mortality	0.03	0.02	0.023	0.024	0.035	0.006*	0.03	0.035	0.009
Constant	–3.433	–3.403	–3.558	–4.122	–4.825	–1.661	–4.718	–4.383	–4.376
R2	0.584	0.528	0.608	0.627	0.53	0.527	0.602	0.506	0.686
N	9872	9898	3673	5847	4524	3.916	5.662	7.044	4.384

Variable	Mali	Mozamb.	Nam.	Niger	Nigeria	Rwa.	Sen.	Tanz.	Togo
Age	0.385	0.342	0.209	0.364	0.322	0.179	0.203	0.31	0.212
Age2	–0.003	–0.003	–0.001	–0.002	–0.002	0.000ns	0.000ns	–0.002	0.000ns
ED0	0.333	0.090ns	0.119ns	0.824	0.579	0.485	0.646	0.022ns	0.435
ED1–6	–	–	–	–	–	–	–	–	–
ED7–8	–0.162ns	–0.378	–0.403	–0.051ns	–0.42	–0.108ns	0.085ns	–0.714	–0.542
ED9–10	–0.355	–0.758	–0.976	–0.599	–0.522	–0.122ns	–0.398	–0.95	–0.806
ED11–12	–0.778	–1.168	–1.352	–1.089	–1.069	–0.67	–0.425	–1.63	–0.938
ED13+	–1.469	–2.135	–1.698	–1.759	–1.958	–0.933	–0.937	–2.03	–1.729
Mortality	0.04	0.025	0.013	0.026	0.034	0.022	0.054	0.019	0.022
Constant	–5.819	–4.698	–2.413	–5.933	–4.654	–3.401	–3.952	–4.134	–3.699
R2	0.592	0.562	0.543	0.623	0.622	0.603	0.534	0.589	0.62
N	4.603	8.312	6.295	6.08	19.054	3.525	8	4.429	4.227

Table A-2 a: (Continued)

Variable	Uganda	Zambia	Zimbabwe
Age	0.401	0.328	0.32
Age2	–0.003	–0.001	–0.003
ED0	–0.008ns	–0.044ns	0.197ns
ED1–6	–	–	–
ED7–8	–0.248	–0.269	–0.602
ED9–10	–0.53	–0.889	–0.865
ED11–12	–1.114	–1.418	–1.369
ED13+	–1.967	–2.37	–1.803
Mortality	0.014	–0.001ns	0.009*
Constant	–5.42	–4.6	–3.601
R2	0.631	0.677	0.563
N	3.526	6.532	4.84

Notes: All coefficients are significant at the .01 level, except as noted below. * significant at the .05 level. ^{ns} not significant.
ED0=dummy variable=1 if years of schooling=0; otherwise =0.
ED1–6=dummy variable=1 if 1<=years of schooling<=6; otherwise=0.
ED7–8=dummy variable=1 if 7<=years of schooling<=8; otherwise=0.
ED9–10=dummy variable=1 if 9<=years of schooling<=10; otherwise=0.
ED11–12=dummy variable=1 if 11<=years of schooling<12; otherwise=0.
ED13+=dummy variable=1 if years of schooling>=13.
Mortality=percentage of children born to women in respondent's cluster who have died.

Table A-2 b: Regression coefficients, children ever born, by country, rural places

Variable	Benin	B.F.	Bur.	Cam.	Chad	Com.	Congo	C.I.	DRC
Age	0.472	0.49	0.339	0.531	0.627	0.272	0.379	0.442	0.5
Age2	–0.004	–0.004	–0.001	–0.005	–0.006	–0.001	–0.003	–0.003	–0.004
ED0	0.367	0.197	–0.074*	0.523	–0.026ns	0.441	0.2	0.253	–0.122
ED1–6	–	–	–	–	–		–	–	–
ED7–8	0.142ns	0.021ns	–0.112ns	–0.221	–0.651	–0.255*	–0.329	–0.224ns	–0.165
ED9–10	–0.109ns	–0.956	–0.532	–0.632	–0.710ns	–0.59	–0.746	–0.907	–0.575
ED11–12	–0.631	–1.712	–1.558	–1.228	–1.981*	–0.934	–1.226	–1.332	–1.05
ED13+	–1.466	–1.422	–1.637	–1.968		–1.605	–1.623	–2.057	–3.004
Mortality	0.043	0.028	0.013	0.011	0.013	0.013	–0.002ns	0.023	0.024
Constant	–7.432	–7.706	–5.592	–7.305	–8.792	–4.284	–4.996	–6.602	–7.288
R2	0.604	0.715	0.69	0.578	0.637	0.563	0.604	0.584	0.606
N	13201	15327	10594	9333	7.639	5.208	9441	9711	34350

