URBANIZATION AND FERTILITY RATES IN ETHIOPIA[1]

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Abstract

Fertility rates are important determinants of both overall population growth and demographic transitions from high to low age dependency ratios, which in turn have important consequences for economic growth, poverty reduction, and improved health and nutrition outcomes. Ethiopia currently has one of the highest fertility rates in the world, although there are marked differences between rural and urban fertility rates. This paper explores the drivers of rural and urban fertility rates, including systematic tests of differences in key determinants. This further allows us to project fertility rates into the future based on alternative urbanization, economic growth, and education scenarios. Finally, we link these alternative projections with existing estimates of the benefits of fertility reductions on economic growth, nutrition, and poverty reduction

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1. Introduction

Demographic changes have long been recognized as a critical component of economic development, although there is considerable debate about whether population helps or hinders development, and whether governments can substantially alter population growth rates. With regard to the first of these debates, Malthusian arguments that population growth induces food supply constraints have been viewed with skepticism by most economists, given the possibility of population-induced technological change in both agriculture (Boserup 1965) and industry (Henderson 2010), with the latter capable of financing food imports. More recently, David Bloom and colleagues (Bloom et al. 2007; Bloom and Williamson 1998) have argued that the change in age structures matters more than population growth per se, with the transition from low to high age dependency ratios inducing higher savings rates and greater investments in education. In successful Asian countries, this demographic "window of opportunity"—chiefly induced by lower fertility rates—explains 25–40% of the region's miraculous economic growth. High population growth has also been associated with increased poverty (Eastwood and Lipton 2004) and increased malnutrition (Headey 2011). However, what is not clear is the extent to which direct population policies substantially influence fertility rates. Economists view fertility rates as a demand-led factor heavily influenced by income levels, livelihoods, and education factors. Efforts to directly influence fertility rates (through contraception family planning or more draconian measures) may therefore be less important than these indirect factors. Indeed, even in the Chinese context, the effectiveness of the country's one-child policy is heavily debated among demographers.[3]

In Ethiopia these debates are highly relevant. Although the country is undergoing rapid economic growth (albeit from a low base), Ethiopia has a long history of Malthusian population dynamics (Pankhurst 1985). In the middle ages, rapid population growth and the resultant deforestation of the population dense highland

[3] For example, Hasketh, Lu, and Xing (2005) observe: "The policy itself is probably only partially responsible for the reduction in the total fertility rate. The most dramatic decrease in the rate actually occurred before the policy was imposed. Between 1970 and 1979, the largely voluntary "late, long, few" policy, which called for later childbearing, greater spacing between children, and fewer children, had already resulted in a halving of the total fertility rate, from 5.9 to 2.9. After the one-child policy was introduced, there was a more gradual fall in the rate until 1995, and it has more or less stabilized at approximately 1.7 since then."

areas contributed to the collapse of the agricultural bases of several early empires, which eventually led to its downfall. In more recent times Ethiopia has sadly become notorious for some of the worse famines of the 20th century. And although there are large tracts of largely uninhabited land in the lowland peripheries of Ethiopia, the population-dense highlands face shrinking farm sizes and major problems of deforestation and soil degradation (Ringheim, Teller, and Sines 2009; Yusuf et al. 2005). These problems are clearly related to population growth rates that are too high relative to the local resource base and to traditional farming practices. Indeed, the total population is estimated to be growing at 2.6 percent per year, chiefly as a result of high fertility in rural areas (CSA 2008). Moreover, Demographic Health Survey (2010) data suggest that Ethiopia not only has one of the largest fertility rates in the world (at 5.4 children in 2005), the country also has the largest rural-urban fertility differential in the world: in 2005 an average rural woman can be expected to give birth to 6 children in her lifetime, relative to just 2.4 children in urban areas.

The federal government of Ethiopia clearly recognizes the importance of reducing fertility rates. A National Population Policy was initiated in 1993 when the current government took power, with the general objective of harmonizing the relationship between population dynamics and other factors that affect the country's development. The specific objectives of the policy include raising the contraceptive prevalence rate among married women from 4 percent in 1990 to 44 percent by 2015, raising the age of marriage from 15 to 18 years, and reducing the total fertility rate from 7.1 children in 1990 to 4 children in 2015. However, the most recent DHS data show achieving these targets is a remote possibility. For example, in 2005 only 15 percent of married women used either a traditional or a modern method of contraception. And despite a significant decline in mortality rates (from 217 to 123 deaths per 1000 live births between the late 1980s and 2004) the decline in fertility rates has been gradual, declining to 5.4 children in 2005 (CSA 2005).

