How Is Fertility Behavior in Africa Different?*

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Abstract

Sub-Saharan Africa's fertility decline has progressed much slower than elsewhere. However, there is still substantial disagreement about why, partly because four leading potential causes—cultural norms, expected offspring mortality, land access, and school quality—are challenging to measure. I use large-scale woman-level data to infer what role each explanation plays in fertility differences between Sub-Saharan Africa and East Asia, South Asia, and Latin America, based on estimations of fertility outcomes by region, cohort, area of residence, and grade level. I show that the differences in fertility between Sub-Saharan Africa and the other regions first increase and then decrease with years of education. For women without education, fertility rates in Sub-Saharan Africa are comparable to those in Latin America. Similarly, for women with secondary education or higher, fertility rates in Sub-Saharan Africa align with those in South and East Asia. There are substantial and statistically significant differences for women with some primary education for all three comparison regions. The differences are more pronounced for children ever born than for surviving children. Overall, the results suggest that offspring mortality and the lower quality of primary schooling are the dominant reasons why fertility decline in Sub-Saharan Africa lags behind other regions.

JEL: J1, O1, I15, I25

Keywords: Education quality, mortality, cross-national

1 Introduction

Most developing countries have seen astonishing declines in total fertility rates over the last half-century, moving from around six children to replacement level (Pörtner, 2018). Sub-Saharan Africa is the exception, with a current total fertility rate more than twice as large as the other regions, as shown in Figure 1. Hence, Sub-Saharan Africa is projected to experience most of the world's future population growth and to be home to more than a quarter of the world's population by 2100 (Gerland et al., 2014). Despite a long-standing interest, there is still significant disagreement about how, or even if, fertility behavior in Sub-Saharan Africa differs from other regions (van de Walle and Foster, 1990; Ainsworth, 1996; Casterline, 2017).[1] The disagreement arises partly from many suggested causes for the differences being either difficult to measure well or unobservable.

This paper provides new evidence on how completed fertility in Sub-Saharan Africa compares to other regions. I use women-level data from all Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) collected in East Asia, South Asia, Latin America, and Sub-Saharan Africa. With this large-scale micro-level data, I estimate fertility outcomes separately by region, cohort, area of residence, and grade level. The main contribution to the literature is that this approach allows me to infer what role four difficult-to-observe factors—cultural norms, expected offspring mortality, potential land access, and school quality—play in explaining differences in fertility between Sub-Saharan Africa and the other regions.

The most prominent cultural norms explanation is "African exceptionalism," which argues that strong pronatalistic cultural norms in Sub-Saharan Africa lead to higher fertility than we should expect given Sub-Saharan Africa's level of development and mortality risk (Caldwell and Caldwell, 1987, 1988; Caldwell, Orubuloye, and Caldwell, 1992; Bledsoe, Banja, and Hill, 1998; Bongaarts and Casterline, 2013; Bongaarts, 2017; Casterline and

[1]For a concise history of fertility decline in Sub-Saharan Africa and a more in-depth review of recent research, see Casterline (2017).

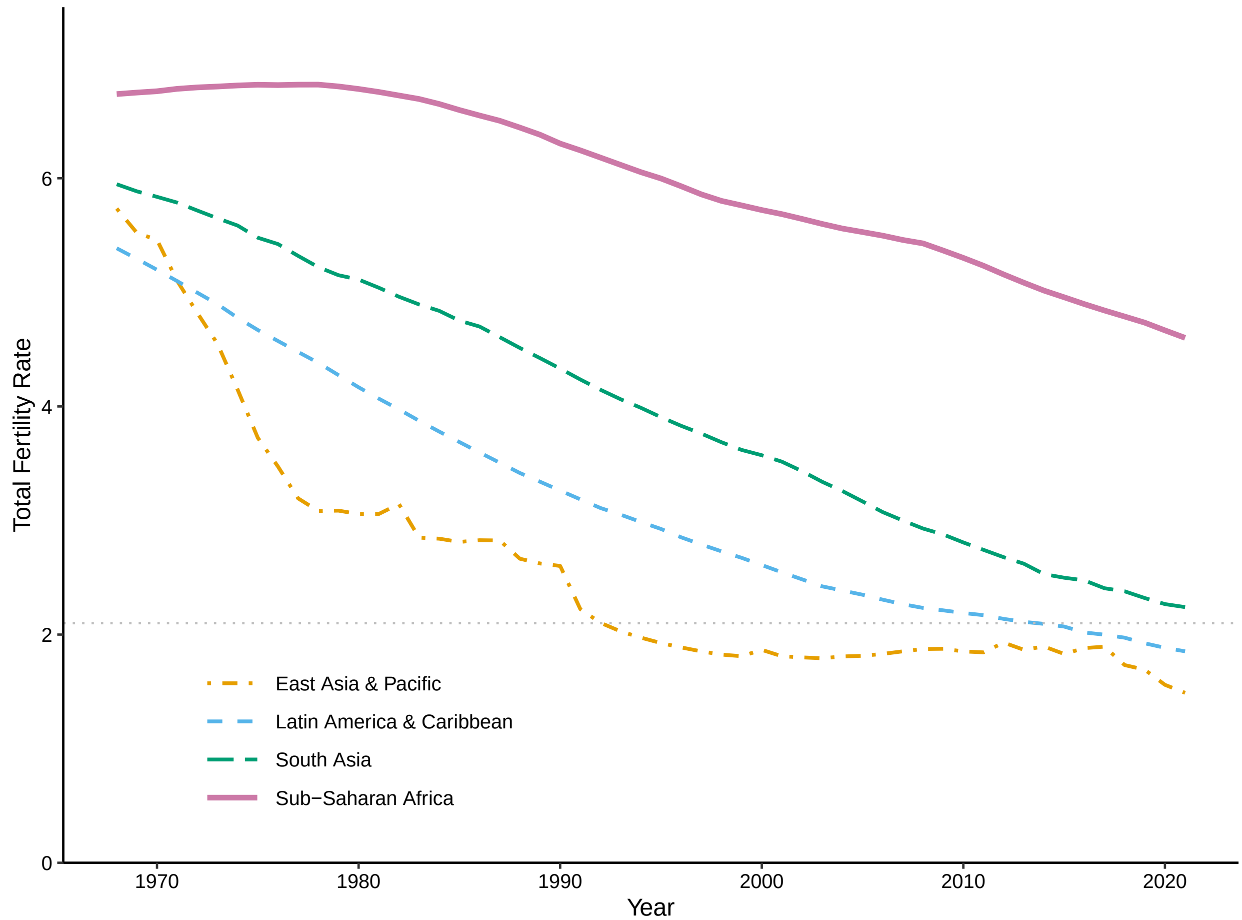


Figure 1: Total Fertility Rate by Region from 1970 to 2021. Source: World Bank World Development Indicators

Agyei-Mensah, 2017). We cannot measure these norms directly, so the argument is based on Sub-Saharan Africa's higher reported ideal family sizes. However, we measure ideal family size only after fertility decisions are made for completed fertility, and ideal family size may increase for reasons other than cultural norms.

Second, differences in mortality risk may explain the differences in fertility, but there is little agreement on how to measure the relevant mortality risk and whether the response varies across regions and mortality levels (Easterlin, 1975; Schultz, 1997; Pörtner, 2018).[2] Presumably, parents assess offspring mortality risk when making fertility decisions, but that assessment is unobserved (Montgomery, 2000). The standard under-five

[2]See discussion in the Online Appendix for more detail.

mortality rate ignores later offspring mortality, which is generally higher in Sub-Saharan Africa (Canning, Günther, Linnemayr, and Bloom, 2013; Ward et al., 2021). Furthermore, country-wide mortality rates fail to capture differences in mortality risk within countries, such as by education or area of residence (Strauss and Thomas, 1995a; Pörtner and Su, 2018; Balaj et al., 2021). Even with convincingly measured mortality risk, the correct specification of the empirical relationship is debatable, with theory suggesting an inverse-U relationship (Sah, 1991; Pörtner, 2001; Doepke, 2005).

Third, there is more land per capita in Sub-Saharan Africa than in the other regions. At the projected population growth, its population density in 2100 will only equal China's current density (Gerland et al., 2014, p 235). This lower population density in Sub-Saharan Africa, combined with less well-established property rights, may lead to a higher return to children in rural Sub-Saharan Africa elsewhere (Caldwell, Orubuloye, and Caldwell, 1992; Besley, 1995; Goldstein and Udry, 2008; Ali, Deininger, and Kemper, 2015). However, household surveys contain limited information on current land access and none on potential future land access, making it impossible to measure how much land a household could command.