Table A-2 b: (Continued)

Variable	Ethiopia	Gab.	Ghana	Guinea	Kenya	Lesotho	Lib.	Mad.	Malawi
Age	0.406	0.49	0.356	0.455	0.513	0.27	0.436	0.42	0.447
Age2	–0.002	–0.005	–0.002	–0.004	–0.005	–0.002	–0.003	–0.003	–0.003
ED0	0.155	–0.056ns	0.187	–0.026ns	0.254	0.051ns	–0.152	0.241	0.152
ED1–6	–	–	–	–	–	–	–	–	–
ED7–8	–0.371	–0.378	–0.018ns	–0.263*	–0.584	–0.256	–0.329	–0.55	–0.266
ED9–10	–1.057	–0.775	–0.617	–0.593	–0.876	–0.653	–0.352*	–1.037	–0.715
ED11–12	–1.295	–1.289	–1.171	–0.891	–1.661	–1.041	–1.007	–1.736	–1.417
ED13+	–1.645	–2.083	–2.197	–1.737	–2.415	–1.572	–2.316	–2.377	–2.39
Mortality	0.003ns	0.026	0.032	0.024	0.023	0.006	0.02	0.036	0.007
Constant	–6.194	–6.549	–5.581	–6.627	–6.903	–3.686	–6.283	–6.193	–6.259
R2	0.679	0.483	0.663	0.618	0.664	0.621	0.552	0.531	0.686
N	22010	4698	5704	10021	11041	10.79	8.802	16.568	23.483

Variable	Mali	Mozamb.	Nam.	Niger	Nigeria	Rwa.	Sen.	Tanz.	Togo
Age	0.533	0.476	0.284	0.594	0.472	0.241	0.409	0.428	0.419
Age2	–0.005	–0.004	–0.002	–0.005	–0.004	0.000ns	–0.003	–0.003	–0.003
ED0	–0.040ns	–0.004ns	0.335	0.129ns	0.191	0.444	0.309	0.110*	0.326
ED1–6	–	–	–	–	–	–	–	–	–
ED7–8	–0.158ns	–0.131ns	–0.413	–0.328ns	–0.135*	–0.169	–0.073ns	–0.452	–0.521
ED9–10	–0.389*	–0.613	–0.881	–0.733	–0.342	–0.457	–0.497	–0.792	–0.983
ED11–12	–1.156	–1.407	–1.456	–2.462	–1.055	–0.905	–1.256	–1.601	–0.244ns
ED13+	–1.652	–3.368	–1.86	–2.759	–2.206	–1.276	–1.65	–2.262	
Mortality	0.021	0.019	0.015	0.012	0.036	0.023	0.026	0.004*	0.029
Constant	–7.358	–6.737	–3.937	–8.542	–7.164	–4.584	–6.507	–5.917	–6.805
R2	0.522	0.536	0.608	0.65	0.622	0.684	0.604	0.64	0.678
N	9.021	14.194	8.924	11.558	28.639	16.697	12.097	14.947	7.696

Variable	Uganda	Zambia	Zimbabwe
Age	0.597	0.5	0.355
Age2	–0.005	–0.004	–0.003
ED0	0.106*	–0.032ns	0.254
ED1–6	–	–	–
ED7–8	–0.268	–0.375	–0.551
ED9–10	–0.607	–0.718	–0.827
ED11–12	–1.238	–1.525	–1.385
ED13+	–2.161	–2.75	–2.23
Mortality	–0.003ns	0.001ns	0.028
Constant	–8.142	–6.909	–4.576
R2	0.671	0.661	0.637
N	9.878	7.67	8.527

Notes. All coefficients are significant at the .01 level, except as noted below. * significant at the .05 level. ns not significant.
ED0=dummy variable=1 if years of schooling=0; otherwise =0.
ED1–6=dummy variable=1 if 1<=years of schooling<=6; otherwise=0.
ED7–8=dummy variable=1 if 7<=years of schooling<=8; otherwise=0.
ED9–10=dummy variable=1 if 9<=years of schooling<=10; otherwise=0.
ED11–12=dummy variable=1 if 11<=years of schooling<12; otherwise=0.
ED13+=dummy variable=1 if years of schooling>=13.
Mortality=percentage of children born to women in respondent's cluster who have died.