Given the critical welfare consequences of reducing the fertility rate, this study explores the determinants of fertility rates in Ethiopia. However, unlike most previous studies (reviewed in Section 2) we systematically disaggregate explanations of fertility rates in rural and urban areas. This is important precisely because Ethiopia has unusually large rural-urban fertility differentials, but also because Ethiopia is currently one of the most under-urbanized countries in the world, and is therefore

predicted to urbanize rapidly in coming years. Our approach also allows us to rigorously test whether rural and urban fertility have different determinants using the 2005 Ethiopian Demographic and Health Survey (described in Section 3). Specifically, the econometric tests reported in Section 4 allow us to explore whether the determinants of rural and urban fertility rates are different, whether these determinants have statistically different magnitudes, and whether the rural-urban fertility differential is explained by observed factors (such as rural-urban education or wealth differences) or unobserved factors (such as the impact of urban living on attitudes). Given the various interactions between urbanization and fertility differentials—as well as economic growth and education—a second objective of this paper is to project fertility rates into the future, based on alternative urbanization and development scenarios (Section 5). This in turn allows us to re-estimate alternative age dependency paths for Ethiopia, which have consequences for important welfare objectives, such as economic growth and poverty reduction. Section 6 concludes by reviewing our main results and their implications for Ethiopia's development strategies.

2. A review of existing theories and evidence

As we noted above, the relationship between fertility and economic development has captured the interests of many economists and is still a controversial subject. In this section we aim to briefly overview economic theories of fertility, and theories of the impact of fertility rates on economic growth. The former is clearly relevant for the specification of our fertility regressions (Section 4), while the latter is pertinent for our projections of the impact of fertility on economic growth and poverty reduction.

In terms of the underlying socioeconomic determinants of fertility (as opposed to the proximate health-related determinants), economic theories of fertility have long focused rigorously separate supply and demand factors, with cultural preference (related to religion, for example) treated as exogenous. Economic theories also tended to emphasize demand side factors, as opposed to supply side constraints, such as access to contraceptives. For example, Becker (1960) introduced a number of important economic concepts that led to the construction of demand side

theories. One important notion is that children possess both consumption good characteristics (i.e. they yield utility or happiness to their parents) and investment good characteristics (e.g. they can provide security for parents in their old age, and provide labor and income for the household, such as farm labor or remittances).

A second notion is that of quality and quantity tradeoffs, which posits a likely substitution from quantity to quality as family income increases (Becker and Lewis 1973). A third notion is that of opportunity costs. In other words, while children yield benefits, they also come with both explicit costs (feeding, education, and so on) and implicit costs (such as the time required for rearing children, which could be applied to other activities). This implies that parental demand for children is very much a function of a variety of individual and social livelihood factors, such as location, occupation, land-labor ratios, costs and returns to education, female wages, and the development of formal social security systems. In addition to these economic factors, infant mortality rates are another demand-side factor deemed to be positively related to fertility rates, since a greater likelihood of infant death requires a family to have more births in order to reach its desired number of children. In some cultures there are also gender preferences that may lead parents to have larger numbers of children in the hope of satisfying a threshold demand for male children. It has also been noted that religious factors may influence the demand for children. For example, Muslim populations tend to have higher fertility rates than non-Muslim populations (both within and between countries), although this effect may relate more to slower transitions (Westoff and Frejka 2007).

A wide range of studies have attempted to test these theories with both cross-country and household level data. One stylized fact consistent with the demand-side view of fertility decisions is that individual's desired number of children often closely matches their actualized number of children, at least in an approximate fashion. Infant mortality rates and fertility rates are also very closely correlated both across countries and within them (Ben-Porath 1976; Benefot and Schultz 1996; Murthi, Guio, and Drèze 1995). Some research has found a negative correlation between family size and child quality that supports the Becker and Lewis (1973) theory (Rosenzweig and Wolpin 1980; Li, Zhang, and Yi 2005). Incomes also have a pervasively positive effect on fertility, especially over the longer run, but there are gender nuances at work, especially in the short run (Schultz 1997). In cases where

the husband's income increases fertility rates may increase as the family has an increased ability to support more children (Freedman and Thornton 1982). On the other hand, an increase in the wife's earning from her participation in the labor force is shown to have a negative substitution effect by making childbearing a costly activity for the household (McNown 2003; Engelhardt, Tomas, and Alexia 2004; Foster & Rosenzweig 2006).