Finally, differences in school quality may drive differences in fertility outcomes. Female education is strongly associated with lower fertility, often explained as the effect of higher opportunity cost of time on fertility (Schultz, 1985; Strauss and Thomas, 1995b; Schultz, 2002; Bongaarts, 2010; Heath and Jayachandran, 2018; Liu and Raftery, 2020).[3] Nevertheless, while we can easily measure years of education, a given number of years of education may not provide the same level of human capital across countries.[4] Notably, although the quality of education is poor in many developing countries, Sub-Saharan Africa appears to be doing substantially worse than other regions (Bold, Filmer, Martin, Molina, Stacy,

[3]Indeed, the disruption in expanding education access in Sub-Saharan Africa during the 1980s may explain part of stalled fertility decline (Goujon, Lutz, and KC, 2015; Kebede, Goujon, and Lutz, 2019). See also Vogl (2022) on mothers' education and fertility decline in Sub-Saharan Africa.

[4]Even within countries, variations in school quality may explain varying returns to years of schooling (Behrman and Birdsall, 1983).

Rockmore, Svensson, and Wane, 2017; World Bank, 2017; Bold, Filmer, Molina, and Svensson, 2019; Nestour, Moscoviz, and Sandefur, 2020; Pritchett and Sandefur, 2020; Singh, 2019; Evans and Mendez Acosta, 2021). Hence, the same grade level may lead to lower human capital accumulation in Sub-Saharan Africa than in other regions, which, in turn, could mean relatively higher fertility.

How does the estimation approach help evaluate these explanations? The grade-level specific fertility allows me to examine the relative roles of cultural norms and school quality because the expected effect differs by grade. The "African exceptionalism" hypothesis suggests higher fertility in Sub-Saharan Africa than in other regions, possibly moderated by education. If education alters cultural norms on fertility, the highest disparities should be among women with no or little education, and the differences should decline with schooling. Furthermore, if cultural norms are more robust in rural than urban areas, there should be larger regional differences in rural compared to urban areas.

Contrast this with the expected differences if variations in school quality affect fertility. Here we should see little difference in fertility for women with no or low levels of education. The differences should increase through primary school until we reach the secondary level. As many countries have selective entrance into secondary schools, only women who learned "enough" in primary school move up. Hence, we should see minor differences for secondary school and above. To further separate these two explanations, I also estimate literacy by grade level as an (imperfect) measure of school quality.[5]

To examine the role of offspring mortality, I compare grade-level children ever born and the number of surviving children. Suppose Sub-Saharan Africa's higher offspring mortality explains at least part of the difference in fertility behavior. In that case, the difference across regions for surviving children should be smaller than for children ever born.

[5]While there has been substantial progress in measuring school quality for current students and recent graduates, there is limited information on school quality for older women with complete fertility (Filmer, Rogers, Angrist, and Sabarwal, 2018). An examination of how school quality affects fertility is beyond the scope of this paper but is work in progress using survey-based school quality measures (Oye, Pritchett, and Sandefur, 2016; Nestour, Moscoviz, and Sandefur, 2020; Pritchett and Sandefur, 2020).

Furthermore, the reduction in differences should be larger the less educated the mother. The number of surviving children is also of interest for two other reasons. First, if households have a target number of children, it is likely based on how many children survive to be able to share in the labor burden of the household or assist their parents in their old age (Pörtner, 2001). Second, for the individual country's long-term population growth rate, what matters is how many females reach reproductive age and have children (Preston, 1978).

By estimating difference-in-differences in fertility outcomes across areas of residence, I can examine whether potential land access matters for differences in fertility across regions.[6] The idea behind this approach is that differences across regions in potential land access are likely smaller for urban than for rural areas, which means that the built-up nature of urban areas ameliorates, at least partly, the land access concern when examining determinants of fertility. Hence, if differences in land access across urban and rural areas matter more in Sub-Saharan Africa than in other regions, there should be a larger urban/rural differential in fertility in Sub-Saharan Africa than in other regions.

I find that completed fertility in Sub-Saharan Africa mainly differs from other regions for women with some to upper primary education. There is little consistent evidence for differences among better-educated women, and the differences for women with no or low levels of education depend on the comparison region. Furthermore, for grade levels with significantly higher fertility in Sub-Saharan Africa than the other regions, the differences are substantially smaller for surviving children than for children ever born. Finally, the results for literacy rates follow a similar pattern as the fertility outcomes. These results suggest that higher offspring mortality risk and the poorer quality of primary schooling in Sub-Saharan Africa are behind the differences in fertility.

The paper proceeds as follows. The next section discusses data, the estimation strategy, and descriptive statistics on the distribution of education across regions. The results

[6] Lerch (2019) examines the changes in the urban-rural fertility differential over the fertility transition but does not examine differences in fertility determinants, such as education.

section follows, presenting analyses of children ever born, surviving children, and literacy together with rural-urban differences across regions. I then examine three potential threats to the approach's validity. The final two sections are the discussion of the results and the potential limitations of the method, followed by the conclusion.

2 Data and Estimation Strategy

The data comes from 235 Demographic and Health Surveys (DHS) and 118 Multiple Indicator Cluster Surveys (MICS) from countries in the four regions, East Asia, South Asia, Latin America, and Sub-Saharan Africa, collected between 1990 and 2022.[7] To take full advantage of the large-scale microdata, I first estimate the outcomes for each combination of region, area of residence, and ten-year cohort. Then, I calculate the differences across regions, using bootstrapping to estimate confidence intervals.

All analyses are for women aged 40 to 49, born in the three cohorts, 1950–1959, 1960–1969, and 1970–1979.[8] This age group has fertility outcomes closest to complete, which avoids two limitations of using younger age groups. First, even if completed fertility is eventually the same, regional differences in non-complete fertility may arise from variations in the distribution of births by age. Second, changes in fertility timing can bias estimates of fertility decline and exaggerate differences for non-complete fertility (Pörtner, 2022). The drawback is that using completed fertility ignores more recent changes. Therefore, I also estimate fertility outcomes for the 30–39 age group born in the 1960–1969, 1970–1979, and 1980–1989 cohorts and present those results in the Online Appendix.

The first step is estimating outcomes for each region, area of residence, and cohort

[7] The Online Appendix shows the year of collection split by region and survey type for all surveys used.

[8] The 1940s cohorts are not included because the sample sizes are small resulting in very noisy estimates and the 1980s because no women surveyed would be older than 42 resulting in downward biased estimates. Results for these cohorts are available upon request.

combination, using the following weighted OLS model:

$$Y_i = \alpha + \mathrm{D}_i^{educ}\beta + \epsilon_i, \tag{1}$$

where Y_i is the outcome for the individual woman, i, and D^{educ} is a vector of indicator variables for each possible year of completed schooling. I estimate this model for three outcomes, children ever born, number of surviving children, and literacy of the woman.

For each outcome, I calculate differences between Sub-Saharan Africa and each of the other regions by grade level for each area of residence and cohort:

$$\hat{Y}_{SSF} - \hat{Y}_{-SSF}, \tag{2}$$

where Y_{SSF} is the relevant outcome for Sub-Saharan Africa and Y_{-SSF} is for the comparison region, both based on estimation results for Equation (1). Furthermore, for each cohort, I estimate difference-in-difference by grade level for the fertility outcomes:

$$\left(\hat{Y}_{SSF}^{rural} - \hat{Y}_{SSF}^{urban}\right) - \left(\hat{Y}_{-SSF}^{rural} - \hat{Y}_{-SSF}^{urban}\right). \tag{3}$$

The confidence intervals for the differences and difference-in-difference are calculated using bootstrapping with 1,000 replications. I treat each region as an independent sample, so the bootstrap sampling retains the number of observations in each region and is done independently by region (Efron and Tibshirani, 1994, p 88–89).

Completed grade level is based on the reported years of schooling in the DHS individual recoded data and calculated based on education level and grade/year of schooling within that education level for the MICS surveys.[9] Education is recoded, so the maximum number of years of schooling is 16.

[9] In the MICS 6 surveys, the education question changed to highest grade attended, with a follow-up question about whether that grade was completed. For those women, I calculate grade level as for prior surveys and subtract one if the level was not completed.

For the area of residence, I rely on the definitions used by DHS and MICS, both of which, in turn, rely on the individual country's definition of urban and rural. Below I also discuss the potential implications and results when restricting the samples to control for migration.

There are two main advantages of this estimation strategy. First, I do not have to rely on functional form assumptions to capture the potentially non-linear relationship between education and fertility (Ainsworth, Beegle, and Nyamete, 1996). Second, it avoids the potential problems associated with using the total fertility rate when comparing fertility. While the total fertility rate is critical as a period fertility measure, it is susceptible to tempo effects from changing timing of childbearing and increasing length of birth spacing, which can make it a downward-biased estimate of cohort fertility (Hotz, Klerman, and Willis, 1997; Bongaarts, 1999; Ní Bhrolcháin, 2011). For example, the introduction of sex selection in India led to significantly longer birth spacing, resulting in the total fertility rate substantially overestimating how fast cohort fertility fell, and where, even now, the predicted cohort fertility is 10%–20% above the period fertility rate (Pörtner, 2022). A potential drawback is that although the data set is large, there are still region, area, cohort, and grade level combinations with relatively few women, as shown below.

