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THE RELATIVE IMPORTANCE OF EDUCATION ON FERTILITY DESIRES IN SUB-SAHARAN AFRICA: A MULTI-LEVEL ANALYSIS

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Abstract

Scholars suggest that in high fertility settings where there is high wanted fertility, lowering the desired family size is a necessary precondition for fertility declines. Though accumulated evidence has linked socio-economic developments to changes in fertility desires, little efforts have taken to disentangle the relative importance of key socio-economic determinants such as education, income, and area of residence in a multi-level context. Combining individual and community-level data from Demographic and Health Surveys of 34 African countries to aggregate level indicators, we have quantified and compared the relative role of female education on fertility desire at the individual, community, and country levels. Results show that at the individual level, female education has a stronger effect compared to household wealth, and area of residence. The high levels of reported desired family size in the rural parts of SSA are mainly a consequence of their relatively lower levels of educational attainment compared to their urban counterparts. At the community level, the relative impact of female education is even more striking. The simulation results revealed that moving the most economically disadvantaged and illiterate woman from a low educated to a high-educated community would reduce her desired family size by about 20 percent. On the other hand, lifting the same woman from the poorest to the wealthiest community would reduce her family size desire only by 6 percent. Our findings are robust to alternative measures of fertility preferences. This study, thus, confirmed the findings of previous studies that have looked at the relationship and causal link between actual fertility and women's level of educational attainment.

Keywords

Desired fertility, sub-Saharan Africa, female education, multi-level analysis, community education.

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The Relative Importance of Female Education on Fertility Desires in Sub-Saharan Africa: A Multi-Level Analysis

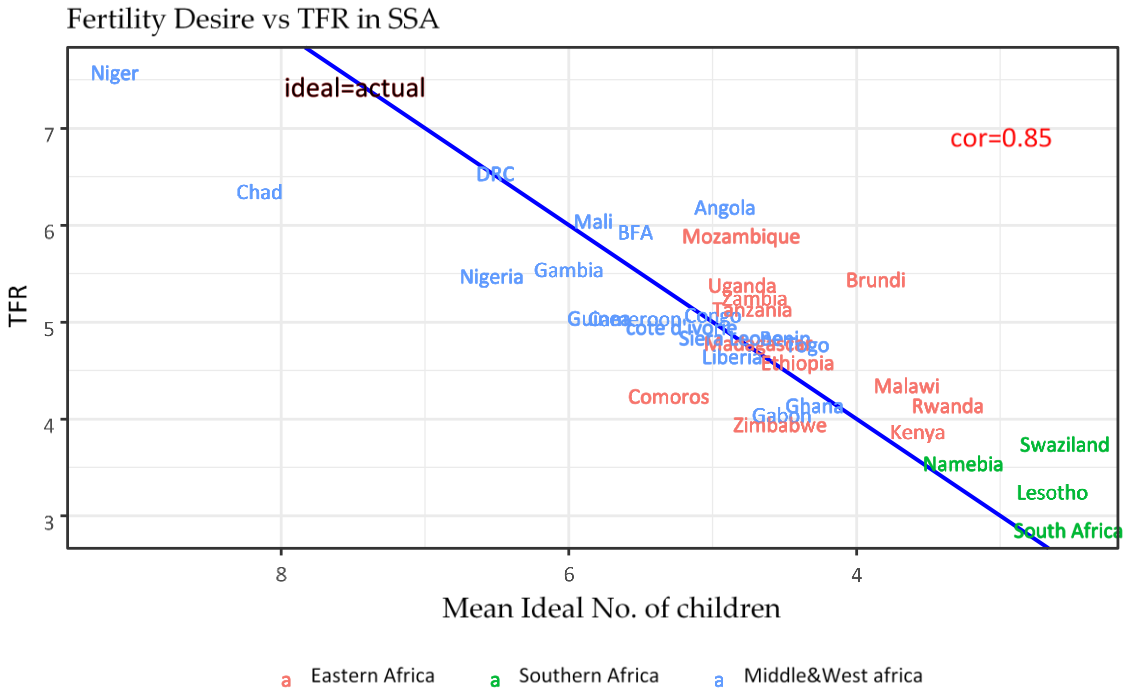
Endale Kebede

1. Introduction

The secular decline in fertility that has been taking place in many parts of the world is one of the defining events shaping the demographic and socio-economic landscape of our times. Following the end of World War II, Asia and Latin America underwent a remarkably fast fertility transition that had taken the European pioneers in this process more than a century. Fertility declines in these regions were possible due to initially high unwanted fertility and gradually lower desired family size, facilitated by the availability of birth control methods and other family planning services (Feyisetan and Casterline 2000; Casterline 2009). In contrast, sub-Saharan Africa (SSA) showed little to no sign of fertility decline until the 1980s, and the ongoing fertility declines are happening at much slower pace – sometimes even with stalls – compared to other regions (Bongaarts 2008; Kebede et al. 2019; Ezeh et al. 2009). More puzzling even, fertility in the region has remained high despite the availability of birth control and other family planning services, as well as substantial improvements in child mortality.

The reasons brought forward for this so-called "African exceptionalism" (Bongaarts and Casterline 2013) are manifold. Sustained high fertility could be associated with the high pro-natalist attitudes prevalent in the region (Caldwell and Caldwell 1990). Vast empirical evidence confirms that differences in fertility preferences can explain much of the variation in fertility across countries (Pritchett 1994; Hirschman 1994; Bryant 2007). Pritchett (1994, p. 39) concludes that "a [A] low level of desired fertility appears to be both necessary and sufficient for low fertility. […] In contrast, an improvement in contraceptive access (as distinguished from contraceptive use) is neither sufficient nor necessary for large fertility reductions". Despite the recent emergence of a change in mentality towards the adoption of family limitation in a number of African countries, the desired number of children at any given level of fertility in SSA is considerably higher than in other developing regions (Casterline and Agyei-Mensah 2017; Bongaarts 2017). Comparisons between the last two consecutive most recent DHS reveal that on average the ideal number of children in SSA has only declined by 0.1 child (from 5.02 to 4.92 children per woman). More strikingly even, in contrast to the experience of other developing regions where people had already started to desire smaller family sizes at the onset of the fertility transition, in SSA we observe a very modest excess (actual vs. desired) fertility at this stage. As indicated by the blue line in Figure 1, the realized fertility in the region is close to the desired fertility, and in a number of countries, the ideal family size is even higher than the actual.

Figure 1: Mean ideal number of children vs TFR in 34 SSA countries for childless women



Source: Most recent DHSs.

This leaves little room for the reduction of actual fertility through the elimination of unwanted births using voluntary family planning services and opens up the question of why people in SSA continue to desire that many children. Despite the strong connection between desired family size and later realization, SSA's fertility desires have so far not received enough attention. According to classical demographic transition theory, high fertility results from the desire for large family sizes in response to socio-economic demands, rather than a failure to achieve desired smaller family sizes (Notestein 1945b; Easterlin 1975; Schultz 2001). By increasing the direct, as well as the opportunity cost of children, changes in socio-economic settings can erode the economic basis for high fertility desires. According to Bongaarts (2017), differences in the pace of fertility decline between Africa and other developing regions can be explained to a large extent through the slow pace of socio-economic development.

In the ongoing debate about persistent high fertility in SSA, the present study aims to disentangle the relative effects of different socio-economic factors on fertility desires. More specifically, we are interested in the relative contribution of education compared to wealth and area of residence. Since the importance of different socio-economic factors can vary by level of spatial aggregation and higher-level effects can mask combined individual-level effects or an independent effect at the national level, we apply a multi-level framework to differentiate effects on fertility preferences at the individual, the community and the

country level using data from 34 SSA countries. This type of analysis is particularly promising in SSA, where fertility continues to be well above four children per woman in the majority of the countries, and more than one-third of women aged 20-39 have no formal education (Wittgenstein Centre for Demography and Global Human Capital 2018). The results of this study, thus, will help to understand the link between education and fertility, as well as to reassess the gains from future investments in education.

Education and Fertility Desires

Since the pioneering work of Cochrane (1979), various micro-level studies have emphasized the importance, particularly of female education, in explaining fertility decline (Castro Martin 1995; Kravdal 2002; Bongaarts 2010). Education is generally associated with lower desired family size (Cleland 2002; Behrman 2015), but due to a strong economic paradigm in fertility research, the role of education is typically seen in conjunction with changes in income and other development indicators. In line with predictions from the neoclassical economic models of fertility, increases in women's education negatively affect fertility preferences by increasing their forgone income (Becker 1981). Similarly, unified growth theory explains that industrialization expands not only urbanization and income but also the incentive to accumulate human capital which subsequently leads to fertility decline (Galor 2011). This conflation of education with other development indicators becomes most obvious in the construction of the Human Development Index (HDI) which lumps indicators of human capital (mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age) together with per capita gross national income and life expectancy. Yet, recognizing and determining the importance of human capital relative to other driving forces of development has important policy implications, particularly in achieving the sustainable development goals (Lutz 2017), which is why we want to look at them separately.

Female education has also been shown to affect fertility desires through a number of non-economic pathways, such as increased knowledge and changing attitudes around fertility regulation (Cochrane 1979; Cleland and Wilson 1987), promotion of new norms (Caldwell 1976; 1980), social interactions (Bongaarts and Watkins 1996), enhanced female autonomy (Jejeebhoy 1995), and improved child health (Pamuk et al. 2011). These pathways can be complex and several studies have found the effects of female education on the desired number of children to be context-dependent, varying across regions (Jejeebhoy 1995; Castro Martin 1995; Günther and Harttgen 2016; Casterline and Agyei-Mensah 2017), countries (Muhoza, Broekhuis, and Hooimeijer 2014; Behrman 2015), and across communities within countries (Kravdal 2002). Rather than being merely a function of their individual socio-economic status, women's fertility preferences are also influenced by the level of socio-economic development of the community and the country in which they reside. The desired number of children among uneducated women from poorer and mostly illiterate communities differs markedly from the number of children desired by women

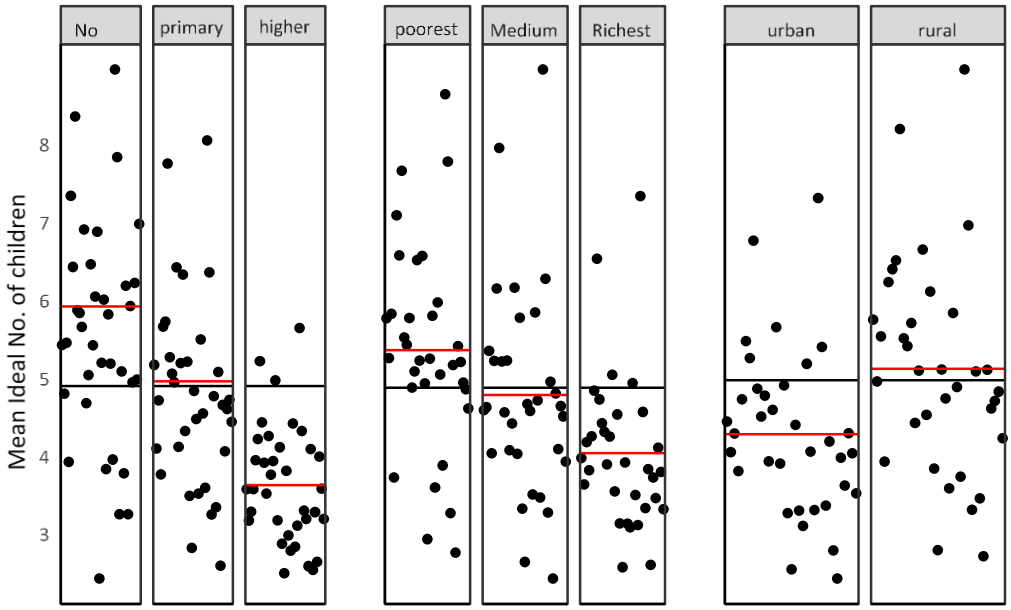
who live in mostly literate and richer communities, which is why we have to account for these different levels in assessing the relative importance of education.