Similarly, more women's education tends to reduce fertility (Jain 1981; Chaudhury 1986; Axinn 1993; Bledsoe and Cohen 1993), partly through female labor force participation and higher wages (i.e. higher opportunity costs), and partly through supply side factors such as increased knowledge of contraception, and a later age of first marriage. However, the level of education that can affect fertility decisions is still not clear. In most studies it seems only secondary and tertiary education is found to significantly affect fertility, but some studies have found some significant negative impact even with primary level education (Dzekedzeke and Nyangu 1994; Garenne 2008). On the other hand, Jain (1981) found that a small amount of education in least literate societies might initially increase fertility at the early stage of development due to a positive income effect.

In terms of the effect of urbanization on fertility, it has long since been established that urban fertility rates are pervasively lower than rural fertility rates, especially in poor countries (Kuznets 1974). The urban fertility in Sub-Saharan Africa is on average almost 30 percent lower than the rural fertility (Shapiro and Tambashe 2000; Dudley and Pillet 1998). Table 1 shows the most recent rural and urban fertility rates based on Demographic Health Surveys conducted in the last 5 years (DHS 2010). The table shows that while urban fertility rates are lower than rural rates everywhere, the differential in Ethiopia (at 3.6 children) is much larger than the African average (2.0 children), and is indeed the highest of any country surveyed by the DHS.

Table 1: Rural and urban fertility differentials in Ethiopia in relative terms

	Rural	Urban	Difference	Number of countries
Ethiopia	6.0	2.4	-3.6	
Africa	6.1	4.1	-2.0	23
Asia	3.3	2.5	-0.8	8
Central Asia & MENA	2.6	2.2	-0.4	9
Latin America	3.7	2.4	-1.3	10

Source: DHS (2010).
Note: MENA: Middle East and North Africa

What is less clear, however, is how exactly urban living reduced fertility rates. There are obviously some expected channels. As a stylized fact, mean incomes are pervasively higher in urban areas (even when adjusted for smaller household size), women tend to engage more in wage labor, paternal and maternal education levels are higher, infant mortality rates are lower, and there is generally better access to contraceptives in urban areas. Moreover, while there is always a rural-urban differential in fertility, urban fertility rates still vary both across countries and within countries. For instance, in the case of Addis Ababa, the nation's capital, the total fertility rate (TFR) dropped from 3.3 to 1.9 between 1990 and 2000, which is even below the population replacement rate. However, the contraceptive prevalence rate was only 34 percent in Addis Ababa in 2000, such that the drop in the TFR occurred in the absence of any considerable family planning initiatives (Sibanda et al. 2003). Hence there are many puzzles still unanswered with respect to the precise channels through which urbanization influences fertility trends.

Existing work has illuminated these questions somewhat. Kirk and Pillet's (1998) study of fertility trends in sub-Saharan Africa found a widening rural-urban fertility differential at early stages of fertility declines (this is also evident in Table 1), and that this differential was not satisfactorily explained by other rural-urban differences, such as household wealth or female education. This was in contrast to Asian countries where the rural-urban fertility differentials were smaller and more easily explained by differences in education, wealth, and other factors. Hence in the African context in general, and in Ethiopia in particular, further research is still needed to explain these much wider rural-urban fertility differentials.

However, previous work in Ethiopia has not examined this issue in any comprehensive fashion. Several studies that have been done on fertility under the Ethiopian context employ the Bongaarts framework to identify the proximate determinants of fertility such as contraceptives, postpartum insusceptibility, sterility, abortion, and marriage (Hailemariam and Zewoldi 1994; Population Studies and Training Center 2003; Sibanda et al. 2003; World Bank 2007; and of course the main descriptive results of the 2000 and 2005 DHS surveys (Central Statistical Agency [Ethiopia] and ORC Macro 2001, 2006). Others focus on segments of the population to look into the fertility determinants. For instance, Alemayehu et al. (2010) look into determinants of adolescent fertility in Ethiopia and a study by Gurmu and Mace (2008) focuses on the link between fertility and poverty in Addis Ababa.