2.1 Regression Weights

The DHS and MICS surveys provide weights to calculate nationally representative results (ICF International, 2012). The challenge lies in appropriately weighting observations across birth years and countries for the regression models. Within countries, women differ in their likelihood of being observed because birth years vary in their likelihood of being covered by multiple surveys. Across countries, modeling should account for differing population sizes since survey samples are not proportional to the populace. For instance, despite being one-third of Sub-Saharan Africa's population, Nigeria, Ethiopia, and the Democratic Republic of the Congo contribute fewer surveys than Senegal. Finally, the weighting should use the population size close to when fertility decisions were made, rather than, as is often done, more current population sizes, which skew results towards high fertility countries.

I employ the following procedure for weighting. First, to overcome the differences in the likelihood of being surveyed by birth year and the differences in the number of surveys across countries, I rescale each country-cohort combination so weights add to one within each. Second, to incorporate differences in population size, I multiply the rescaled weights with the log of population size of the relevant area of residence when the women turned 20. I chose age 20 because population size split by urban and rural is then available for all women in the sample and is still early in the women's reproductive ages. Each year's urban and rural population sizes are drawn from the World Bank Open Data using the "wbstats" R package.

2.2 Sample Sizes and Educational Distribution

The final sample consists of all surveyed women aged 40 to 49 with complete information on number of children ever born (live births), the number of children who have died, year of birth, and education. There are 427,575 urban women and 712,819 rural women in the sample. Table 1 shows the number of observations by region, cohort, area of residence, and highest grade level completed.[10] There is clustering on particular grade levels, such as no education, completed primary, and completed secondary, although the degree of clustering depends on the region and area of residence. Furthermore, even with the large number of observations, some cell sizes are small, especially for higher grade levels in the earliest cohorts in rural areas. I drop all results based on cells with 100 women or fewer to avoid presenting noisy results. These are available upon request.

[10] A subset of DHS surveys asked fertility questions of only ever-married women. For these surveys, I use household data to identify women who would otherwise have been surveyed and assign them zero births and deaths. There are 808 urban women and 795 rural women in this group. The Online Appendix shows the distribution of surveys by whether all women or only ever-married/partnered women were surveyed.

Table 1: Number of Observations by Region, Cohort, and Highest Grade Level Completed for Women in the 40–49 Age Group

	East Asia and Pacific			Latin America and the Caribbean			South Asia			Sub-Saharan Africa		
Grade	1950	1960	1970	1950	1960	1970	1950	1960	1970	1950	1960	1970
						Urban						
0	1,057	2,088	1,106	3,038	2,716	960	5,062	12,349	25,447	9,116	19,456	14,106
1	244	440	221	924	1,179	479	111	256	478	330	528	477
2	523	845	474	1,549	1,885	638	304	617	1,343	662	1,169	923
3	1,653	2,575	610	1,922	2,507	863	399	802	1,632	838	1,587	1,391
4	628	1,900	809	1,629	1,905	693	561	1,028	2,292	1,032	1,856	1,644
5	735	1,337	996	2,980	5,588	1,239	1,091	2,502	6,026	1,286	2,830	2,622
6	2,503	4,526	4,256	2,161	3,397	2,357	431	854	2,043	1,466	4,181	4,062
7	271	628	665	1,100	2,154	1,403	719	1,427	3,782	1,382	2,692	2,370
8	397	945	1,268	1,575	2,699	1,141	787	2,064	5,781	1,041	2,333	2,558
9	1,520	3,076	2,857	1,344	3,579	1,964	669	1,812	5,149	863	2,727	2,738
10	890	1,873	2,099	1,434	1,655	910	1,571	3,338	9,929	1,181	2,921	2,307
11	207	627	1,133	2,720	8,282	2,395	306	452	1,106	546	1,889	1,875
12	2,116	5,245	4,375	1,145	3,476	3,094	591	1,901	6,884	749	3,134	3,988
13	190	543	669	492	1,504	1,104	80	148	442	244	774	757
14	580	1,020	1,053	810	3,302	1,645	222	437	701	166	643	808
15	196	981	1,312	744	771	836	838	1,802	6,043	322	1,151	1,133
16	807	2,565	3,142	2,170	6,275	3,489	499	1,233	3,978	477	1,422	1,906
						Rural						
0	5,364	8,269	4,973	7,009	6,461	2,429	19,895	46,697	117,055	30,721	60,705	48,486
1	1,011	1,309	844	1,187	1,952	912	281	699	1,978	1,060	2,329	2,117
2	1,908	2,624	1,447	1,977	2,926	1,056	645	1,584	4,778	1,749	3,734	3,010
3	3,399	4,498	1,639	1,962	3,158	1,234	780	1,712	5,441	1,871	4,114	3,553
4	1,798	3,574	2,032	1,249	2,137	904	1,027	2,246	7,364	2,156	4,190	3,835
5	1,706	2,729	2,333	1,511	3,960	1,118	1,685	4,672	16,536	1,880	4,469	4,134
6	4,334	6,492	7,796	1,267	2,772	2,476	423	1,175	4,591	1,794	6,563	7,062
7	501	978	1,365	380	980	539	623	1,893	8,290	2,099	5,669	4,719
8	469	1,256	1,911	474	1,089	604	574	2,359	11,543	658	2,743	3,779
9	1,838	3,091	3,641	353	1,225	899	414	1,681	8,990	486	2,113	2,186
10	531	1,274	2,199	305	683	365	623	2,259	11,689	577	1,814	1,656
11	140	508	1,324	407	1,645	555	115	248	1,206	238	1,206	1,224
12	851	2,243	2,857	153	713	847	144	867	5,932	176	1,642	2,296
13	51	276	686	39	188	195	18	49	297	43	271	306
14	215	420	695	98	410	197	36	105	425	49	267	424
15	46	478	790	87	147	79	93	442	2,586	108	492	434
16	190	1,000	1,714	225	763	494	45	197	1,208	82	372	531

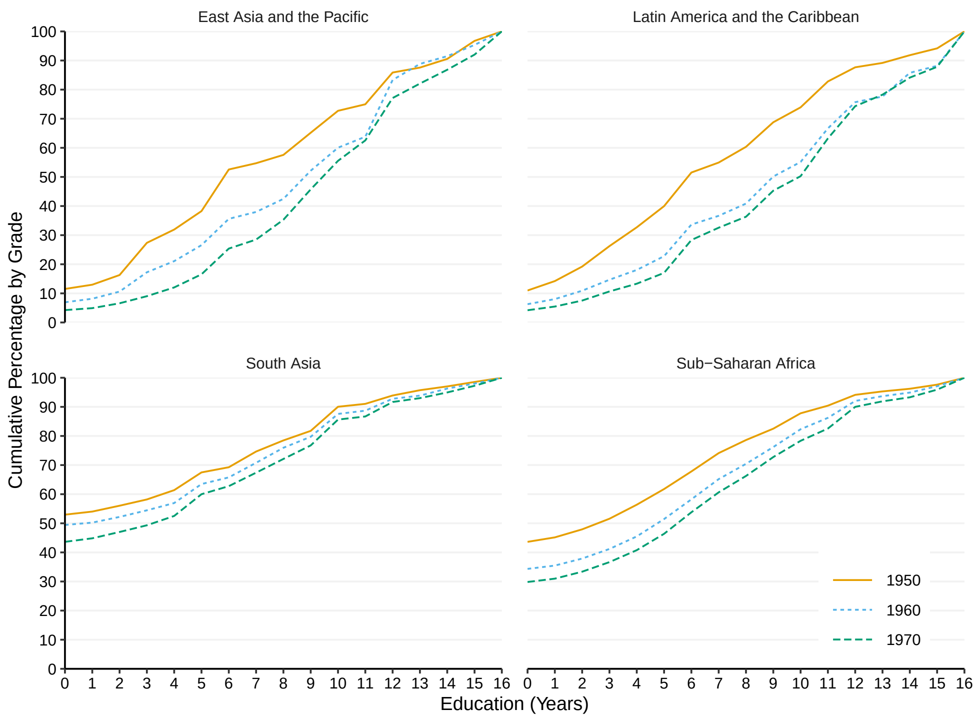
Note. Unweighted raw numbers of observations for women in the 40–49 age group with complete information on children ever born, surviving children, highest grade completed, and area of residence.

Figure 2 shows the cumulative weighted distribution of education by area of residence, region, and cohort.[11] The flatter the line, the fewer women are in a given grade level, and a rightward and downward movement across cohorts indicates an increase in education levels. Furthermore, the area between the lines measures the increase in educational attainment.

As expected, education levels are higher in urban than rural areas across all four re-

[11] The Online Appendix show the same information but by cohort instead of by region.