There are many possible explanations for context-dependent effects of socio-economic status on the desired number of children. Firstly, individual norms and attitudes are acquired through social interactions, and depend on the stock of knowledge that is available in the vicinity, the level of urbanization, which regulates the speed at which new ideas circulate, as well as the economic resources at the community's disposal. Secondly, individuals tend to imitate the reproductive behaviors prevalent in their community, simply to gain acceptance and to avoid criticism from others (Kravdal 2002). This effect is particularly strong in societies without developed welfare states, where informal support networks act as the main form of insurance, making individuals conform more heavily to values and attitudes shared by the community (Caldwell and Caldwell 1987). In addition to these community level effects, socio-economic developments might affect individual fertility preferences from the national level. Overall educational attainment, for example, influences fertility-related content, as well as the image of women in society more broadly that is communicated through the mass media. Socioeconomic development affects support for family planning efforts and national reproductive health campaigns aiming at improving health-related infrastructures while reducing the relative importance of child labor.

To this date and to the best of our knowledge, no single study on SSA has systematically and simultaneously assessed the role of education relative to other socio-economic indicators at these three levels (individual, community and country) in determining fertility intentions. Kravdal (2002) showed the independent effect of individual and community level education on actual fertility in 22 SSA countries. However, the study did not look at intentions, and since detailed information on household wealth was not yet available in DHS before 2003 could only disentangle the effect of education from area of residency. Hence, mediating factors that are possibly affected by female education, such as household wealth, were disregarded. Moreover, by looking at women's ideal number of children at the three levels, we are able to study one (if not the most) important determinant of actual fertility.

The examination of fertility desires according to individual's education, household's wealth quintile and area of residence for the 34 SSA countries included in the present analysis reveals a pattern consistent with the above arguments (see Figure 2). The mean ideal number of children declines with improvements in socio-economic status (education, wealth) and is lower in urban compared to rural settings. Despite possible issues of collinearity between the three indicators, women's educational status appears to be the strongest predictor of the mean ideal number of children. Secondly, fertility desires and socio-economic status vary substantially across countries within SSA. The dispersion is particularly strong among poor, uneducated, rural women compared to their wealthy, better-educated, urban counterparts.

Figure 2: Mean ideal number of children by socio-economic status of women in 34 SSA



Source: Most recent DHSs.

Fertility Preferences: Definitions and Measurement Issues

There is some variation in the terms used to denote fertility desires or ideal family size and the corresponding questions included in surveys. For this reason, we have to be careful in being clear about the terminology we use and the advantages and disadvantages of different ways of measuring fertility preferences. We will also have to be careful of how to deal with non-numeric responses to questions about fertility preferences and the possible preference round numbers, such as stating 10 children instead of 9 or 11.

As mentioned, the present study uses ideal number of children as a measure of women's intentions among a plethora of indicators (Thomson 2015). Desired family size is usually defined as the number of children a respondent would like to have based on his/her own assessment of the costs and benefits of childbearing, and "if there were no subjective or economic problems involved in regulating fertility" (Easterlin 1975, p. 82). It was first consistently and internationally measured by the World Fertility surveys (Lightbourne 1985). Later, DHS employed a range of questions to collect detailed information on fertility desires, and construct multiple indicators of family size preferences. These indicators have been used to measure unmet need for family planning, to assess reproductive norms, and to forecast future courses of actual fertility. The first type of questions asks respondents about their fertility preferences prospectively. For parents, the question is; "*Do you like to have another child, or would you prefer not to have any more children?*" Related questions are also asked about the desired waiting time, for those who want an additional child. In

addition, the surveys include questions about the wantedness of recent births or pregnancies.

DHS also provide more direct indicators of family size preferences based on the ideal number of children assessed retrospectively, using the following question; *"If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?"* For childless respondents, this question measures desires prospectively: *"If you could choose exactly the number of children to have in your whole life, how many would that be?"*. The ideal number of children is the most used measure of fertility preference. However, this indicator has several limitations (McClelland 1983; Casterline and El-Zeini 2007; Johnson-Hanks 2007; Bongaarts 1990):

First: Indicators of ideal family size are subject to a social desirability bias in which responses may only reflect the overall ideal family size of the society (Livi Bacci 2001). For example, the two-child family, one boy and one girl- has long been considered as an ideal family composition in many western European countries. On the other hand, in many SSA countries, large household size is generally considered as a societal ideal.

Second: Individual plans may change over the life course following changes in economic, social, health, and other period conditions (Iacovou and Tavares 2011; Hayford 2009; Freedman, Coombs, and Bumpass 1965). Experiences associated with changes in educational attainment, child survival, career trajectories, gender composition preferences, as well as partner's influence may contribute to changes in desired family size (Bongaarts 1990; Bankole & Westoff, 1998; Morgan and Rackin 2010). Namboodiri (1983) explained that each birth experience provides new information that could change family size desires and expectations. Hence, fertility intentions should be examined at different parities (Yamaguchi and Ferguson 1995).

Third: Rationalization or 'post facto revision of family size preferences' that lead respondents to adjust their ideal number of children to their actual number of living children. In our sample of 34 SSA countries, 75 percent of women (aged 45-49) reported an ideal number of children higher than the number of living children, and about 8 percent of sampled women stated the same number of children for both indicators.

Fourth: Women's fertility intentions and expectations are heavily influenced by the fertility preferences of their husbands and/or households. Many empirical studies present women's fertility desires as the main indicator of fertility norms and decisions, based on the presumption that women are the primary childbearers, and their desire and intentions determine the subsequent fertility. However, partners' diverging desired family size is the primary source of differences between women's fertility desires and expectation (Thomson 1997; Miller and Pasta 1996). A study in Nigeria has shown that when a husband and a wife disagree on the desire for an additional child, the preference of both is equally important in the actual occurrence of the next birth (Akinrinola Bankole 1995). However, survey results in which both men and women were interviewed revealed that women's and men's

respective fertility desires are more similar than different (Testa 2006; Rutstein and Rojas 2006).

Fifth: Number heaping. In high fertility settings, women who provide numeric answers to questions of ideal family size may not be able to state it precisely. They instead tend to round numbers, such as reporting 10 children instead of 9 or 11 (see Appendix Figure A.3). In countries such as Chad and Niger, the vast majority of women state 10 as an ideal number of children. Even in countries where the mean ideal number of children is smaller, there is a tendency for the large majority of women stating four, five, or six children as ideal. These may reveal the social desirability bias in DHS.

Despite these limitations and measurement issues, with some practical remedies in data analysis, indicators of women's fertility desires could provide a quantitative base for assessing overall fertility norms and demands in the population. For example, sampling young women, and analyzing the ideal number of children controlling for parity as is implemented in the present study can minimize biases associated with rationalization. Moreover, several studies have shown strong connection between women's fertility desire and achieved fertility (Günther and Harttgen 2016; Pritchett and Summers 1994). Furthermore, Van de Kaa (2001) explained that fertility preference indicators should play a causal role in theories of fertility decline.

Non-Numeric Responses

In DHS, a small but significant proportion of responding women do not numerically answer to questions about ideal family size, but provide instead non-numerical responses, such as 'it is up to God', 'as many as possible' or 'I do not know'. Appendix Table A.2 presents the proportion of women who provide non-numeric responses to the question of ideal family size in 34 SSA countries by survey year. It shows that in earlier surveys, a substantial proportion of women provided non-numeric responses. For example, in the first surveys of Nigeria (1990) and Burkina Faso (1993), about 60 percent and 25 percent, respectively, of women provided non-numerical responses. In recent surveys, however, the share of non-numeric responses significantly declined. In Burkina Faso's 2010 DHS, only 3.5 percent of women provided non-numeric answers.

Though many researchers have taken such kind of responses as missing values, studies have shown that non-numeric responses are meaningful in understanding fertility transition theories (Frye and Bachan 2017; Hayford and Agadjanian 2011). In relation to A. J. Coale (1973) precondition that lasting fertility decline happens when childbearing is "within the calculus of conscious choice", demographers often associate non-numeric responses to 'pre-transitional mindset' that women lack deliberate control over their fertility. On the other hand, a decline in non-numeric responses to ideal family size are precursors of the onset of fertility transitions (Caldwell 1976; Van de Walle 1992). Appendix Figure A.1 shows the prevalence of non-numeric responses by the mean ideal number of children across SSA countries. It reveals that non-numeric responses are more prevalent in

pre/early-transitional context in countries where the mean ideal number of children (and thus TFR) is higher.

Moreover, research has shown that the 'up to God" or 'I do not know' responses to ideal family size question may reflect socio-economic characteristics of respondents-such as educational attainment- as well as uncertainty stemming from high child mortality (Riley, Hermalin, and Rosero-Bixby 1993; Sandberg 2005). A study in Malawi has shown that better-educated women tend to answer numerically, and report smaller ideal family size (Yeatman 2009). Appendix Figure A.2 displays the average proportion of non-numeric responses in SSA by individual socio-economic status, in most recent surveys. The non-numeric responses are generally higher among non-educated, poor, and rural women. The average proportion of non-numeric respondents among women with no formal education is about six percent, while it is below two percent among those with completed secondary education or more.

Due to its association with predictors of family size preferences, excluding non-numeric responses from our sample data could cause a severe bias. However, as shown in Appendix Table A.2 and Appendix Figure A.2, the proportion of women providing non-numeric responses to fertility preferences in SSA is declining over time, and the correlation between non-numeric responses and key predictors of fertility preference is not substantial. Thus, the bias associated with non-numeric responses could be minimized by employing only the most recent DHS data, which is the approach used in this paper.