A 2007 World Bank report is also comprehensive in using both DHS data to explore both proximate and underlying determinants of fertility, and an economy-wide macroeconomic simulation model (a computable general equilibrium model) to look into the impact of demographic change on economic outcomes such as consumption growth and savings. That analysis showed that two of the proximate determinants of fertility in Ethiopia are the age at marriage and first birth, and the extremely low use of contraceptives. Both age at marriage and contraceptive use were found to be much lower in rural areas, albeit with regional variation. To underlying determinants the study ran both aggregate and rural and urban regressions on the 2000 Ethiopian Demographic Health Survey (EDHS) with disaggregations by age groups. However, no systematic tests were conducted, nor was there any investigation of why urbanization seemed to reduce fertility, although it did note an association between urban living and secondary education. Finally, in terms of macroeconomic modeling the study indicated that fertility will most likely continue to reduce quite quickly if the government achieves its education targets, and that this fertility reduction will produce a so called “demographic dividend” in the form of faster growth in per capita consumption.

Although the World Bank study and others have made impressive contributions to this literature, to our knowledge there exists no comprehensive study that separately looks into the social and economic causes of fertility in rural and urban Ethiopia, particularly with regard to explaining why the rural-urban fertility differential is so unusually large. Hence, in this study we try to more systematically

test for rural urban differences in fertility determinants through a range of econometric tests described in the next section.

3. Data and estimation

3.1. Data

The data used for this study is EDHS (Ethiopian Demographic and Health Survey) of 2005. The EDHS is a nationally representative survey of 14,070 women between the ages of 15 and 49 and 6,033 men with ages between 15 and 59. This survey is conducted in Ethiopia as part of the worldwide Demographic and Health Surveys (DHS) project (CSA 2005). The survey contains information on the population and health situation of the country. Some of the topics covered include family planning, fertility levels and determinants, fertility preferences, child and maternal mortality, child health, nutrition, and knowledge of HIV/AIDS. Table 2 provides a list of the variables used in this study (some of which are constructed by the authors), including definitions and measurement issues.

The sample for the survey was designed to provide representative estimates for the variables of interest for Ethiopia as whole, urban and rural areas as separate domains, and 11 geographic areas with 9 regions and 2 city administrations (CSA 2005). The sample selection was done in two stages with 250 clusters (145 urban and 395 rural) selected from the list of enumeration areas[4] (EAs) from the 1994 population and housing census sample frame. The sample was also drawn from the 1994 Census frame. However, CSA (2005) indicates that there could be some bias in the representativeness of the regional estimates of Somali and Afar regions since the census frame excluded some part of these regions which were predominantly nomadic. Since the selected 540 EAs are not distributed proportionally by region according to the census population, the sample was weighted to produce national estimates. On the second stage of sample selection the households were randomly selected from each previously selected cluster.

[4] Enumeration areas are formed by subdividing each *woreda* into convenient areas and are either total urban or rural.

In addition to the DHS, Geographic Information Systems (GIS) estimates of travel times to nearest cities were merged with the DHS data based on the coordinates of the surveyed clusters. The purpose of adding this variable is to have information on the effects of isolation on fertility rates, and also because the rural-urban divide is somewhat arbitrary in locations where rural people have good access to cities (e.g. peri-urban areas). Information on how travel times are estimated can be sourced in Schmidt and Mekamu (2009).

Table 2: Variable description and measurement issues

Variable name	Definition	Measurement Issues
Dependent variables		
Children-ever-born	Number of children-ever-born by a woman	
Desired children	Number of children a woman desires to have in her life time	
Explanatory variables		
Women's age		
Age	Age of woman in years	
Age2	Square of age of woman in years	
Woman's Education		
No education	Woman has not attended any education	
Primary	Attended primary education	These variables are only a measure of quantity and do not measure quality of education. Also, the variable relate to attendance not completion.
Secondary	Attended secondary education	
Higher	Attended higher education	
Husband's education		
No education	Husband has not attended any education	
Primary	Attended primary education	
Secondary	Attended secondary education	
Higher	Attended higher education	
Religion		
Muslim	Dummy to indicate whether the woman is a Muslim	
Christian	Dummy to indicate whether the woman is a Christian	
Other religion	Dummy to indicate whether the woman has other religion	