(a) Urban



(b) Rural

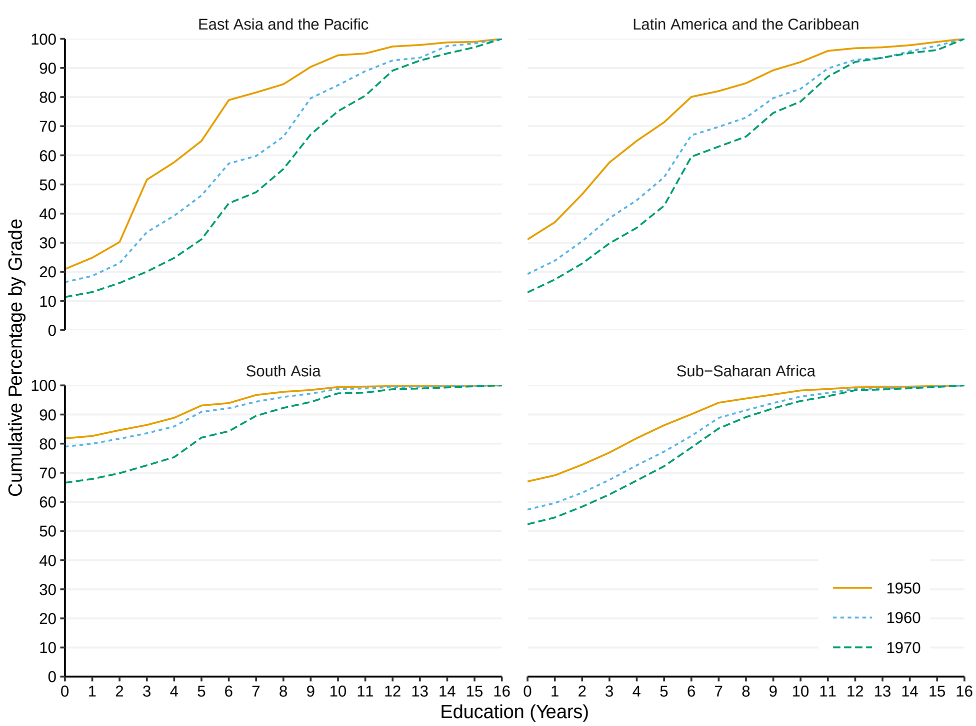


Figure 2: Cumulative Distribution of Education for Women Age 40–49 Across Cohorts by Area of Residence and Region

gions. Over the three cohorts, all regions have seen improvements in education levels across both urban and rural areas. The most substantial increase was for rural East Asia, where the median grade level saw a dramatic leap from three for the 1950 cohort to eight for the 1970 cohort. At the other extreme, urban South Asia saw only modest improvements in education levels, although the medium grade level did increase from zero to four.

The lowest levels of education are observed in South Asia, followed by Sub-Saharan Africa. In South Asia, for the 1950s cohort, more than 50% of urban women and more than 80% of rural women had no education, and, despite the improvements, there are still more than 40% of urban and 65% of rural women without any education in the 1970s cohort. Sub-Saharan Africa fared better but still had almost 45% urban and 70% rural women with no education in the 1950s cohort and 30% urban and more than 50% rural with no education for the 1970s cohort. Despite this, the proportion with some secondary and above are similar across South Asia and Sub-Saharan Africa within each area of residence.

Although urban education attainment in Latin America and East Asia is virtually indistinguishable, rural East Asia outperforms rural Latin America in terms of education. For the 1970s cohort, only about 5% of urban women and just over 10% of rural women had no education. The median urban grade level for the 1970s cohort was between nine and ten years for both East Asia and Latin America, while for the median rural woman, the level was seven years for East Asia and between five and six for Latin America.

There are two main implications for the interpretation of the results. First, minor differences in fertility for no-education women matter a lot for population growth, especially for Sub-Saharan Africa and South Asia. Second, the fertility behavior of women with primary education has become increasingly important and will become even more important with an increasing number of women with at least some primary education.

3 Results

This section presents the estimated differences between Sub-Saharan Africa and the three regions by grade level for urban and rural women across the three cohorts. I first show the results for children ever born, then for surviving children, and then literacy. Finally, I show the difference-in-difference results for children ever born and surviving children. The interpretation of the results is in the Discussion section below.

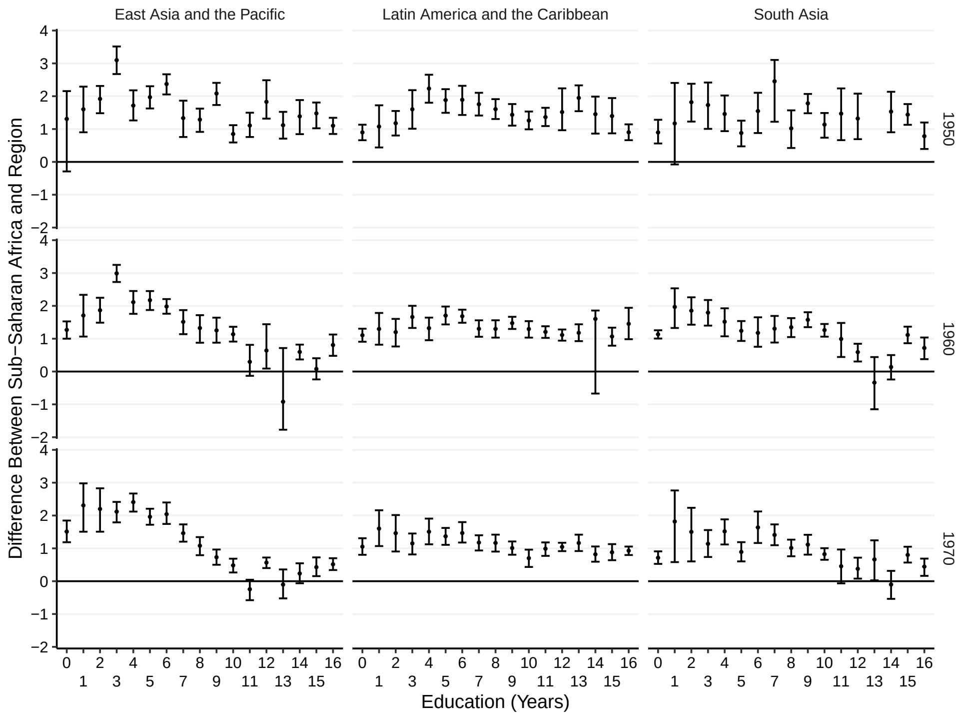
3.1 Children Ever Born Across Regions

Figure 3 shows the predicted differences in completed fertility, measured by children ever born, together with the bootstrapped 95% confidence intervals. For each area, the top row shows results for women born in the 1950s, the middle row for the 1960s, and the bottom row for the 1970s.

The overall pattern across both urban and rural areas is that the difference in completed fertility between Sub-Saharan Africa and the regions is first increasing and then decreasing in education. Generally, the maximum differences in completed fertility are for women with 4 to 6 years of education. However, the size of the difference varies substantially by comparison region and area. On one end, Sub-Saharan African urban women born in the 1970s and with five years of education have about 1.5 children more than the similar group in Latin America and the Caribbean. Conversely, Sub-Saharan African rural women born in the 1970s who have six years of education have approximately 2.75 children more than similar women in East Asia. These estimates all have relatively small confidence intervals.

There is generally a smaller difference for women with no or little education than for women with some primary education. For example, for the 1950s cohort, rural Sub-Saharan African women had less than half a child more than their counterparts from Latin America, and even for the 1970s cohort, the difference is only about 0.8 children. For East and South Asia, the differences are larger at around two children, but still less than the

(a) Urban



(b) Rural

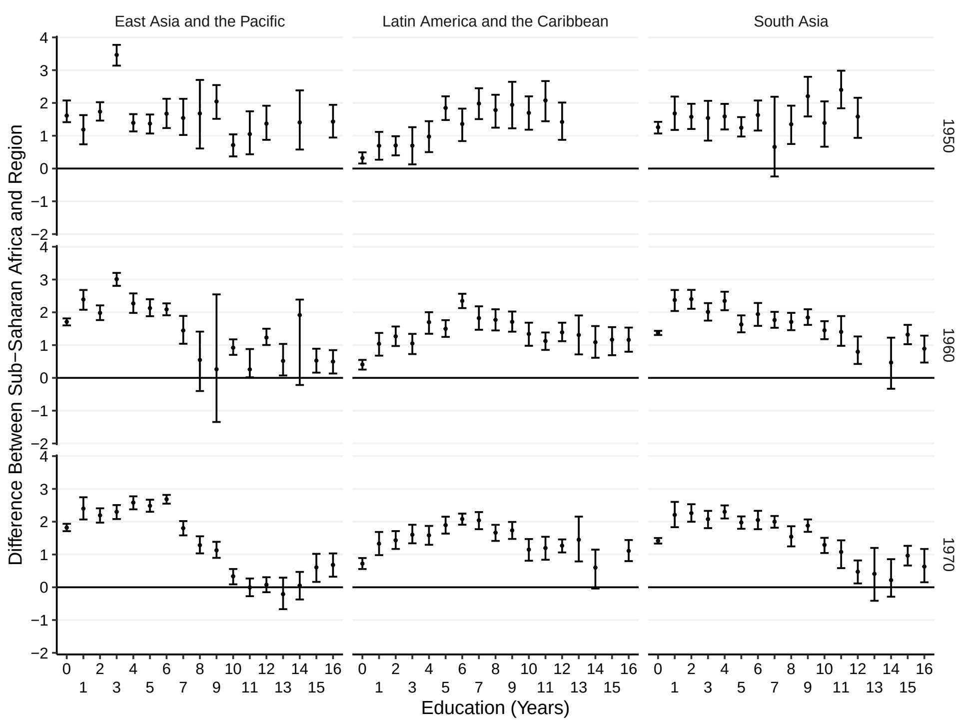


Figure 3: Differences in Number of Children Ever Born Between Sub-Saharan Africa and Regions by Area of Residence and Cohort with 95% Bootstrapped Confidence Intervals

differences for women with more schooling.