2. Data

This study is primarily based on DHS data from 34 SSA countries. Within each country, the survey made use of a two-stage cluster sampling technique and standardized questionnaires to collect comparable, reliable and nationally representative data on population health, living conditions and demographic characteristics of households. The data set pools information about 432,083 women (see Table 1). For reasons mentioned above, only most recent surveys are considered.

DHS provides multiple indicators of women's preferences regarding family size (discussed in the previous section). The present study uses the most direct and easiest to interpret indicator, namely the ideal number of children. In all 34 countries, women were asked: "*If you could go back to the time you didn't have any children and could choose exactly the number of children to have in your whole life, how many would that be?*" To minimize measurement limitations and the associated biases of this indicator, our sample is limited to the most recent surveys, and the analysis were conducted parity-wise.

DHS reports educational status of each member of the selected household including that of women of reproductive age (15-49) and of the head of the family. To examine the effect of individual education on fertility desires, five levels of female educational attainment were created from individual files: no formal education, incomplete primary education,

completed primary education, some secondary education, and completed secondary education or more. While recognizing the possible independent effect of community level education, we derive the mean years of schooling (MYS) of women for each sample cluster. To test whether less educated women could be affected by the reproductive behavior of potentially influential women (including better-educated ones) in the community, we created a categorical variable dividing the distribution of cluster-specific MYS approximately into thirds. Less than 3.2 MYS is categorized as "low", more than 3.2, but less than 6.2 years as "medium", and 6.2 or more years as "high". To assess the impact of country-level education, we include the logged proportion of working-age population (aged 20-64, both sexes combined) with lower secondary education or more (Wittgenstein Centre for Demography and Global Human Capital 2018).

The impact of household economic resources on women's fertility desires is examined using the household's wealth quintile. This categorical variable is constructed using information on assets and the availability of important services within a household, such as water supply, electricity, radio and type of flooring. At the community level, a categorical indicator of relative wealth (poor, medium, rich) is constructed from the mean of wealth quintile scores for all households within the cluster. The impact of economic resources at the national level is assessed using a country's per capita gross domestic product (PPP 2011 international $) around the time of the survey. These data are obtained from the World Development Indicators database (World Bank 2017) and are included into our analysis as a continuous variable, transformed by taking the natural logarithm.

In addition, in our multi-level analysis we control for the impact of area of residence as it is defined and reported in DHS (urban vs rural). Similarly, we control for region-specific differences in fertility desires within SSA by including dummy variables for Central and Western (reference level), Eastern and Southern Africa.

Another major factor associated with lower fertility desires is availability and use of family planning services. By increasing people's capacity to control their fertility, family planning helps people to reduce the number of unwanted births (Coale 1973). Information on the intensity of family planning activities at the national level are available through the Family Planning Effort Index (FPEI, Kuang and Brodsky 2016). The FPEI was intended to measure the strength and weakness of national family planning efforts in four main dimensions: policy context, service provision, monitoring and evaluation, and access to fertility control methods. The index was constructed based on the assessment of 10-15 experts from government, the private sector, academia, non-governmental organizations and international agencies of each country and is available periodically for the period 1972-2014 for a large number of countries. The national experts rated 36 items of their country's family planning programs on a scale from one (no effort) to 10. The FPEI was then calculated by taking the average of the 36 ratings as a percentage of the maximum possible score.

While the FPEI takes account of the input side of family planning, the output side (e.g. actual use of modern contraceptives) are excluded from our analysis for two main reasons.

First: Contraceptive use to some extent is a consequence of fertility preferences, not an explanatory factor. The desire for smaller families creates a demand for family planning services and keeping all other factors constant, women with lower desired family size are more likely to use contraceptives than those with high fertility preferences. Second: Women's contraceptive use is linked to their socio-economic status. Hence, including contraceptive use in the analysis would underestimate the total effect of the antecedent background factors such as education and economic resources. Moreover, the study aims to compare the effects of the demand side determinants of fertility preferences setting aside the supply side factors.

Descriptive country-specific sample statistics including the number of clusters, the number of women sampled, as well as the country level socio-economic indicators included in the analysis are provided in Table 1. Variation in the mean ideal number of children across SSA countries is substantial. While in Swaziland it is as low as 2.5, it reaches 8.6 children in Niger. Likewise, considerable heterogeneity is observed with respect to socio-economic development. GDP per capita, for example, is as low as 682 $ in Burundi, while in Gabon it is 17,000 $. The proportion of working age adults with at least lower secondary education ranges from a low of 4.7 percent in Niger to a high of 71 percent in South Africa. The proportion of urban population reaches a high of 80 percent in Gabon but only 11 percent in Burundi. Unlike the other socio-economic indicators, the FPEI index shows smaller variation between sample countries: at 49.8, the FPEI for Niger, the country with the highest ideal number of children, is not very different from the family planning effort index at the other end of the spectrum (52 for Swaziland).

Table 1: Number of women, clusters, and selected country-level socio-economic characteristics for 34 SSA countries

Country	Survey Year	# Women	# clusters	GDP per capita (PPP - 2011 $)	% adult (20-64) with lower secondary or more	% urban pop.	Family planning effort index	Mean ideal number of children
Angola	2015-16	14,377	622	6955	12.7	40.9	.	4.72
Burkina Faso	2010	13,591	573	1350	11.6	23	45.6	5.07
Benin	2017-18	16,526	553	1931	17.1	41.2	57.2	4.32
Burundi	2016-17	16,909	554	682	8.2	11.2	55.6	3.75
DR Congo	2013-14	14,326	536	760	43.3	40	40.2	5.95
Cameroon	2011	13,550	577	2574	34.1	50.1	38.6	5.27
Chad	2015	4,740	622	2073	10.3	22.1	45.5	7.76
Comoros	2012	10,149	252	1396	32.8	27.9	.	5.15
Congo	2011	9,218	384	5595	37.6	62.2	38.0	4.61
Cote d'Ivoire	2011	3,955	351	2726	19.1	48.7	43.4	5.12
Ethiopia	2016	13,928	638	1529	10.3	18.2	58.9	4.16
Gabon	2012	7,911	330	17100	39.9	85	.	4.49
Gambia	2013	9,899	281	1570	25.6	55.7	46.5	6.00
Ghana	2014	9,233	425	3833	53.8	50.7	53.8	4.03
Guinea	2012	8,145	300	1183	38	39.1	4.6	5.58
Kenya	2014	14,243	1,573	2747	54.2	23.6	49.4	3.39
Lesotho	2014	6,608	397	2672	27	24.8	42.2	2.53
Liberia	2013	8,817	322	770	28.4	47.5	45.6	4.53
Madagascar	2009	16,330	593	1528	14.3	29.4	47.3	4.33
Malawi	2015	24,234	850	1114	34.2	15.7	47.6	3.65
Mali	2012	10,107	413	1862	9.8	34.7	50.9	5.54
Mozambique	2011	13,604	610	913	16.7	30.5	43.0	4.46
Namibia	2013	9,053	522	8858	45.1	40.8	51.2	3.30
Niger	2012	10,201	475	807	4.7	17.3	49.8	8.56
Nigeria	2013	36,154	896	5309	37.3	42.8	40.7	6.21
Rwanda	2014	13,362	491	1516	11.3	24	73.5	3.15
Sierra Leone	2013	15,864	434	1570	21.2	38	41.1	4.67
South Africa	2016	8,485	595	12393	71.2	54.5	60.8	2.87
Swaziland	2006-07	4,947	265	7141	39.5	22.3	52.3	2.45
Tanzania	2015	12,631	606	2421	14.8	28.8	46.6	4.56
Togo	2013-14	9,217	330	1280	18.1	37.2	50.3	4.00
Uganda	2016	18,033	695	1738	19.2	15.1	50.9	4.44
Zambia	2013	15,858	720	3488	40.9	38.4	43.9	4.32
Zimbabwe	2015	19,878	399	1709	68	33	58.7	3.81

3. Method

In order to assess the relative impact of education on fertility desires, we employ multi-level Poisson regression models accounting for the hierarchical nature of our data. Failure to control for the correlation resulting from the characteristics shared by women within the same neighborhood and neighborhoods within the same country can mask underlying unobserved heterogeneity and lead to biased estimates. Because of the small number of observations at the household level, we settle for a more parsimonious three-level model where women (level 1) are nested within clusters (level 2), which are again nested within 34 SSA countries (level 3). The base model is specified in the following way:

$$\log\left(\mathrm{Y}^{N}{}_{i,\mathrm{k},c,t}\right) = \alpha + \beta 1 age_{i,k,c,t} + \beta 2 Educ_{i,k,c,t} + \beta 3 Wealth_{i,k,c,t} + \beta 4 rural_{i,k,c,t} + X^{a}{}_{i,k,c,t} + X^{b}{}_{i,k,c,t} + \mathrm{U}_{K} + U_{c} \quad ---------- (1)$$

where individual i is nested in cluster k and clusters are grouped within country c. The subscript t represent the survey year, which varies among sample countries (see Table 1). Since the response to fertility ideals heavily depend on the number of children a woman already has (rationalization), the above equation was estimated separately for different sub-samples of women at different parity levels, $N = 0{,}1-2, 3-4\ and\ \geq 4$. The outcome variable $\mathrm{Y}_{i,k,c}$ measures the ideal number of children. The error terms U_{K} and U_{c} capture cluster- and country-specific deviation from the conditional mean (the intercept), respectively. They are assumed to be normally distributed with constant variance. We control for age of woman at the time of the survey ($age_{i,k,c}$), as well as individual-level educational status ($educ_{i,k,c}$), household wealth quintile ($wealth_{i,k,c}$), and place of residence ($rural_{i,k,c}$). Moreover, we implement controls at the community-level ($X^{a}{}_{i,k,c,t}$), and at the country-level ($X^{b}{}_{i,k,c,t}$): mean years of schooling among the community's women of reproductive age, mean wealth quintile score, the country's proportion of adult population with at least lower secondary education, log GDP per capita, family planning effort index and other geographical indicators. We develop eight models to test the relative impact of our indicators at multiple level on the desired number of children as shown below.

4. Results

Table 2 reports the multi-level model estimates that compare the relative importance of education and economic resources, at the individual, community and the country-level, on fertility desire of women with no children at the time of the survey. The same specification were estimated for women with 1-2, 3-4 and 4+ children (results are presented in appendix table A.3). Model 1 of Table 2 show the bi-variate effect of selected individual, community and country level variables on the desired number of children, adjusting only for age of women. Older women tend to report higher desired number of children. Both individual education and household economic resources show a strong and statistically significant relationship with fertility desire. The desired number of children is estimated to decrease

with women's level of education. Relative to those with no education, the rate ratio dropped by 10 percent for those with some primary education, by 16 percent for those with completed primary education, by 22 percent for those with incomplete secondary education, and by about one-third for those with at least completed secondary education. Similar to education, the effect of household economic resources shows a negative bi-variate association with the desired number of children, with women from higher wealth quintiles desiring less children. However, the difference in the desired number of children between the lowest and highest wealth quintile is smaller than the difference between having no education and having at least completed secondary education. Compared to women from the poorest households (q1), fertility desires among those from the middle wealth quintile (q3) are about 10 percent lower and about 25 percent lower among women from the wealthiest households (q5).