Table A-3 a: Decomposition results by country, all women aged 15–49, urban places

Reduced form

Variable	Benin	B.F.	Bur.	Cam.	Com.	C.I.	Ethiopia	Gab.	Ghana
Education	36	21	28	64	204	32	49	67	26
Mortality	84	20	14	11	28	18	72	22	14
Age	–29	–22	35	–10	–68	–31	3	–91	–6
Total	91	19	77	64	164	19	124	–2	34

Variable	Guinea	Kenya	Lib.	Mad.	Malawi	Mali	Mozamb.	Nam.	Niger
Education	26	58	27	24	58	20	79	70	84
Mortality	25	12	42	44	10	54	42	8	70
Age	17	–42	–44	–25	6	26	–24	–3	–84
Total	69	28	25	42	74	100	97	75	70

Variable	Nigeria	Rwa.	Sen.	Tanz.	Togo	Uganda	Zambia	Zimbabwe
Education	196	2	9	45	22	76	91	59
Mortality	35	23	56	15	10	17	0	–1
Age	–119	–26	–21	–22	–61	–59	–63	–12
Total	112	–1	44	39	–29	34	28	47

With contraception and marriage

Variable	Benin	B.F.	Bur.	Cam.	Com.	C.I.	Ethiopia	Gab.	Ghana
Education	30	18	25	50	188	26	46	60	22
Mortality	52	9	5	10	2	10	55	9	6
Contraception	0	14	11	18	–11	29	2	1	19
Marriage	44	30	20	39	80	37	30	82	25
Age	–30	–22	34	–11	–69	–31	3	–92	–6
Total	96	50	96	96	191	70	136	61	67

Variable	Guinea	Kenya	Lib.	Mad.	Malawi	Mali	Mozamb.	Nam.	Niger
Education	23	46	21	22	55	18	64	68	73
Mortality	23	5	32	33	9	36	23	7	30
Contraception	1	34	12	11	12	–9	8	–1	–14
Marriage	14	39	49	4	5	34	44	6	128
Age	17	–43	–45	–26	6	26	–24	–3	–85
Total	79	82	69	44	74	105	114	77	133

Variable	Nigeria	Rwa.	Sen.	Tanz.	Togo	Uganda	Zambia	Zimbabwe.
Education	154	1	6	38	17	69	76	59
Mortality	16	10	20	5	6	–3	–1	–1
Contraception	25	4	9	31	38	36	3	26
Marriage	83	48	58	27	54	31	49	21
Age	–123	–26	–21	–22	–62	–59	–64	–12
Total	156	37	72	79	53	74	63	83

Notes: Total may not equal sum of components due to rounding. Figures show percentage of the change in mean number of children ever born that is attributable to the variable in question. Decompositions are reported only for countries with declining mean number of children ever born of at least 0.1.

Table A-3 b: Decomposition results by country, all women aged 15–49, rural places

Reduced form

Variable	Benin	Bur.	Com.	Ghana	Guinea	Kenya	Lesotho	Mad.	Malawi
Education	7	4	82	14	9	35	29	21	63
Mortality	79	18	24	34	64	2	2	88	25
Age	11	86	–3	–19	60	9	20	–55	33
Total	97	109	104	30	132	47	51	54	121

Variable	Mali	Nam.	Rwa.	Sen.	Togo	Zimbabwe
Education	5	89	15	12	10	57
Mortality	84	6	18	68	24	9
Age	37	–17	–7	13	–53	–9
Total	126	78	25	93	–19	58

With contraception and marriage

Variable	Benin	Bur.	Com.	Ghana	Guinea	Kenya	Lesotho	Mad.	Malawi
Education	5	–9	74	12	7	23	26	17	61
Mortality	56	–1	4	17	56	1	1	60	23
Contraception	0	3	0	35	4	50	14	47	–9
Marriage	24	37	53	24	8	18	30	19	2
Age	11	86	–3	–19	60	9	20	–55	33
Total	97	116	128	68	134	102	91	87	111

Variable	Mali	Nam.	Rwa.	Sen.	Togo	Zimbabwe
Education	5	83	9	7	6	46
Mortality	64	4	4	35	10	5
Contraception	–10	11	20	–16	32	37
Marriage	44	16	40	56	76	12
Age	38	–17	–7	13	–54	–9
Total	140	96	65	96	70	91

Notes: Total may not equal sum of components due to rounding. Figures show percentage of the change in mean number of children ever born that is attributable to the variable in question. Decompositions are reported only for countries with declining mean number of children ever born of at least 0.1.