Continued from Table 2		
*Economic status**		
1st wealth quintile	Dummy=1 if household's wealth status is poorest quintile	
2nd wealth quintile	Dummy=1 if household's wealth status is poor quintile	
3rd wealth quintile	Dummy=1 if household's wealth status is middle quintile	
4th wealth quintile	Dummy=1 if household's wealth status is rich quintile	
5th wealth quintile	Dummy=1 if household's wealth status is richest quintile	
Land ownership		
Ln land	Log of land size in hectares	
Ln land2	Log of land size in hectares squared	
Women's occupation		
Not working	Woman doesn't participate in any work outside of her home	Women who have no labor force participation outside of their homes for the past 12 months are the omitted category
Professional	Participates in professional work outside of her home	
Clerical and sales	Participates in clerical and sales work outside of her home	
Agriculture	Participates in agricultural work outside of her home	
Others	Participates in other works outside of her home	
Location		
Distance to health center	Travel time (minutes) to the nearest health center	Uses the DHS GPS points
Urban	Dummy=1 is residence is urban	
Listens to radio	Dummy=1 if woman listens to the radio frequently	
Contraceptive knowledge	Percentage of people living in the village who know about contraceptives	
Child mortality		
Child mortality*	Number of children born alive but died before age five	Treated as endogenous variable.*

Notes: * child mortality is treated as endogenous variables because fertility decisions could also cause mortality outcomes within the household. We therefore use cluster level averages of child mortality rates to proxy for expected child mortality.

3.2. Estimation

Following other empirical studies on fertility, the number of children born by a woman is used as the measure of fertility (Winklemann and Zimmermann 1994; Schultz and Zeng 1995), but also the desired number of children. The former might be regarded as a revealed preference (controlling for age), while the latter is a stated preference. In such economic contexts where the dependent variable of interest is a nonnegative integer or count, the response variable is discrete (unlike the classical regression model), where the distribution places probability mass at nonnegative integer values only (Wooldridge 2002). Given this discrete and non-negative nature of our dependent variable, the OLS model is inappropriate and count data models are therefore used for estimation.

Following the work of Smith, Ruel, and Ndiaye (2004) on child malnutrition in rural and urban areas (also using DHS), a regression equation that includes an urban dummy variable (1 if urban and 0 otherwise) and the interaction of all the independent variables with the urban dummy variable is estimated to see whether the effects of the socioeconomic determinants differ across urban and rural households. Afterwards, separate regression equations are run for urban and rural areas and a seemingly unrelated estimation is obtained along with the Chow-test for coefficient differences among urban and rural areas. These estimations are done for both the number of children-ever-born by a woman and the desired number of children.

The national level regression equation is given by:

$$y_i = \alpha + \sum_{k=1}^{k} \beta_k X_{ik} + \sum_{n=1}^{n} \beta_n (X_{in} * u_i) + \varepsilon_i$$

where the β_s are the parameters to be estimated, the X_s are the explanatory variables and the expression ($X_{in} * u_i$) are interactions of the explanatory variables with the urban dummy. The interaction variable obviously tests whether the effects of the explanatory variables on fertility differ by location. However, we also separately estimate urban and rural equations and conduct Chow tests to check for parameter differences among these groups.

Another complication is that the DHS does not have information on consumption or income variables. Instead, the DHS measures a wealth index constructed from the information on asset holdings using principal component analysis. While this wealth index has been shown to be a good proxy for economic status—such as strong correlations with education and other non-material welfare indicators (Filmer and Pritchett 2001) - it does have some limitations. The wealth index has not been shown to be a systematically close proxy for consumption expenditure in all countries. This is not a bad thing per se (consumption is also measured with error and is not conceptually the same as wealth), but it means we have to be careful with interpretation.

Another consideration in the estimation is the possible endogeneity of child mortality in the household. Since household fertility and mortality rates are likely to respond to the same determinants (such as access to health services), we use the average child mortality in the cluster, excluding the household in consideration, as a proxy for the infant mortality risk that an individual household faces. The use of this variable also helps to capture the expected child mortality that a household faces since the formation of such expectations are more likely to be influenced by what happens within the neighborhood. We note that this type of approach has been previously used in the development literature, particularly the literature on migration (Trang and Purnamasari 2011).