This regional pattern is reversed when looking at women with about ten years of schooling—i.e., approximately one year of secondary school in most countries—or more. There are mostly no statistically significant differences between Sub-Saharan African and both East and South Asian women. This result holds both for urban and rural women. Sub-Saharan African women with ten or more years of education do, however, have about one child more than women in Latin America and the Caribbean.

3.2 Surviving Children

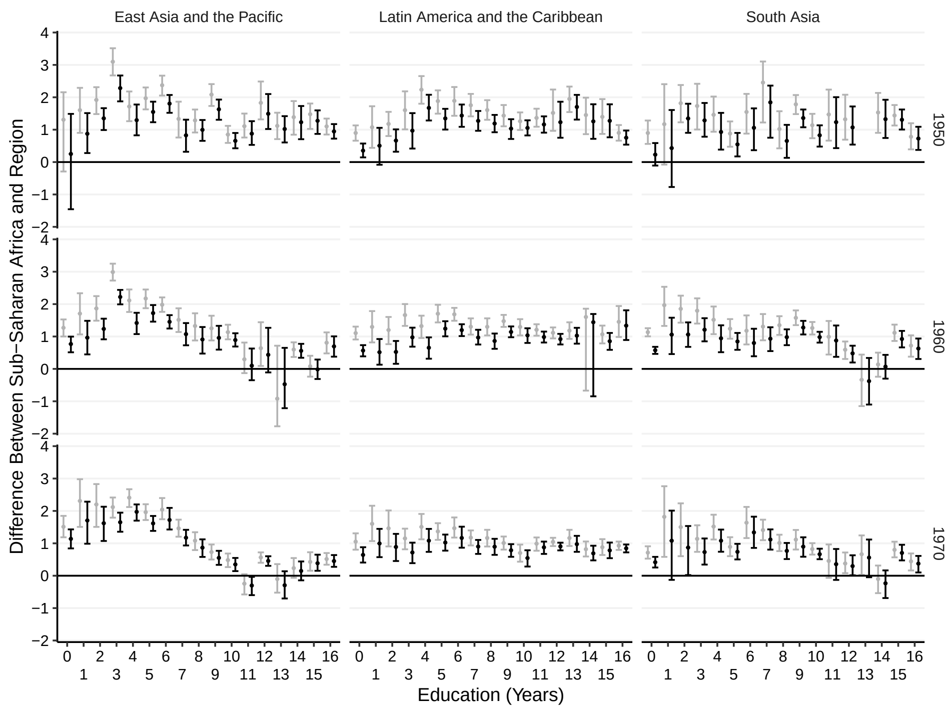
Figure 4 shows differences in the number of surviving children between Sub-Saharan Africa and the other regions, together with the bootstrapped 95% confidence interval. For comparison, results for children ever born are in grey.

Overall, the estimated differences in surviving children by grade level are smaller than or equal to the children-ever-born differences.[12] The reduction in the difference when using surviving children instead of children ever born is larger, the lower the grade level, and is especially prominent for rural women. The reductions in differences for the lower-education women vary between 0.5 and 1 child for rural women and between 0.25 and 0.75 for urban women.

Even with the substantial reduction in differences, the overall pattern across grade levels is similar to the one for children ever born, with differences first increasing and then decreasing in grade level. Furthermore, some of the differences are still substantial. For example, rural women with no education in Sub-Saharan Africa have between 1 and 1.5 more surviving children than the similar group in Asia, with the difference increasing in grade level until around grades 4 to 6, where it is between 1.5 and 2.25 children.

[12] I examine whether these results are driven by HIV/AIDS below.

(a) Urban



(b) Rural

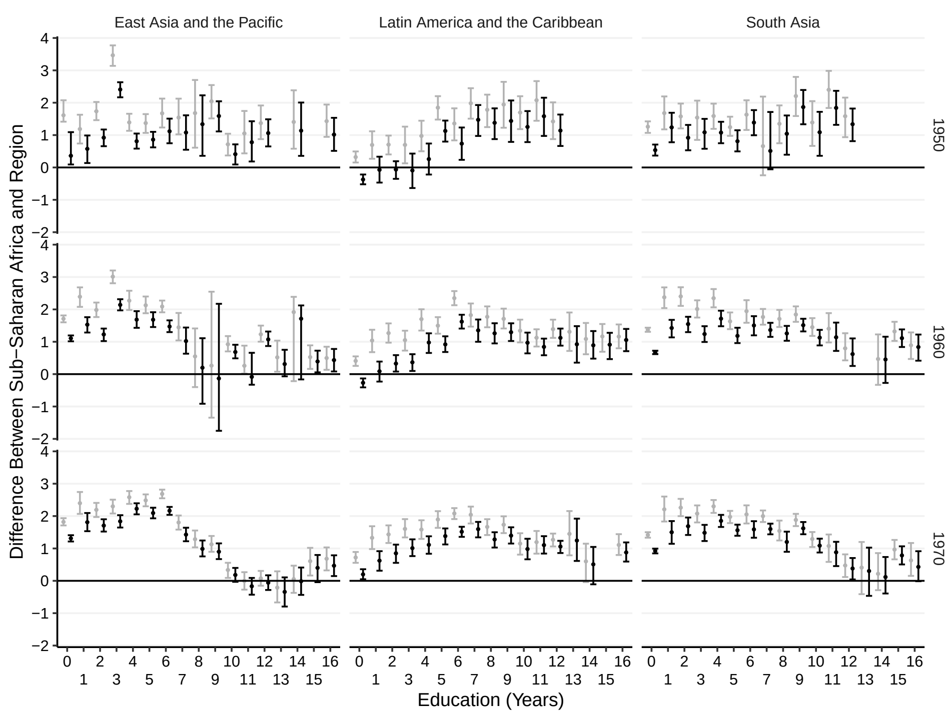


Figure 4: Differences in Number of Surviving Children between Sub-Saharan Africa and Regions for Women Age 40–49 by Cohort with 95% Bootstrapped Confidence Intervals in Solid and Number of Children Ever Born in Grey

3.3 Literacy Differences By Grade

Although school quality is unobserved, I explore differences in literacy outcomes across regions as indirect evidence of school quality's impact on fertility differences. Figure 5 shows the estimated differences in literacy rates between Sub-Saharan Africa and each region using the same estimation approach as above. The literacy variable combines self-reported and enumerator-tested literacy to ensure sample comparability.

Minimal literacy differences exist among uneducated women across regions.[13] However, literacy rates diverge significantly between Sub-Saharan Africa and both East Asia and Latin America from early primary school. The peak difference is for third and fourth grades, where women from East Asia and Latin America are 30 to 40% more likely to read than women in Sub-Saharan Africa. The gap narrows in upper primary and early secondary school, consistent with reading ability-based grade progression and selective secondary school entrance. Results for South Asia are noisier but generally follow the same pattern.