Model 2 focuses on the simultaneous adjustment of effect of education at the individual, community- and country-level, controlling for age. Increased education continues to be associated with a strong, statistically significant drop in fertility desires at all levels. However, the adjusted effects are weaker than the unadjusted bi-variate effects presented in Model 1. The estimated effect for the proportion of adults (20-64) with at least a lower secondary education at the country-level has weakened substantially and become statistically insignificant, suggesting that the country-level effect of education no longer plays a significant role once individual- and community-level effects have been controlled for. Similarly, in Model 3, the estimated coefficients of the effects of increased economic resources at all levels turn out to be much lower than in the bi-variate case (Model 1). However, the effect of wealth continues to be statistically significant and of considerable size at all three levels. The unexplained country and community-level variations are higher in the model where only economic resources are controlled for (Model 3) than in the model where only education variables are included (Model 2), indicating that education has more explanatory power by itself.

Finally, Model 4 controls for both education and economic resources at all levels simultaneously. Most notably, this leads to a reduction in the importance of economic resources at all levels, while the effects of education prove to be relatively robust to the inclusion of wealth. At the individual level, the effect of increased wealth remains statistically significant, but effect sizes are small: relative to women from the poorest wealth quintile, women in the fourth, and fifth quintile are estimated to have only 5-8 percent lower desired fertility. At the community-level, desired fertility for women from richest neighborhoods is estimated to be only 8 percent lower compared to women from relatively poorest neighborhoods, while the difference in the odds ratios for the richest and medium wealth neighborhoods is no longer statistically significant. Similarly, at the country level, the effect of GDP per capita appears substantially weakened.

Table 2: Estimated incidence rate ratio (and 95% confidence interval) of the expected ideal number of children, for childless women (15-49) in 34 SSA countries

	(1)		(2)		(3)		(4)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Individual Level								
Woman's education								
None (reference)	1.00		1.00				1.00	
Incomplete primary	0.90	0.89-0.91	0.93	0.92-0.94			0.93	0.93-0.94
Completed primary	0.84	0.83-0.84	0.90	0.89-0.91			0.90	0.89-0.91
Incomplete secondary	0.78	0.77-0.79	0.85	0.84-0.86			0.86	0.85-0.87
Completed secondary or more	0.70	0.69-0.71	0.78	0.77-0.79			0.80	0.79-0.81
Quantile of wealth index								
Poorest (reference)	1.00				1.00		1.00	
Poorer (q2)	0.94	0.93-0.95			0.96	0.95-0.97	0.97	0.96-0.98
Middle (q3)	0.90	0.89-0.91			0.94	0.93-0.95	0.96	0.96-0.97
Richer (q4)	0.84	0.84-0.85			0.92	0.91-0.93	0.95	0.94-0.96
Richest (q5)	0.75	0.74-0.76			0.85	0.84-0.86	0.92	0.91-0.93
Area of residence								
Urban (reference)	1.00							
rural	1.20	1.29-1.21						
Community Level								
MYS among women 15-49								
[0-3.2)(reference)	1.00		1.00				1.00	
[3.2,6.4)	0.80	0.79-0.80	0.85	0.84-0.85			0.89	0.88-0.90
6.4 or more	0.66	0.65-0.67	0.74	0.74-0.75			0.82	0.81-0.84
Mean wealth index quantile score								
Poor [0-2.4)(reference)	1.00				1.00		1.00	
Medium (2.4-3.64)	0.87	0.86-0.87			0.90	0.89-0.90	0.94	0.93-0.95
Rich (3.64-5)	0.74	0.73-0.74			0.81	0.80-0.82	0.92	0.90-0.93

	(1)		(2)		(3)		(4)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Country Level								
Percent of adult (20-64) population with lower secondary education or more (natural log)	0.84	0.74-0.96	0.94	0.84-1.05			0.91	0.80-1.04
GDP per capita (PPP 2011 $)(natural log)	0.93	0.84-1.02			0.92	0.84-1.02	1.00	0.91-1.09
Family planning effort index (natural log)	0.84	0.68-1.04						
Sub-region								
Middle and West Africa (reference)	1.00							
Eastern Africa	0.77	0.68-0.89						
Southern Africa	0.51	0.43-0.64						
Age of woman								
15-19 (reference)			1.00		1.00		1.00	
20-24			1.05	1.04-1.06	1.05	1.04-1.06	1.05	1.04-1.06
25-29			1.11	1.10-1.12	1.14	1.13-1.15	1.12	1.10-1.12
30-34			1.17	1.16-1.19	1.21	1.20-1.22	1.18	1.16-1.19
35-39			1.23	1.22-1.25	1.27	1.26-1.29	1.24	1.22-1.25
40-44			1.28	1.27-1.30	1.23	1.32-1.35	1.29	1.27-1.30
45-49			1.34	1.32-1.35	1.40	1.38-1.41	1.34	1.32-1.35
Random Effects			**MRR**		**MRR**		**MRR**	
Level 3 (Country)			1.23		1.30		1.23	
Level 2 (Cluster)			1.13		1.15		1.13	
No. of countries	34		34		34		34	
No. of clusters	17,871		17,871		17,871		17,871	
No. of Women	119,392		119,392		119,392		119,392	

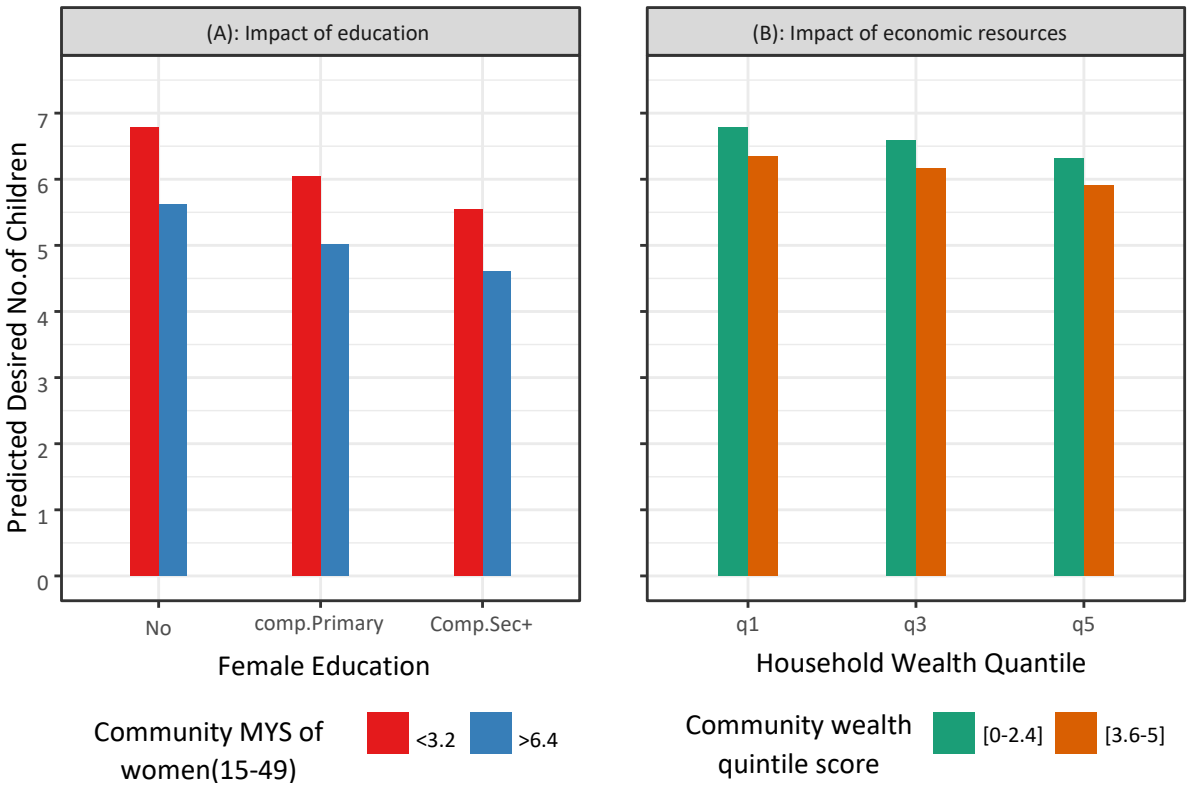
Note: IRR-Incidence Rate Ratio; MRR=Median Rate Ratio

On the other hand, the effect of female education remains strong and statically significant. The incidence rate for women with at least completed primary education is 15 percent lower than for those with no formal education. More strikingly even, at the community-level women from the most educated communities are estimated to report an 18 percent lower desired number of children compared to women from the least educated communities. The effect of the country-level education variable remains statistically insignificant. Results for the median rate ratio reported at the bottom of the table indicate a fairly higher level of unobserved heterogeneity at the country-level rather than at the community-level. This suggests that unobserved or unmeasured factors at the country level that are affecting women's fertility desires have a stronger impact compared to those at the community level .

Figure 3 shows the predicted desired number of children for different combination of education and economic resources based on the mutually adjusted Model 4 (Table 2). Panel A shows the simulation of different combinations of assumptions for education on the individual and community level for women from the lowest wealth quintile (q1), living in the poorest communities of a country with per capita GDP of only $700, and only 5 percent of the population (20-64) have lower secondary education or more. Under these circumstances, increasing education at the individual-level leads to a sizable drop in the desired number of children. In a community where women on average have less than 3.2 years of education, lifting a woman from no formal education to completed secondary education keeping all else constant would reduce her desired number of children by about 18 percent (from 6.78 to 5.5 children per woman). In a highly educated community where women have more than 6.4 MYS, the same hypothetical experiment would reduce desired fertility from 5.62 to 4.6 children. On the other hand, the impact of acquiring economic resources on fertility desires of the most disadvantaged women is minimal. As displayed in panel B, for women with no formal education and living in poorly educated community, increasing household wealth, from the poorest quintile (q1) to the highest (q5) quintile would result in only a minor drop in the desired number of children-from about 6.78 to 6.31.

The simulation results reveal the relatively stronger impact of education than economic resources at the community level too. For example, moving a woman with no formal education from a low educated community to a high-educated community would reduce her fertility preference by about 17 percent (from 6.78 to 5.62). In contrast, panel-B showed that the benefit of lifting from a poorest community to the richest (mean wealth quintile above 3.6) would lead only to minor changes in the desired number of children: from 6.78 to 6.34 for the poorest woman (q1) and from 6.31 to 5.9 for the richest women (q5).