4. Results

4.1. Descriptive statistics

We begin our analysis with some basic descriptive statistics on the number of children born and the desired number of children. Both variables are disaggregated by age brackets. In the case of the number of children the reasons are obvious (older women have had more time to have more children), but even for desired number of children the answers to these questions may be influenced by the number of children already born, and hence by maternal age. Turning to the results, Table 3 shows that at any age level there is statistically significant difference between rural and urban levels of both actual children-ever-born and desired numbers, with rural fertility indicators invariably exceed urban levels. For example, for women in their 30s there is a huge difference between rural and urban levels in number of children-

ever-born (2.33 to 2.74 more children per rural woman, compared to urban woman). In general there is less variation between rural and urban women in desired number of children across age brackets, although the differences are still big (generally, rural women desire 1 to 1.6 more children than urban women). It is also interesting to note that at older ages the actual number of children-ever-born tends to be higher than the stated preference for number of children. This suggests that either women have insufficient decision-making power, insufficient access to contraceptives, or that—because of infant mortality rates and other health risks—households systematically overshoot their desired number of children.

In the bottom of Table 3 we also disaggregate by education. While these numbers are not net of age, they still may be insightful regarding possible interactions between education and location. We find significant rural–urban fertility differences for women with no education, and particularly large differences for women with primary education only. However, for secondary and tertiary education no clear differences emerge.

Table 3: Average number of children born and desired number of children by age category, education and place of residence

	Number of children-ever-born			Desired number of children		
	Rural	Urban	Difference	Rural	Urban	Difference
Age						
15-19	0.21	0.07	0.14***	3.46	2.79	0.67***
20-24	1.35	0.53	0.82***	4.41	3.18	1.23***
25-29	3.15	1.4	1.75***	4.91	3.57	1.34***
30-34	4.82	2.49	2.33***	5.4	3.84	1.56***
35-39	6.19	3.45	2.74***	5.41	4.38	1.03***
40-44	6.99	4.59	2.4***	5.7	4.32	1.38***
45-49	7.54	5.64	1.9***	5.99	4.39	1.6***
Education						
None	4.09	3.12	0.97***	5.15	4.16	0.99***
Primary	3.95	1.72	2.23***	5.06	3.56	1.5**
Secondary	0.92	1	-0.08	3.32	3.28	0.04
Higher	0.44	1.34	-0.9	3.69	3.3	0.39

Source: Authors' calculations from EDHS (2005).
Note: ** significant at 5 percent; *** significant at 1 percent.

In Table 4 we disaggregate the results by regions. Although we have not controlled for age, the age structure of women is fairly similar across regions, with the exception of Addis Ababa. In all regions we again see larger fertility indicators in rural areas. The levels are statistically different in all regions with the exception of the children-ever-born variable for the Somali region (where representativeness may explain the statistically weak result) and for the desired number of children in Addis Ababa. It is also interesting to note that the differences appear to vary across regions, and that there are fertility differences across urban areas, and across rural areas. For example, Addis Ababa appears to have lower fertility rates than urban areas of other regions, and previous studies have suggested that total fertility rates in Addis Ababa are even below replacement levels. Although it is not straightforward to explain this result, Addis is by far the largest city in Ethiopia, with a population of at least 3 million, which is around 6 times the next biggest city, Dire Dawa. Women in Addis also desire less children (3.28 children) than women in other urban centers such as Dire Dawa (4.6 children), while urban women in the Somali region desire 6.6 children.

Table 4: Children born and desired number of children by region and across rural and urban areas

	Children-ever-born			Desired number of children		
	Rural	**Urban**	**Difference**	**Rural**	**Urban**	**Difference**
Tigray	3.36	1.66	1.7***	4.93	3.91	1.02***
Afar	3.67	1.55	2.12***	8.9	3.84	5.06***
Amhara	3.48	1.76	1.72***	4.25	3.21	1.04***
Oromiya	3.57	1.76	1.81***	4.44	3.12	1.32***
Somali	3.83	2.8	1.03	10.55	6.64	3.91***
Ben-Gumz	3.47	1.82	1.65***	5.2	3.31	1.89***
SNNP	3.4	2.44	0.96***	4.76	3.92	0.84***
Gambela	2.94	2.32	0.62***	4.92	3.71	1.21***
Harari	3.56	1.31	2.25***	6.25	3.53	2.72***
Addis Ababa	2.39	1.21	1.18***	4.19	3.28	0.91
Dire Dawa	3.88	1.75	2.13***	7.2	4.59	2.61***

Source: Authors' calculations from EDHS (2005).
Note: ** significant at 5 percent; *** significant at 1 percent.