3.4 The Role of Urban-Rural Differences

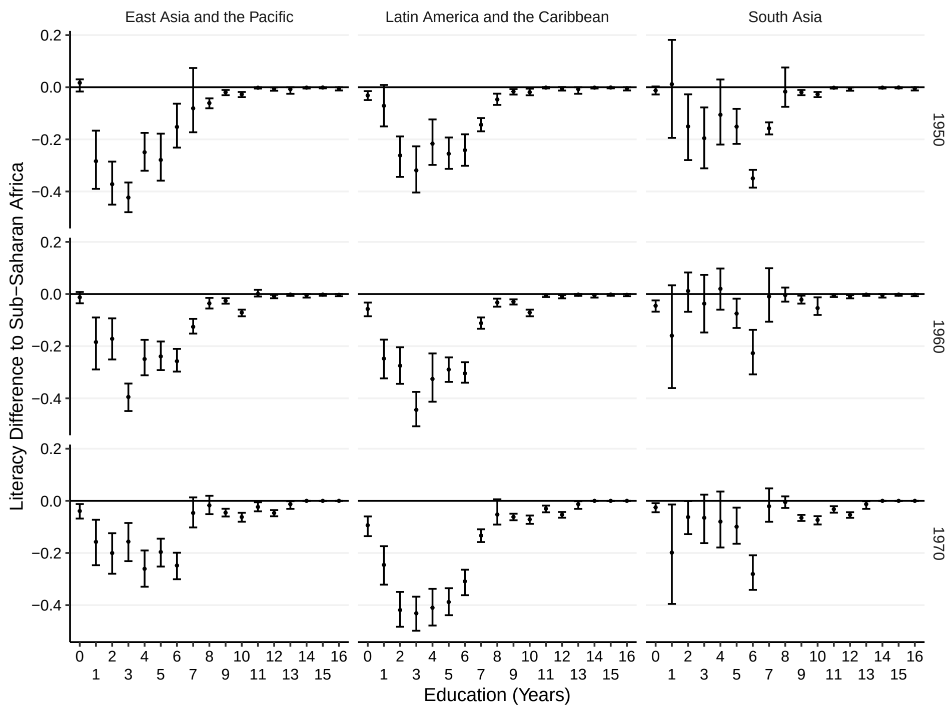
Figure 6 shows difference-in-difference estimates with bootstrapped 95% confidence intervals for women in the 40–49 age group. A positive estimate indicates a larger difference between rural and urban in Sub-Saharan Africa than in the comparison region. Hence, if unobserved land availability plays a significant role in explaining differences in fertility, we should see statistically significant positive estimates.

Generally, the difference-in-difference results follow the same general pattern as above. There is an inverse-U shape from no education to the beginning of secondary school, with the largest difference for upper primary school and little significant difference from around grade ten up.[14] Especially noteworthy are the larger difference between rural and

[13] Any differences likely arise from either participation in adult literacy programs or learning from other family members (Blunch and Pörtner, 2011).

[14] The primary exception is that the 1950s and 1960s cohorts for East Asia do not show a clear pattern.

(a) Urban



(b) Rural

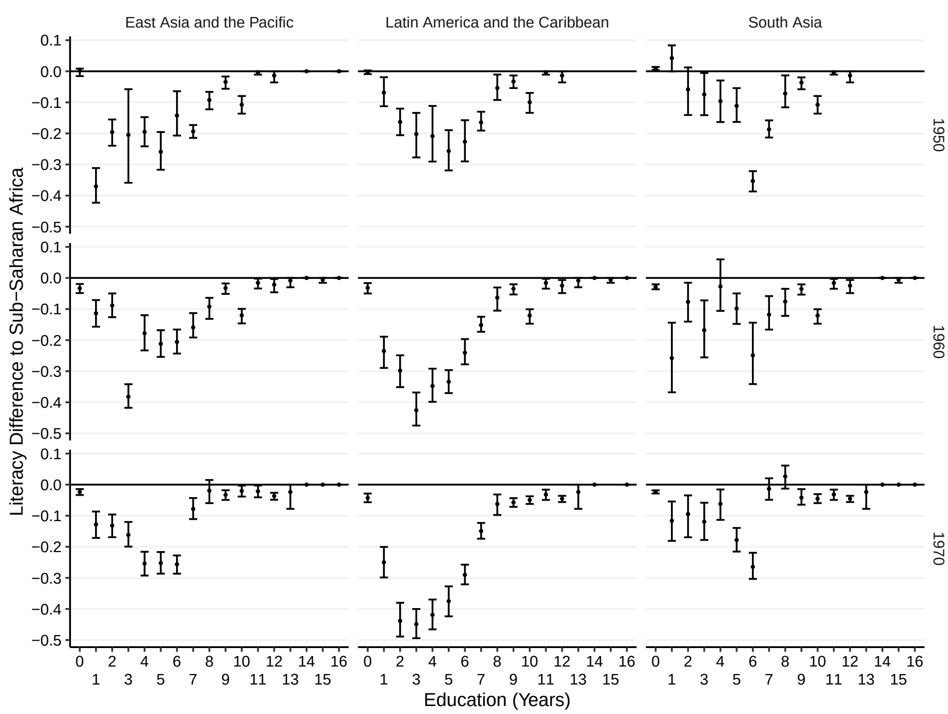
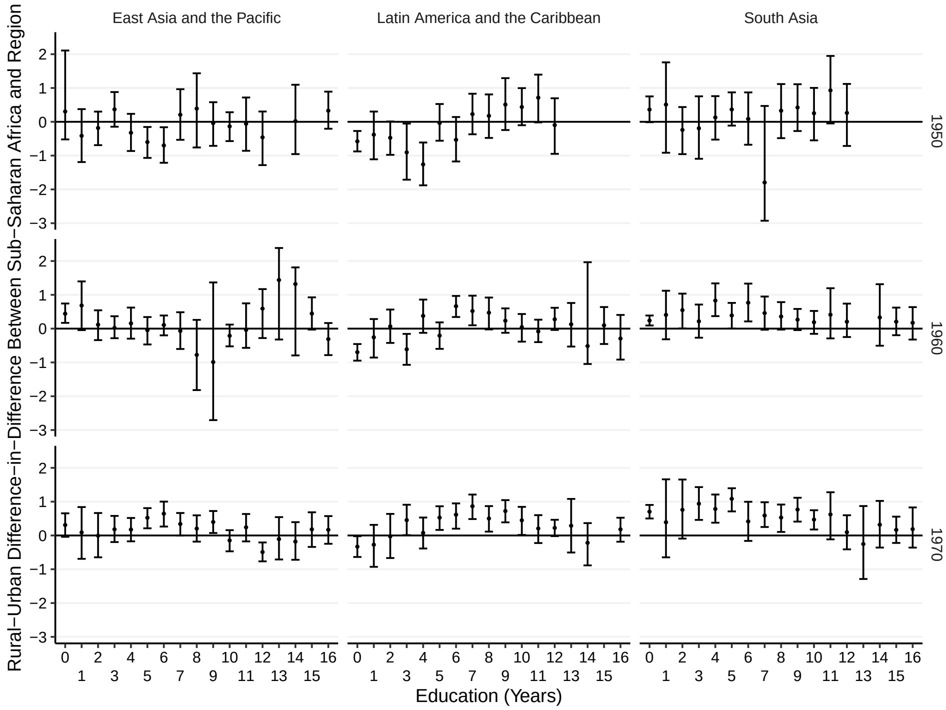


Figure 5: Differences in Literacy (Tested and Self-Reported) Between Sub-Saharan Africa and Regions for Women Age 40–49 by Cohort with 95% Bootstrapped Confidence Intervals

(a) Children Ever Born



(b) Surviving Children

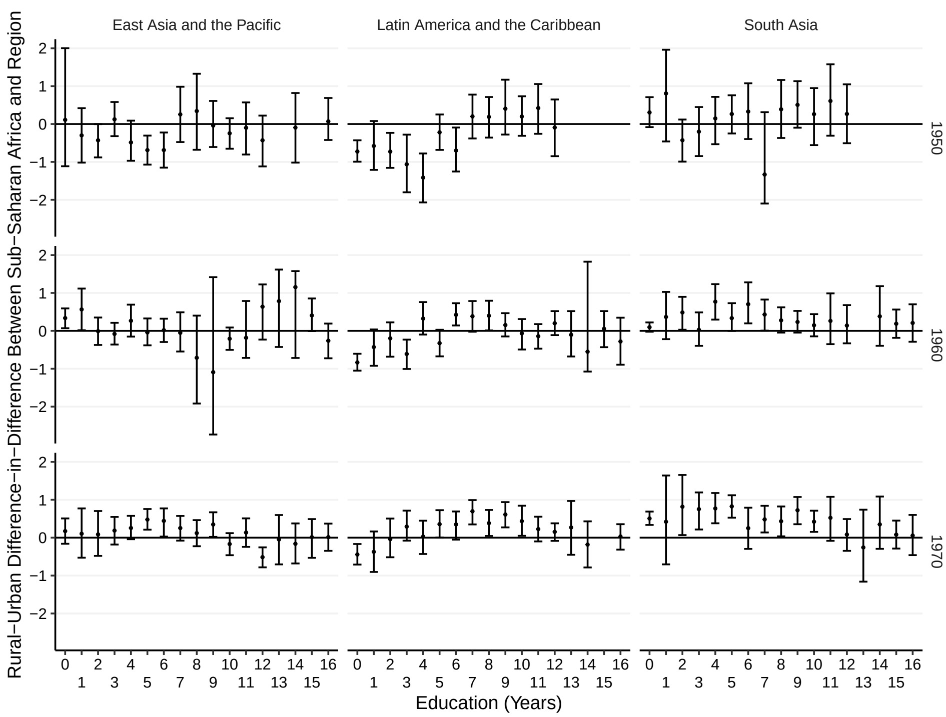


Figure 6: Difference-in-Difference in Children Ever Born and Surviving Children Between Sub-Saharan Africa and Regions for Women Age 40–49 by Cohort with 95% Bootstrapped Confidence Intervals

urban in Latin America than in Sub-Saharan Africa for women with no or one year of education, and that this larger difference is even more pronounced and covers more grades for earlier cohorts.