Figure 3: Simulations of desired fertility under different education and economic resources scenario[1]



4.1. Comparing Effect of Education and Area of Residence

Extensive evidence from developing countries suggests that urban dwellers tend to aim for smaller family sizes compared to people living in rural areas (Eloundou-Enyegue and Giroux 2012). The main reasons are the higher financial cost of supporting a child in the city, the lack of available living space, the reduced demand for labor outside an agrarian context as well as higher exposure of urban economies to negative consequences of economic downturns. However, the strength of the effect of area of residence, and whether it is linked to differences in other socio-economic developments such as education and income is less clear. Consistent with previous studies, we find a strong bi-variate association between place of residence and fertility desires; relative to urban residents, the incidence rate for rural residents is about 22 percent higher. As shown in model 5 of Table 3, this effect disappears almost entirely and becomes statistically insignificant once we

[1] It is simulated for hypothetical a country with GDP/capita (PPP) of $700, and only 5 percent of adult population has secondary education. Panel-A is calculated for economically most disadvantaged women who lived in the poorest household (q1) and low economic resource community. Panel-B, on the other hand, is calculated for women with no formal education who reside in a low educated community.

Table 3: Estimated incidence rate ratio (and 95% confidence interval) of the expected ideal number of children, for childless women (15-49) in 34 SSA countries

	(5)		(6)		(7)		(8)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Individual Level								
Woman's education								
None (reference)	1.00		1.00		1.00		1.00	
Incomplete primary	0.93	0.92-0.94	0.93	0.92-0.94	0.93	0.92-0.94	0.93	0.92-0.94
Completed primary	0.90	0.89-0.91	0.90	0.89-0.91	0.90	0.89-0.91	0.90	0.89-0.91
Incomplete secondary	0.85	0.84-0.86	0.86	0.85-0.87	0.86	0.85-0.87	0.86	0.85-0.87
Completed secondary or more	0.78	0.77-0.79	0.80	0.79-0.81	0.80	0.79-0.81	0.80	0.79-0.81
Quantile of wealth index								
Poorest (reference)			1.00		1.00		1.00	
Poorer (q2)			0.97	0.96-0.98	0.97	0.96-0.98	0.97	0.96-0.98
Middle (q3)			0.96	0.96-0.98	0.96	0.96-0.98	0.96	0.96-0.98
Richer (q4)			0.95	0.94-0.96	0.95	0.94-0.96	0.95	0.94-0.96
Richest (q5)			0.92	0.91-0.93	0.92	0.91-0.93	0.92	0.91-0.93
Area of residence								
Urban (reference)	1.00		1.00		1.00		1.00	
Rural	1.05	1.04-1.06	1.00	0.99-1.01	1.00	0.99-1.01	1.00	0.99-1.01
Community Level								
MYS among women 15-49								
[0-3.2) (reference)	1.00		1.00		1.00		1.00	
[3.2,6.4)	0.86	0.86-0.88	0.89	0.89-0.90	0.89	0.88-0.90	0.89	0.88-0.90
6.4 or more	0.77	0.76-0.78	0.81	0.80-0.83	0.82	0.81-0.84	0.81	0.80-0.82
Mean wealth index quantile score								
Poor [0-2.4) (reference)			1.00		1.00		1.00	
Medium (2.4-3.64)			0.94	0.93-0.95	0.94	0.93-0.95	0.94	0.93-0.95
Rich (3.64,5)			0.92	0.90-0.93	0.92	0.90-0.93	0.91	0.90-0.93

	(5)		(6)		(7)		(8)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Country Level								
Percent of adult (15-64) population with lower secondary education or more (natural log)	0.93	0.81-1.07	0.92	0.81-1.05	0.97	0.88-1.07	0.96	0.87-1.06
GDP per capita (PPP 2011 $)(natural log)			1.00	0.91-1.09	1.00	0.91-1.09	1.02	0.91-1.13
Family planning effort score (natural log)							0.97	0.81-1.17
Sub-region								
Middle and West Africa (reference)					1.00		1.00	
Eastern Africa					0.84	0.74-0.94	0.83	0.73-0.93
Southern Africa					0.58	0.48-0.69	0.58	0.46-0.72
Age of woman								
15-19 (reference)	1.00		1.00		1.00		1.00	
20-24	1.05	1.04-1.06	1.05	1.04-1.06	1.05	1.04-1.06	1.05	1.04-1.06
25-29	1.11	1.10-1.12	1.12	1.11-1.13	1.14	1.13-1.15	1.12	1.10-1.12
30-34	1.17	1.16-1.19	1.18	1.16-1.19	1.21	1.20-1.22	1.18	1.16-1.19
35-39	1.23	1.22-1.25	1.24	1.22-1.25	1.27	1.26-1.29	1.24	1.22-1.25
40-44	1.28	1.27-1.30	1.29	1.27-1.30	1.23	1.32-1.35	1.29	1.27-1.30
45-49	1.34	1.32-1.35	1.34	1.32-1.35	1.40	1.38-1.41	1.34	1.32-1.35
Random Effects	**MRR**		**MRR**		**MRR**		**MRR**	
Level 3 (Country)	1.23		1.23		1.15		1.15	
Level 2 (Cluster)	1.12		1.13		1.12		1.11	
No. of countries	34		34		34		34	
No. of clusters	17,871		17,871		17,871		17,871	
No. of Women	119,392		119,392		119,392		119,392	

Note: IRR-Incidence Rate Ratio; MRR=Median Rate Ratio

control for the various effects of education. Model 6 extends model 5 by adding indicators of economic resources but the effect of education remains unchanged, while the coefficient for area of residence shows a small reduction reflecting the lower economic resources of rural residents compared to urban residents. High levels of reported desired fertility in the rural parts of SSA are thus mainly a consequence of low levels of educational attainment among the people that live there.

In line with previous studies, our results presented in Model 7 confirm large variation in fertility desires across the larger sub-regions within SSA. Though it could partly derive from regional differences in socio-economic development, our multi-level results suggest that after controlling for education, income and rural residence, people in central and western African countries have higher fertility preferences compared to women from eastern and southern African countries: about 16 percent and 42 percent higher, respectively. This confirms the exceptionally high prevalence of pro-natalist attitudes associated with cultural norms that supported child bearing in central and western African countries (May 2012). The reduction in the country median rate ratio associated with the inclusion of sub-regional dummies also indicates the considerable impact of region-specific unobserved factors determining fertility desires in SSA.

Bongaarts (2011) attributes the high levels of desired fertility in SSA to the relative weakness of family planning programs in the region. The supposed channels through which family planning efforts determined differences across countries in the speed of fertility decline could correlate with education. Therefore, in Model 8 (Table 3) we further control for country-level variation in the intensity of family planning efforts. However, the effect of family planning efforts as measured by the FPE index turns out to be small and insignificant, while the effects of education, at both individual and the community-levels remains strong and unchanged. On the other hand, the inclusion of family planning reduces the effect of per capita GDP.

4.2. Sensitivity Analysis: Measurement Issues

As described earlier, the ideal number of children is not an ideal indicator of fertility preferences. DHS provides information on a number of alternative measures, such as women's desire to have another child; the length of time a woman would like to wait before having another child (in case she already had one); and whether the most recent birth has been wanted or not. Casterline and El-Zeini (2007) suggest that 'desire for another child' is indeed the most valid and reliable indicator of fertility preferences. The related question posed to women in DHS reads: "*Would you like to have another child, or would you prefer not to have any more children?*" Although answers to this question do not provide a quantitative measure of the intensity of women's fertility desires, tabulating them by parity can give an insight into women's desires to stop childbearing once a target number has been achieved in the spirit of 'family limitation' mentalities (Casterline and Agyei-Mensah 2017).

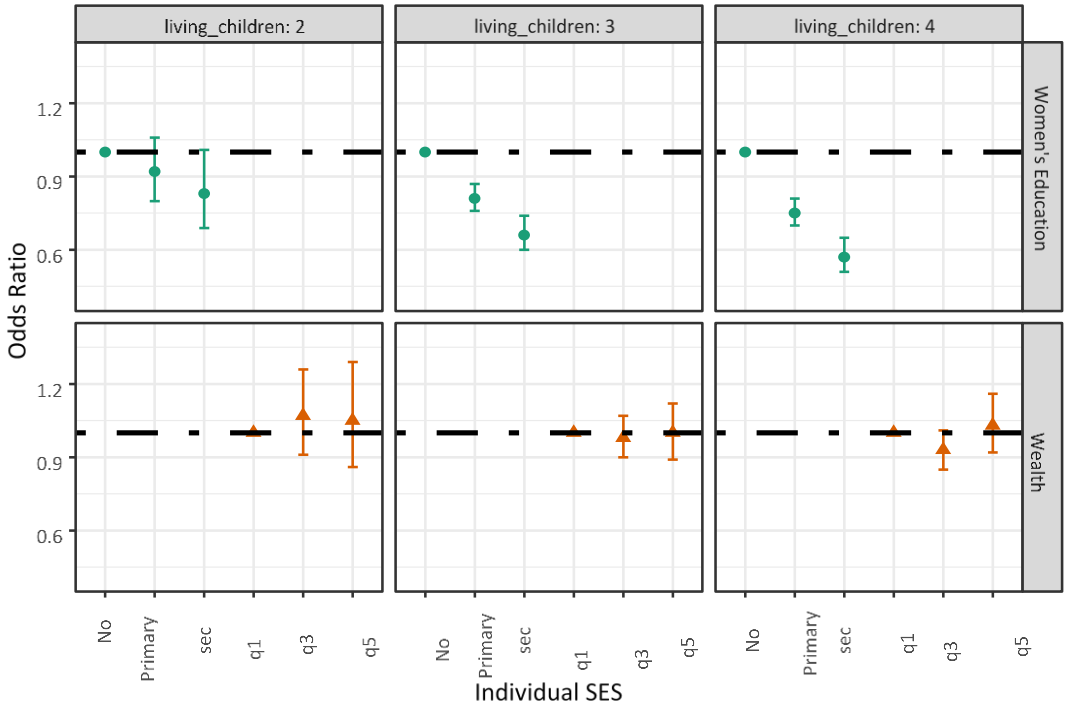
Thus, in order to see if our results hold with an alternative indicator of fertility preferences, we re-specify our original model (equation 1) using desire for another child as the dependent variable. Since the desire to have another child will heavily depend on the number of children a woman already has, we estimate this new specification described by equation 2 separately for different sub-samples of women at different parity levels N. This also helps avoid the potential bias induced through ex-post rationalization in the case of ideal number of children.

$$\text{logit}(Y_{N,i,k,c}) = \alpha + \beta 1 age_{i,k,c} + \beta 2 Educ_{i,k,c} + \beta 3 Wealth_{i,k,c} + \beta 4 rural_{i,k,c} + X^{a}{}_{i,k,c} + X^{b}{}_{i,k,c} + \mu k + \mu c \quad (2)$$

$$where\ \mu k \sim N(0, \sigma 2);\ \mu c \sim N(0, \sigma 2);\ Number\ of\ living\ children\ N = 1,2,3,4$$

The outcome variable $Y_{N,i,k,c}$ measures whether a woman i with N surviving children wants an additional child or not. The explanatory variable $age_{i,k,c}$ divides women into categorical 5-year age groups depending on their age at the time of the survey, whereas $educ_{i,k,c}$ stands for individual educational status, $wealth_{i,k,c}$ is the household wealth quantile, and $rural_{i,k,c}$ controls for a woman's area of residence (urban/rural). The community- and country-level controls remain unchanged.