4 Potential Threats to Validity

At least three possible issues may affect the method's validity. First, the emergence of HIV/AIDS in the 1980s introduced possibly unanticipated changes that affected fertility decisions and mortality risk. Second, the method relies on the absence of systematic reporting bias, which may arise if there is a strong son preference. Finally, systematic differences in the definitions of area of residence and differential selective migration can affect the results. This section discusses how sensitive the results above are to these factors. All figures supporting the discussion in this section are in the Online Appendix.

First, HIV/AIDS can impact fertility through both behavioral changes and biological effects and through higher offspring mortality rates in areas with a higher prevalence of HIV (Gregson, 1994; Yeatman, 2009; Shapira, 2017). Critically, the households may have anticipated none of these changes, which could explain the smaller difference in surviving children between other regions and Sub-Saharan Africa. The group in the sample most likely affected by the spread of HIV is the 1970s cohort, who were in their prime childbearing ages in the 1990s, and in their 30s during the 2000s. The 1960s cohort is the second-most affected since they were in their 30s during the 1990s. There should be little effect on the 1950s cohort, as they would have been in their 40s in the 1990s.

To examine the sensitivity of results to the spread of HIV/AIDS, I compare the original results with those from a sample that exclude the countries with more than 10% of adults (15–49) infected with HIV in 2000: Botswana, Eswatini, Lesotho, Malawi, Namibia, South Africa, Zambia, and Zimbabwe.[15] For most of the grade levels, there is little to no

[15]This list is based on data from https://www.unaids.org/en/resources/fact-sheet.

difference between the primary samples and when excluding high HIV countries. To the extent that there are differences, most are the higher grade levels and more so for the rural areas than the urban areas. Yet, these differences also show up for the prior cohorts that are likely not affected by HIV/AIDS, making it likely that these increases may be due to the high-HIV countries being among the wealthier countries in Sub-Saharan Africa.[16]

Second, the reliability of the results depends on the correctness of the birth information provided by the respondents. A concern, particularly in South Asia, is that son preference leads to underreporting of births of girls who have since died (Pörtner, 2022). DHS enumerators probe for missed births, with the method varying by survey, but systematic recall error based on son preference may persist.[17]

Suppose son preference affects selective reporting of deceased children. In that case, one approach is to estimate the number of sons born and then scale by $1 + \frac{100}{105}$ to get the total number of children, assuming a natural sex ratio of 105 boys per 100 girls. However, this approach may overestimate the effects of unequal sex ratios as Sub-Saharan Africa has a lower-than-normal sex ratio due to higher male fetal loss (Garenne, 2002; Morse and Luke, 2021). This lower sex ratio is borne out by the sample, where the weighted sex ratios in Sub-Saharan Africa range from 102 to 104.5 boys per 100 girls, depending on cohort and area of residence. For comparison, South Asia has weighted sex ratios ranging from 104.1 to 109.1.[18]

The differences in children ever born from Sub-Saharan Africa to East Asia and South Asia decrease slightly with this approach. In constrast, the Latin America–Sub-Saharan Africa difference changes little. Overall, the results suggest that differences in sex ratios,

[16]For comparison, there is significant disagreement in the literature on the effect. Some analyses show insignificant aggregate effects of HIV on fertility (Fortson, 2009; Kalemli-Ozcan, 2012; Juhn, Kalemli-Ozcan, and Turan, 2013; Karlsson and Pichler, 2015). Othere find significantly increasing fertility with higher HIV rates and a higher number of surviving children, despite the increased mortality risk (Wilson, 2015; Gori, Lupi, Manfredi, and Sodini, 2017; Chin and Wilson, 2018).

[17]MICS surveys mostly do not use birth histories but instead ask about number of children, either living with the respondent, living somewhere else, or who have died.

[18]Unweighted sex ratios for South Asia are higher, 108.3 to 112.6, because of the large size of the surveys from India.

either from selective recall or higher male fetal loss, explain little of the fertility differences. The small changes also imply that future improved maternal health, potentially increasing the number of male fetuses carried to term, will likely have minimal impact on Sub-Saharan African fertility.

Finally, I rely on the definitions of area of residence provided by DHS and MICS, which, in turn, are based on individual countries' definitions of urban and rural areas.[19] An underlying assumption in the analyses above is that all childbearing for women not born in the type of area they were surveyed in occurred after they relocated. This assumption is consistent with a swift adjustment to urban fertility levels for recent migrants from rural areas (White, Tagoe, Stiff, Adazu, and Smith, 2005; White, Muhidin, Andrzejewski, Tagoe, Knight, and Reed, 2008; Martine, Alves, and Cavenaghi, 2013). However, even if recent migrants adjust quickly, a "healthy migrant" type effect may still skew the results if the lower-fertility women migrate from rural to urban areas, increasing the average fertility in both places.

To investigate migration's influence, I create a sample using surveys with information on prior residence(s).[20] The sample includes women born in the surveyed area and women whose last previous area of residence was the same as their current type. For comparison, I use all women from surveys that collected location information, whether they have moved or not or have missing location information.

The confidence intervals for the no-migration samples are significantly larger than for the comparison. Otherwise, there is relatively little difference in the point estimates across the created sample and the comparisons. If anything, the results suggest that Sub-Saharan African women who moved to urban areas have relatively lower fertility than similar women in other regions. These results are consistent with recent research that argues

[19]The Online Appendix uses DHS data to show that urban areas in Sub-Saharan Africa have a higher proportion of husbands/partners engaged in agricultural work than the other regions, suggesting that the urban areas in Sub-Saharan Africa are somewhat more "rural" than in other regions.

[20]DHS phases 6 and 7 did not include prior location question in the core questionnaires and location questions were not added to MICS until phase 6.

that most of the rapid urban growth in developing countries is due to rapid internal urban population growth and that rural-urban migration rates are low (Chen, Valente, and Zlotnik, 1998; de Brauw, Mueller, and Lee, 2014; Jedwab, Christiaensen, and Gindelsky, 2017; Menashe-Oren and Bocquier, 2021).

5 Discussion

These results suggest that how fertility behavior in Sub-Saharan Africa differs from other regions depends critically on which region and education combinations are compared. There are little to no differences for approximately secondary school and above when comparing Sub-Saharan Africa with South and East Asia, and little difference when we compare no-education women between Sub-Saharan Africa and Latin America. There are substantial and statistically significant differences for women with some primary education for all three comparison regions. This section examines how well each of the four explanations—cultural norms, offspring mortality, potential land access, and school quality—fit the results above.

The significant differences between Sub-Saharan Africa and East and South Asia in children ever born and surviving children for no and low education women provide support for the African exceptionalism explanation. That these differences are smaller for urban than for rural women is also consistent with this hypothesis, provided cultural norms change with urbanization.

Yet, the support for African exceptionalism is countered by the substantially smaller differences between Sub-Saharan Africa and Latin America for the same group of women. Particularly, the just barely statistically significant difference in the number of surviving children for no-education rural women for the 1970s cohort combined with more surviving children for low-education women in Latin America than in Sub-Saharan Africa for the earlier cohorts calls into question that there should be something special about fertility behavior in Sub-Saharan Africa. Nonetheless, this result does not imply that cultural norms have no effect. One way to explain these results is that both Latin America and Sub-Saharan Africa have strongly pronatalistic cultural norms, in Latin America's case, likely because of the influence of the Catholic Church.

One may also argue that the increasing difference in fertility with education between the regions and Sub-Saharan Africa is consistent with African exceptionalism. However, this interpretation requires that an entrenched cultural norm changed with schooling in one region with pronatalistic norms, Latin America, while somehow not affecting cultural norms in Sub-Saharan Africa. Hence, Latin America's experience suggests that either these cultural norms changed quickly or that the rapid expansion of education meant that even if low-education women retained a high fertility norm, there were simply too few of them relative to the overall population to matter much for TFR.

Overall, the estimated differences in surviving children by grade level are smaller than or equal to the children-ever-born differences, suggesting that offspring mortality explains a substantial portion of the differences in children ever-born. A prime example of the importance of offspring mortality is that no-education rural women in Latin America had more surviving children than the no-education group in Sub-Saharan Africa for the 1950s and 1960s cohorts and only barely statistically significantly fewer for the 1970s cohort.

It is worth pointing out that the reduction in differences is by no means guaranteed. For risk-averse parents who want to avoid being left with no surviving children, the optimal response to higher offspring mortality may, indeed, be to increase their fertility more than proportionally and, on average, end up with more surviving children than they would at lower mortality levels.[21] Yet, by itself, the result tells us nothing about whether there is an "overresponse" to mortality, that is, whether a reduction in offspring mortality leads to a decline in net fertility or the number of surviving children. One would need the preferred number of surviving children at different mortality rates to calculate this.