Figure 4: Estimated odds ratios (and 95 percent confidence intervals) for the likelihood of wanting additional child by parity associated with increasing women's education and household wealth, for women aged 15-49 in 34 SSA countries

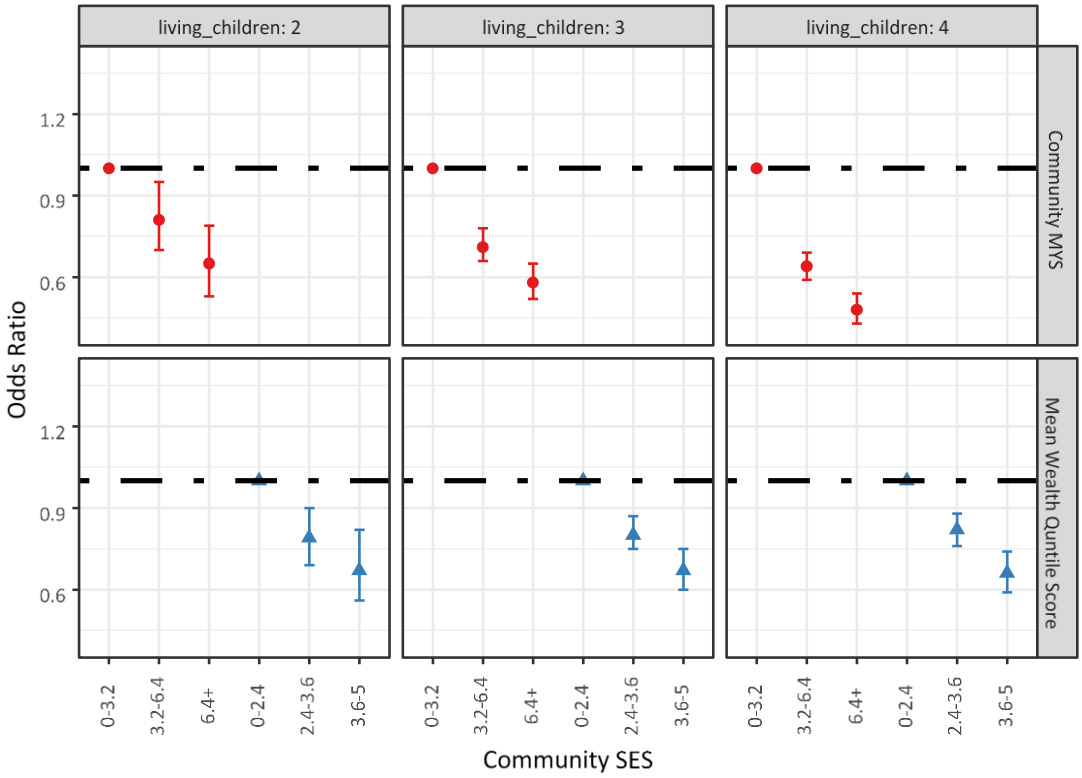


Appendix Table A4 reports the estimated odds ratios and the associated 95 percent confidence intervals for the likelihood of wanting another child by women's parity level from the logistic regressions specified in equation 2. Consistent with the multi-level Poisson model results, the importance of area of residence in predicting fertility desires remains low in the logistic regression: Disregarding the number of living children, the odds of wanting another child for rural residents are not significantly different from those of their urban counterparts. At the country-level, though insignificant, the proportion of adult population with lower secondary education or more is negatively associated with women's desire for an additional child at all parity levels, whereas per capita GDP is negatively associated with the desire to stop childbearing.

Figure 4 compares the effect of increasing female education and household wealth on fertility preferences for women with two, three and four living children estimated in three separate model runs. Irrespective of parity, the odds of wanting another child drop significantly with increasing education and the impact of female education is estimated to be higher at higher parties. Relative to those women with no formal education, the likelihood of wanting another child by women with completed secondary education or more is lower by 17 percent at parity two, by 34 percent at parity three, and by 43 percent at parity four. The larger drop in the odds of wanting another child for women with higher educational status could reflect a stronger 'family limitation' mentality among better-educated groups of women. Household wealth quintiles, on the other hand, do not appear to be related to desires to have another child in any statistically significant way. Disregarding parity, the preference for an additional child among women from the lowest wealth quintile score (q1) is not significantly different from the preferences of women in the

highest wealth quintile (q5). These results confirm our conclusions drawn from the Poisson models where female education is found to be a stronger predictor of ideal number of children than household wealth.

Figure 5: Estimated odds ratios (and 95 percent confidence intervals) for the likelihood of wanting additional child by parity associated with increasing Community MYS and community wealth quantile scores, for women aged 15-49 in 34 SSA countries



The relative effect of community education vs. community wealth quantile score is also examined in Figure 5. For women with only two living children, the odds of wanting another child by those residing in the least educated communities is about 20 percent higher than those from a community where the MYS of women of reproductive age is between 3.2 and 6.4 years, and about 35 percent higher than those from highly educated communities (MYS>6.4 years). Moreover, the drop in the odds associated with each higher level of community-level education markedly increase with parity, suggesting less desire for further children within better educated communities. Similarly, the odds of wanting another child substantially drop with the community mean wealth quantile score at each parity. However, the decline in the odds ratio with higher level of community wealth does not get stronger with the number of living children

5. Discussion and Conclusion

The originality of this research lies in its analysis of the relative effect of education and economic resources on women's fertility desires at individual, community, and country level. Using DHS data for 34 SSA countries, we show that both individual and community levels of education have a significant dampening impact on woman's fertility desires. In this, it confirms the findings of Kravdal (2002) and Colleran & Snopkowski (2018) that are showing similar results in relation to actual fertility. Comparing the relative effect of education and economic resources, we found that education at all levels has a stronger effect compared to economic wealth, while the effect of both is statistically significant at individual and community level. However, when we include both variables at all levels in a model, the importance of economic resources is reduced, not so much at the individual level, but at the more aggregate level, i.e. community level. At the same time, the effect of education proves to be relatively robust, also when we control for place of residence and when we test other measures of fertility intentions based on parity. In fact, this result is not surprising and summarized plenty of literature that has looked at the relationship and causal link between fertility and women's level of educational attainment (Bongaarts 2010, Jejeebhoy 1995, Gustafsson 2001, Kravdal 2002).

On the other hand, why education is more influential in determining fertility intentions than other contextual parameters such as wealth and place of residence has not been very much researched in the SSA context. Several studies have shown that the association between wealth and fertility (realization in most cases) differs significantly by settings, but is usually positive at very high levels of fertility (Colleran and Snopkowski 2018; Skirbekk 2008). From an evolutionary perspective, it has been shown that the abundance of resources lead to an increase in output, also in terms of fertility, within small-scaled, pre-transition economies (Kaplan 1996). However, this would mean that high-income countries would experience the highest fertility of all, which is not the case. Obviously, there is a turning point when the effect size of wealth on fertility becomes negative. On this aspect, it is interesting to turn back to the wealth flows theory of (Caldwell 1976) on intergenerational transfers that postulates that in pre-transitional primitive traditional societies, the net flows of resources are from children to parents and thereafter in transitional societies the flows reverse, from parents to children, therefore leading to investments in the children accompanied by a more limited number of off-springs per family. This theory has been widely disputed, for instance criticizing the measurement of flows of (Kaplan 1994). Caldwell stresses the factors affecting the demand for children that are the results of social changes that concentrate greater family concern on the children. This theory that stresses the factors affecting the demand for children is very close to the early work on the demographic transition of (Notestein 1945), who hypothesized that social and economic development would bring fertility down by changing parents' aspirations and the role of children.

In a transitional society, at which stage are most of the SSA countries in our sample, the spread of mass education will influence culture, norms and modes of behavior. In this setting, the existence of substantial group differences in fertility intentions can be expected

since those segments of the population most exposed to new ideas, by reason of their education or geographical location, will form the vanguard of change, while others less exposed to education will most likely pursue more traditional fertility patterns. In that sense, the importance of wealth can have a mixed effect that could be one explanatory factor between the lack of correlation with fertility intentions and realization.

What we have demonstrated also here is that education at the community level has an effect on a woman's fertility intentions above and beyond that of her own education, paraphrasing Kravdal 2002. There again the predominant effect of community education relatively to community wealth and place of residence could be explained by the "spill-over" from other people's education that so that for instance uneducated women living in an educated society could pursue a different fertility career compared to uneducated women living in an uneducated society. It could also mean that neighboring populations are more homogenous in terms of wealth than they are in terms of education especially in transitional societies, or that the mixed effects observed at the individual level accumulate at the community level and provide less clear reproductive cues than education would.

From a policy point of view, the fact that education is more determinant for the reduction of fertility intentions is rather good news because education is usually a state direct investment and wealth more of an outcome from different elements, directly or indirectly or not at all influence by state policy.

Education as a dominant factor affecting desired fertility in SSA, and in turn, the actual fertility has clear implications: Changes in women's level of education on the sub-continent will be important to accelerate the fertility transition. The speed of these changes will strongly influence population growth in the mid- to long-term. While the momentum of population growth guarantees further large increase at least until the middle of the century, the sub-continent could show very different fertility feature thereafter depending on the educational investments that will be made.

This article has some limitations that are in part inherent to the data that we are using. The indicator chosen to evaluate family planning services in each country, i.e. FPE index does not show much variation across countries and was mainly chosen because of the lack of other supply indicators for all sample countries. A second limitation is that we are using cross-sectional data and cannot infer the causal relation between a change in any of the independent variables and the desired number of children. We have limited the number of variables as not to complicate the analysis but as a result may have occulted some variables that could be of importance such as women's labor force participation and level of autonomy, the survival of infant and children. This could be the input for further work, that could also look at how the relationship will evolve in the African context as those countries move slowly to the later stage of the demographic transition.

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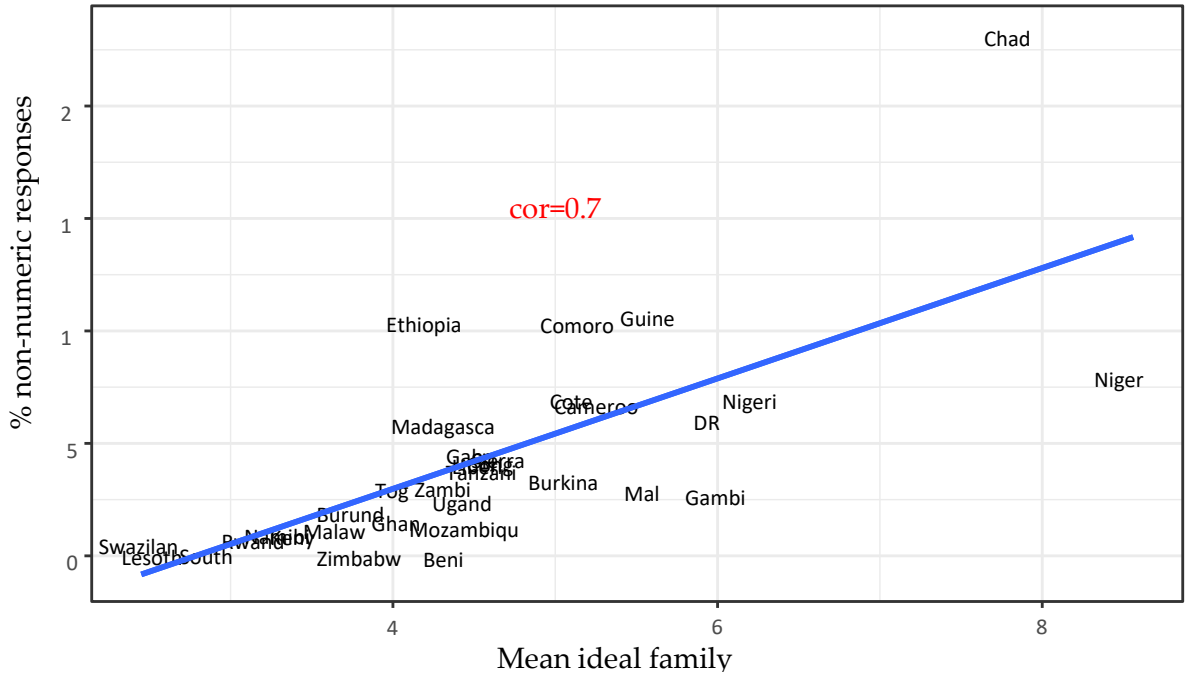
Appendix

Appendix Table A.1. Variable definition and data sources

Variable	Definition	Source
Age	Age of woman at the time of the survey in five years interval(15-19,20-24,…..45-49)	DHS
Women's education	highest years of schooling: No formal education, incomplete primary, completed primary, incomplete secondary, and completed secondary or more	DHS
Household Wealth	Wealth quantile score of the household (q1,q2,…q5)	DHS
Area of residence	Area of residence(urban or rural) of sampled woman	DHS
Community education	Mean years of schooling of reproductive age women with in the cluster: low (<=3.2(low), more than 3.2, but less than 6.2 years (medium), and >=6(high)	DHS
Community wealth	Categorical indicator of relative wealth (poor, medium, rich) of the community is constructed from the mean of wealth quintile scores for all households within the cluster	DHS
Country education	Percent of adult(20-64) population with lower secondary education or more(natural log)	WIC
National Income	GDP per capita(PPP 2011 $)(natural log)	WB/WDI(2017)
FPEI	Family planning effort score(natural log)	Kuang and Brodsky (2016)
Sub-region	Regional location of the country: Central and western Africa, Eastern Africa, and Southern Africa	United Nations 2017 WPP

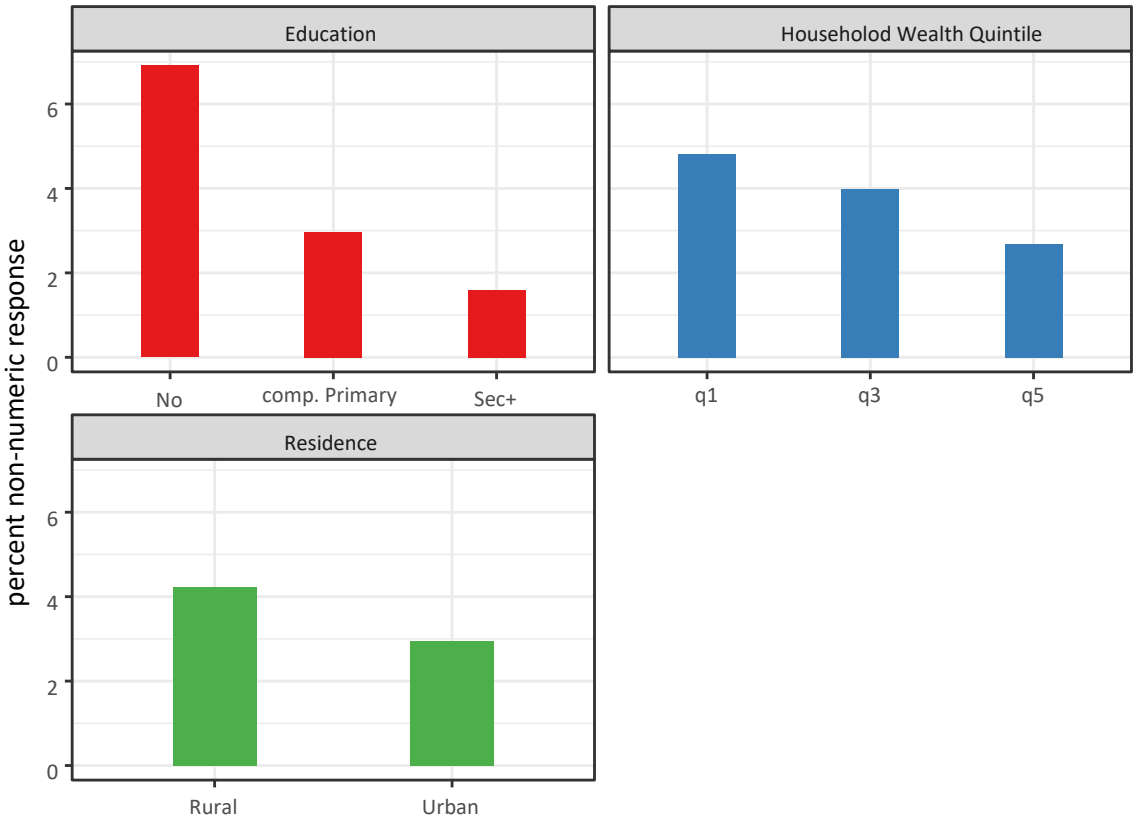
Appendix Figure A.1.: Proportion of women providing non-numeric responses to ideal family size questions vs mean ideal number of children from the most recent DHS of 34 SSA countries



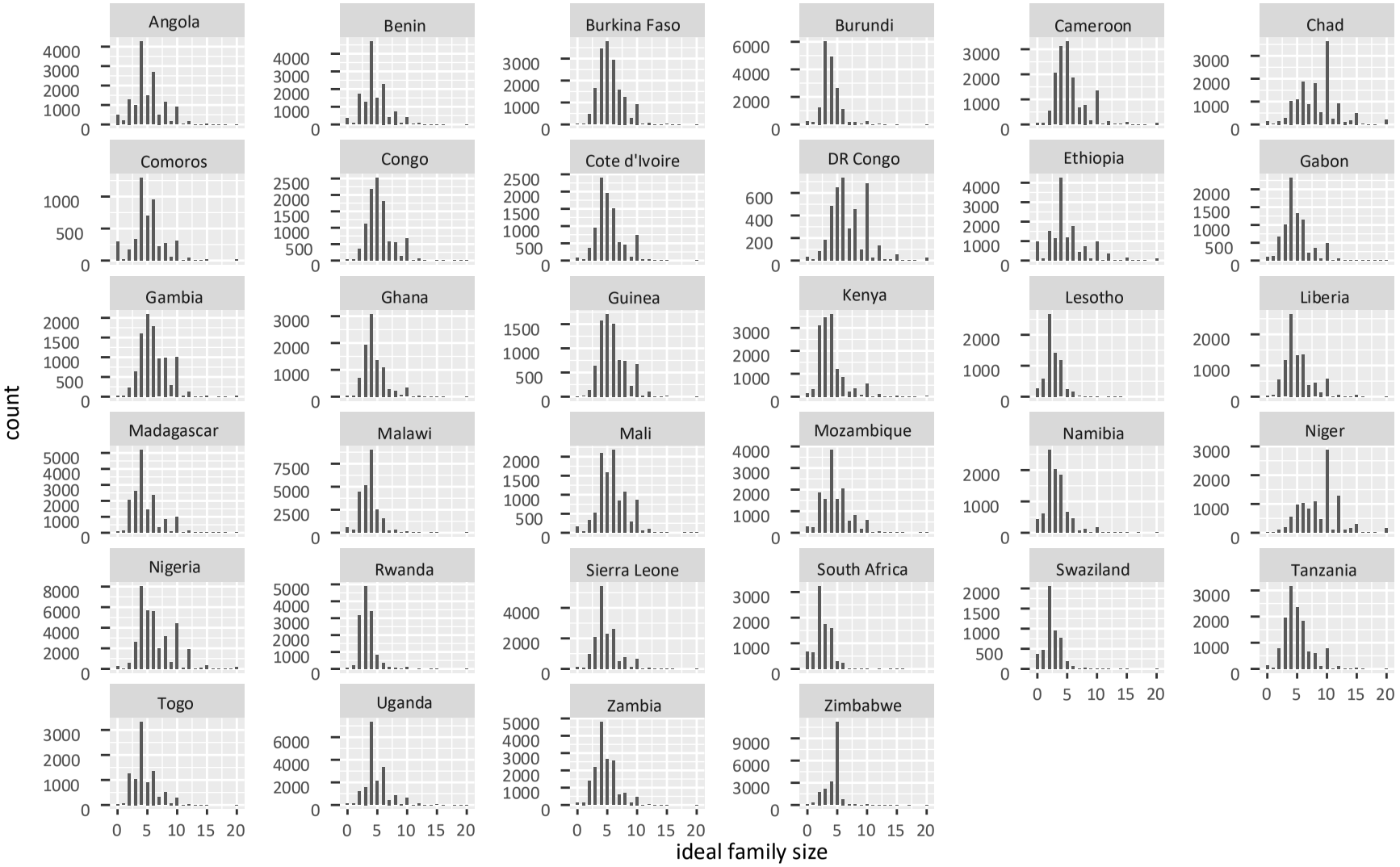
Appendix Table A.2: Percentage of women providing a non-numeric response to question of ideal family size by survey phase in 34 SSA countries