[21] See also Pörtner (2001) and the discussion on mortality risk in the Online Appendix.

The reductions in the differences are smaller, although still there, for women with some secondary schooling or above. These results are consistent with the observed pattern of higher offspring mortality the less education a woman has received and the generally higher mortality in Sub-Saharan Africa, even for the better educated, than in the other regions.

One of the advantages of examining completed fertility is that the number of surviving children, which captures how many children a household ends up with, allows us to bypass the issue of imperfectly measuring mortality risk and the problem that there may be substantial differences in after-5 mortality across regions. However, even when using surviving children, there is still the potential that the higher mortality in Sub-Saharan Africa will bias the estimated differences upward. This bias comes from the fertility pattern in Sub-Saharan Africa, where women have births late in their 30s. Hence, the Sub-Saharan African women in the 40 to 49 age group still have children who are relatively young and, therefore, are at higher risk of dying.

Unobserved land access likely does not explain much, if any, of the observed differences. If more potential land in Sub-Saharan Africa mattered for fertility, we should see positive difference-in-difference estimates. Furthermore, unobserved land access should matter more for lower-education women, given that the more education, the less dependent on land a household is likely to be and the more secure their property rights should be (Besley, 1995; Goldstein and Udry, 2008).[22] However, the estimates are generally small, with most less than one child for both children ever born and surviving children; some are even negative, as is the case for low-education women when comparing Latin America and Sub-Saharan Africa.

The final explanation is that the fertility differences are driven by the substantially lower quality of primary education in Sub-Saharan Africa than in other regions. This ex-

[22] For example, in Ghana, officeholders, who control distribution of land, are better educated than other farmers in their villages, which, in turn, means that better educated households are more secure in their land tenure rights and have higher agricultural output because they can invest more in their land (Goldstein and Udry, 2008).

planation fits the observed pattern in differences well. As we move from no education, we should expect fertility differences to increase. This increase happens because the material that each grade is supposed to cover is cumulative, making Sub-Saharan African women fall further and further behind as we go up in grades if the school quality is low. For the sake of exposition, say that Sub-Saharan African schools cover material at half the pace of other regions and that a full year of human capital accumulation reduces fertility by 0.5. In that case, if fertility started at six for women with no education, the differences in fertility between Sub-Saharan Africa and the other regions would be 0.25, 0.5, and 0.75 for the first three years of education. The conjecture of worse school quality in Sub-Saharan Africa is supported by the increasing differences in literacy with grade level for the lower grades of primary school.[23]

If school quality is behind the increasing difference, why do the differences decrease from around grade six and disappear almost entirely for grade ten or above, at least when compared to East and South Asia? There are two potential selection explanations. One is self-selection out of education based on the return to education. Low quality of education also implies a low return to the time spent in school. We should, therefore, expect girls to leave school earlier, the worse the quality of education. Hence, as we go up in grades, we are left with those who either went to higher-quality schools or were otherwise able to learn despite low-quality instruction. In many countries, entrance into secondary school and above is very competitive. Hence, we only observe women with higher grade levels if they were lucky enough to go to a higher quality school or were somehow sufficiently motivated and able to learn the required material independently.

Note that the convergence in literacy for higher grades does not imply that Sub-Saharan African women's human capital catches up to that of women in other regions. In addition to the selection effects described above, the literacy variable measures a foundational

[23]This lower quality, especially at primary school level, could explain why fertility begins to decline at higher levels of education in Sub-Saharan Africa than in other regions (Martin, 1995; Ainsworth, Beegle, and Nyamete, 1996; Benefo and Schultz, 1996; Thomas and Maluccio, 1996; Lloyd, Kaufman, and Hewett, 2000; Alam and Pörtner, 2018).

and low-level skill required for further learning. Hence, with increasing grade levels, we should eventually expect a convergence in literacy. Furthermore, the grade level at which surveys stop asking literacy questions is not random, which likely overestimates differences for higher grades. Because of concerns about school quality, many surveys in Sub-Saharan Africa now include even secondary school women when asking literacy questions. At the same time, most countries in the other regions stop at grade six. Finally, the results include self-reported literacy abilities, which respondents often exaggerate.[24]

In summary, the two potential causes examined here that appear particularly important for understanding differences in fertility behavior across regions are offspring mortality and school quality. The smaller differences in, especially, surviving children between Sub-Saharan Africa and Latin America for rural women make it difficult to argue that there is something unique about any pronatalistic norms in Sub-Saharan Africa. Nevertheless, the fact that we observe a difference of almost one surviving child between Sub-Saharan Africa and South Asia for rural women with no education is important for differences in the overall population growth rates, given that these women represented 50% and 65% of the respective rural populations. This difference may be due to differences in cultural norms, although the difference for the same group in urban areas is less than 0.5 children.

Finally, the method does have at least four potential drawbacks. The method works best for completed fertility and therefore tells us little about recent development in fertility behavior across regions, such as recent stalls in fertility declines (Bongaarts and Casterline, 2013; Bongaarts, 2017; Gerland, Biddlecom, and Kantorová, 2017; Schoumaker, 2019). The results for women 30 to 39—presented in the Online Appendix—follow the results presented here very closely. The main difference is that the differences are smaller for the younger age group than for women with completed fertility.

All conclusions here are inferred based on the estimation results rather than tested directly. Moreover, distinguishing between the different explanations requires untestable

[24]Enumerator-tested literacy results show a similar pattern but are limited to grade six and below and to the 1960s and 1970s cohorts. These results are available upon request.

assumptions about how the unobservables affect fertility. For example, an assumption behind the cultural norm discussion is that cultural norms impact women with no education more than women with education.

Which grade a woman leaves school at is not random and likely depends on school quality. One implication is that the results should not be taken as causal. Another implication is that the literacy result may be biased. For example, we may underestimate early primary school quality for higher-quality education systems since women with higher innate abilities will have progressed to higher grades, leaving those with lower innate abilities in the lower grades.

Last, even with the current large-scale data set, some cells have few observations. The result is relatively noisy estimates of differences in fertility for some grades. Higher grades in rural areas are particularly affected by this problem.

6 Conclusion

Sub-Saharan Africa is projected to be home to a quarter of the world's population in 2100, and total fertility rates there have remained stubbornly high in many countries. Estimating completed fertility, measured by children ever born and surviving children for women aged 40 to 49, by grade level for three cohorts across urban and rural areas separately, I examine four potential causes for Sub-Saharan Africa's high fertility levels: cultural norms, expected offspring mortality, potential land access, and school quality.

Of these causes, school quality and mortality risk differences appear especially important in explaining differences in completed fertility across regions. The main differences in fertility between Sub-Saharan Africa and other regions show up for women who have some education to complete primary schooling. This pattern is consistent with a lower quality of primary education in Sub-Saharan Africa than in other regions, well documented in the literature and supported by the literacy results presented here. Furthermore, the number of surviving children shows substantially smaller differences across regions than children ever born. In a few cases, the number of surviving children is even lower in Sub-Saharan Africa than in other regions.

The results and limitations of the analyses point to three worthwhile areas of future research. First, I mostly ignore the potential variation with regions, except for the sensitivity analysis excluding high HIV/AIDS countries in Sub-Saharan Africa. However, it is also essential to understand how fertility decisions vary within regions, especially in Sub-Saharan Africa.

Second, an in-depth examination of the role of school quality in fertility decisions is a critical area of future research. There are two aspects to this question, the role of school quality in the education gradient in fertility, which is the main route discussed here, and the effect of the school quality that any offspring may get. If the time cost of going to school is close to independent of how much learning goes on, this implies that parents should opt for higher fertility and lower school investments. Hence, not only do Sub-Saharan African women with only primary school have a lower opportunity cost of time relative to elsewhere and, therefore, predicted higher fertility, they also have less incentive to reduce fertility and invest in their children's schooling.

Finally, the differences in results between children ever born and surviving children suggest that we need to reevaluate how we measure mortality when estimating the effects of mortality risk on fertility decisions. What is especially relevant is what role after-5 mortality plays in fertility decisions, to what extent after-5 mortality is independent of below-5 mortality, and if that relationship varies across regions. With the large amount of data on completed fertility now available, we can now analyze these relationships.

In terms of policy, a critical focus should be the improvement of the quality of the educational system, especially for primary education. Improving education is of even more importance if the "demographic dividend" is really an "education dividend" (Crespo Cuaresma, Lutz, and Sanderson, 2014). Improving school quality is even more crucial because the number of children of primary and secondary school age, 5–19 years, will increase from 359 to 668 million, a rise of close to 90 percent between 2015 and 2050 (Cleland and Machiyama, 2017).

Ending on a more optimistic note, the differences in fertility between the other regions and Sub-Saharan Africa are smaller in urban areas than in rural areas. Hence, with the growing importance of urban areas in Sub-Saharan Africa, we will likely continue to see a convergence of fertility across regions, especially if the problem of low-quality schooling is addressed.

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