Country	DHS-I	DHS-II	DHS-III	DHS-IV	DHS-V	DHS-VI	DHS-VII
Angola	-	-	-	-	-	-	
Burkina Faso	-	24.8	20.9	5	-	3.5	-
Benin	-	-	4.9	10.2	7.2	0.2	-
Burundi	10.1	-	-	-	-	5	2.2
DR Congo	-	-	-	-	-	6.1	-
Cameroon	-	9.8	15	14.5	-	7	-
Chad	-	-	2.2	12.1	-	23	-
Comoros	-	-	7	-	-	10.5	-
Congo	-	-	-	-	11.6	4.2	-
Cote d'Ivoire	-	-	2.4	-	-	7.1	-
Ethiopia	-	-	-	18	10.4	10.6	10.7
Gabon	-	-	-	9.7	-	4.7	-
Gambia	-	-	-	-	-	2.9	-
Ghana	12.8	-	7.3	7.2	1.6	-	1.7
Guinea	-	-	-	4.1	10.4	11	-
Kenya	5.3	-	5.7	5.3	3.2	-	1
Lesotho	-	-	-	0.3	-	0.2	0.2
Liberia	24.4	-	-	-	6.3	4.2	-
Madagascar	-	6.5	4.7	9	5.9	-	-
Malawi	-	13.2	-	3.4	-	2.1	1.3
Mali	25.1	-	10.5	24.4	17.1	3.1	-
Mozambique	-	-	14.8	1.6	-	0.9	-
Namibia	-	8.1	-	4.1	0.9	1.2	-
Niger	-	13.8	23.8	-	15.3	7.4	-
Nigeria	-	60.8	-	10.6	13.2	7.3	-
Rwanda	-	1.3	-	3.1	3.7	1.1	0.9
Sierra Leone	-	-	-	-	5.4	4.9	-
South Africa	-	-	0.7	-	-	-	-
Swaziland	-	-	-	-	0.7	-	-
Tanzania	-	13.5	7.9	1.8	1.9	-	4
Togo	0.4	-	8.4	-	-	2.6	-
Uganda	8.5	-	6.6	4.3	3.6	2.7	2.4
Zambia	-	6	2.4	-	6.4	6	-
Zimbabwe	7.3	-	0.7	-	1.2	0.9	0.3

Appendix Figure A.2: Proportion of women providing non-numeric responses to ideal family size questions by socio-economic status, from the most recent DHS of 34 SSA countries



Appendix Figure A.3: Distribution of stated women's ideal number of children from the most recent DHS of 34 SSA countries



Appendix Table A.3 : Estimated incidence rate ratio (and 95% confidence interval) of the expected women's ideal number of children, by birth parity in 34 SSA countries

	Number of Living Children							
	Childless		1-2		2-3		4+	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Individual Level								
Women's education								
None(reference)	1.00		1.00		1.00		1.00	
Incomplete Primary	0.93	0.92-0.94	0.92	0.91-0.93	0.92	0.91-0.93	0.93	0.92-0.94
Completed Primary	0.90	0.89-0.91	0.89	0.88-0.90	0.88	0.87-0.89	0.90	0.89-0.91
Incomplete Secondary	0.86	0.85-0.87	0.85	0.84-0.86	0.84	0.83-0.85	0.86	0.85-0.87
Completed Secondary or more	0.80	0.79-0.81	0.79	0.79-0.80	0.78	0.77-0.80	0.78	0.77-0.80
Quantile of wealth index								
Poorest(reference)	1.00		1.00		1.00		1.00	
Poorer(q2)	0.97	0.96-0.98	0.97	0.96-0.97	0.97	0.96-0.98	0.97	0.96-0.98
Middle(q3)	0.96	0.96-0.98	0.96	0.95-0.97	0.96	0.95-0.97	0.97	0.96-0.98
Richer(q4)	0.95	0.94-0.96	0.95	0.94-0.96	0.95	0.94-0.96	0.95	0.94-0.96
Richest(q5)	0.92	0.91-0.93	0.92	0.90-0.93	0.91	0.90-0.93	0.92	0.91-0.94
Area of residence								
urban(reference)	1.00		1.00		1.00		1.00	
rural	1.00	0.99-1.01	0.99	0.98-1.00	1.00	0.99-1.01	1.00	0.99-1.01
Community Level								
MYS among women 15-49								
[0-3.2)(reference)	1.00		1.00		1.00		1.00	
[3.2,6.4)	0.89	0.88-0.90	0.89	0.88-0.90	0.89	0.88-0.90	0.89	0.88-0.90
6.4 or more	0.81	0.80-0.82	0.81	0.80-0.82	0.81	0.80-0.82	0.80	0.79-0.81
Mean wealth index quantile score								
poor[0-2.4)(reference)	1.00		1.00		1.00		1.00	
Medium(2.4-3.64)	0.94	0.93-0.95	0.95	0.94-0.95	0.94	0.93-0.95	0.95	0.94-0.96
Rich([3.64,5]	0.91	0.90-0.93	0.92	0.91-0.94	0.93	0.91-0.94	0.94	0.92-0.95

	Number of Living Children							
	Childless		1-2		2-3		4+	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Country Level								
Percent of adult(20-64) population with lower secondary education or more(natural log)	0.96	0.87-1.06	0.96	0.87-1.06	0.96	0.87-1.06	0.96	0.87-1.06
GDP per capita(PPP 2011 $)(natural log)	1.02	0.91-1.13	1.02	0.91-1.13	1.02	0.91-1.13	1.02	0.91-1.13
Family planning effort score(natural log)	0.97	0.81-1.17	0.98	0.82-1.17	0.98	0.82-1.18	1.00	0.83-1.20
Sub-region								
Middle and West Africa (reference)	1.00		1.00		1.00		1.00	
Eastern Africa	0.83	0.73-0.93	0.83	0.73-0.93	0.83	0.73-0.93	0.82	0.72-0.93
Southern Africa	0.58	0.46-0.72	0.59	0.47-0.73	0.58	0.46-0.72	0.58	0.46-0.72
Age of woman								
15-19 (reference)	1.00		1.00		1.00		1.00	
20-24	1.05	1.04-1.06	1.05	1.04-1.06	1.05	1.04-1.06	1.05	1.04-1.06
25-29	1.12	1.10-1.12	1.12	1.10-1.12	1.10	1.09-1.12	1.12	1.10-1.12
30-34	1.18	1.16-1.19	1.18	1.16-1.19	1.18	1.16-1.19	1.18	1.16-1.19
35-39	1.24	1.22-1.25	1.24	1.22-1.25	1.24	1.22-1.25	1.24	1.22-1.25
40-44	1.29	1.27-1.30	1.31	1.29-1.32	1.28	1.27-1.30	1.28	1.26-1.30
45-49	1.34	1.32-1.35	1.36	1.35-1.38	1.34	1.33-1.36	1.33	1.31-1.35
Random Effects	**MRR**		**MRR**		**MRR**		**MRR**	
Level 3 (Country)	1.15		1.15		1.15		1.15	
Level 2 (Cluster)	1.11		1.11		1.11		1.11	
No. of countries	31		31		31		31	
No. of clusters	17,871		16,803		16,545		15,643	
No. of Women	119,392		122,399		92,802		79,199	

Note: IRR-Incidence Rate Ratio; MRR=Median Rate Ratio

Appendix Table A.4: Estimated odds ratio (and 95% confidence interval) for the likelihood of wanting additional child, for women aged 15-49 who are currently in union, in 34 SSA countries by the number of living children

	Number of living children							
	(1)		(2)		(3)		(4)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual Level								
Women's education								
None(reference)	1.00		1.00		1.00		1.00	
Primary	1.00	0.87-1.16	0.92	0.80-1.06	0.81	0.76-0.87	0.75	0.70-0.81
Incomplete Secondary	0.99	0.84-1.16	0.84	0.72-0.98	0.71	0.65-0.78	0.63	0.58-0.69
Completed Secondary or more	1.15	0.95-1.39	0.83	0.69-1.01	0.66	0.60-0.74	0.57	0.51-0.65
Quantile of wealth index								
Poorest(reference)	1.00		1.00		1.00		1.00	
Poorer(q2)	1.13	0.98-1.30	0.99	0.85-1.14	0.94	0.87-1.02	0.92	0.85-0.99
Middle(q3)	1.30	1.11-1.53	1.07	0.91-1.26	0.98	0.90-1.07	0.93	0.85-1.01
Richer(q4)	1.46	1.23-1.75	1.16	0.97-1.38	1.05	0.95-1.16	0.99	0.90-1.08
Richest(q5)	1.34	1.10-1.64	1.05	0.86-1.29	1.00	0.89-1.12	1.03	0.92-1.16
Community Level								
MYS among women 15-49								
[0-3.2)(reference)	1.00		1.00		1.00		1.00	
[3.2,6.4)	0.78	0.66-0.91	0.81	0.70-0.95	0.71	0.66-0.78	0.64	0.59-0.69
6.4 or more	0.64	0.53-0.78	0.65	0.53-0.79	0.58	0.52-0.65	0.48	0.43-0.54
Mean wealth index quantile score								
poor[0-2.4)(reference)	1.00		1.00		1.00		1.00	
Medium(2.4-3.64)	0.72	0.63-0.82	0.79	0.69-0.90	0.80	0.75-0.87	0.82	0.76-0.88
Rich([3.64,5]	0.67	0.55-0.81	0.67	0.56-0.82	0.67	0.60-0.75	0.66	0.59-0.74

	Number of living children							
	(1)		(2)		(3)		(4)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Country Level								
Percent of adult(20-64) population with completed secondary education or more(natural log)	0.44	0.20-0.97	0.48	0.22-1.05	0.64	0.32-1.28	0.65	0.34-1.25
GDP per capita(PPP 2011 $)(natural log)	1.03	0.68-1.55	1.09	0.72-0.64	1.12	0.77-1.61	1.14	0.81-1.61
Area of residence								
urban(reference)	1.00		1.00		1.00		1.00	
rural	1.10	0.97-1.25	1.09	0.95-1.24	1.07	1.00-1.16	1.01	0.93-1.09
Sub-region								
Middle and West Africa (reference)								
Eastern Africa								
Southern Africa								
Women's Age								
15-19 (reference)	1.00		1.00		1.00		1.00	
20-24	1.24	0.98-0.99	1.22	1.07-1.38	1.21	0.80-1.83	0.39	0.04-3.24
25-29	1.30	1.00-1.01	1.17	1.01-1.37	1.17	0.77-1.75	0.43	0.05-3.52
30-34	1.11	1.08-1.09	0.91	0.75-1.10	0.92	0.61-1.38	0.34	0.04-2.79
35-39	0.91	0.98-0.99	0.62	0.49-0.78	0.63	0.41-0.95	0.27	0.03-2.20
40-44	0.35	1.00-1.01	0.35	0.27-0.45	0.38	0.25-0.58	0.16	0.02-1.34
45-49	0.20	1.08-1.09	0.21	0.15-0.28	0.31	0.20-0.48	0.13	0.01-1.10
Years Since First Cohabitation/Union	0.96	0.95-0.97	0.97	0.96-0.98	0.97	0.96-0.98	0.97	0.95-0.97
Random Effects	**MOR**		**MOR**		**MOR**		**MOR**	
Level 3 (Country)	2.60		2.53		2.35		2.27	
Level 2 (Cluster)	1.52		1.52		1.63		1.80	
No. of countries	34		34		34		34	

Note: OR-odds Ratio; MOR=Median Odds Ratio

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