Apart from location determinants, it is obviously of interest to look at other possible sources of fertility differences. In Table 5 we list our explanatory variables by rural and urban levels, with p-values for differences. Clearly, urban populations have substantially greater wealth, female education, health services, access to contraceptives, and women marry at a slightly older age. Rural areas obviously own more land, but apart from that obvious exception they are clearly socioeconomically disadvantaged.

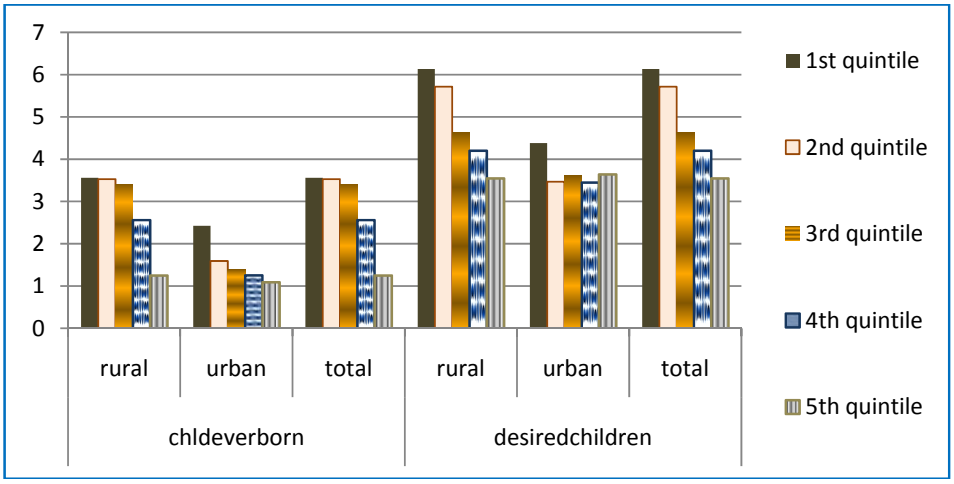
Table 5: Mean of variables by rural and urban areas (mean difference significant at 5 percent for all variables).

	Rural	Urban	Difference
Mother - Age (years)	28.4	26.8	1.6
Mother - No education	75%	25%	50%
Mother - Primary education	22%	25%	-3%
Mother - Secondary education	3%	44%	-41%
Mother - Higher education	0%	7%	-7%
Christian	66%	86%	-21%
Other religion	3%	0%	2%
Child mortality	56%	18%	38%
Mother - Listens to radio	34%	80%	-45%
Land owned (hectares)	2.2	0.2	2
Mother - Not working	67%	56%	11%
Mother - Professional occupation	0%	6%	-6%
Mother - Clerical/sales occupation	8%	27%	-19%
Mother - Agriculture occupation	3%	1%	2%
Mother - Other occupations	3%	10%	-7%
Husband - no education	70%	23%	47%
Husband - primary education	2%	35%	-33%
Husband - secondary education	0%	29%	-28%
Husband - higher education	1%	11%	-10%
Travel time to health center (hrs)	1.3	0.5	0.8

Source: Authors' calculations from EDHS (2005).

In Figure 1 we disaggregate rural and urban fertility outcomes and preferences by wealth quintiles. There are some interesting patterns. With regard to actual number of children the poorest women have higher number of children than those in the richest quintiles. This pattern seems to be consistent for both urban and rural areas. At the national level the number of children ever born seems to be showing a slight decline going from the first to the second quintile. A rather sharp decline is especially observed for those in the richest quintiles. As for desired number of children, the wealth gradient in urban areas is quite flat, but there is a big difference between the poor quintile and the rich quintile. At the national level the gradient is quite steep and linear: moving from one quintile to the next—from poorer to richer—reduces the number of desired children on average by one child.

Figure 1. Average number of children and desired number of children by economic status and place of residence

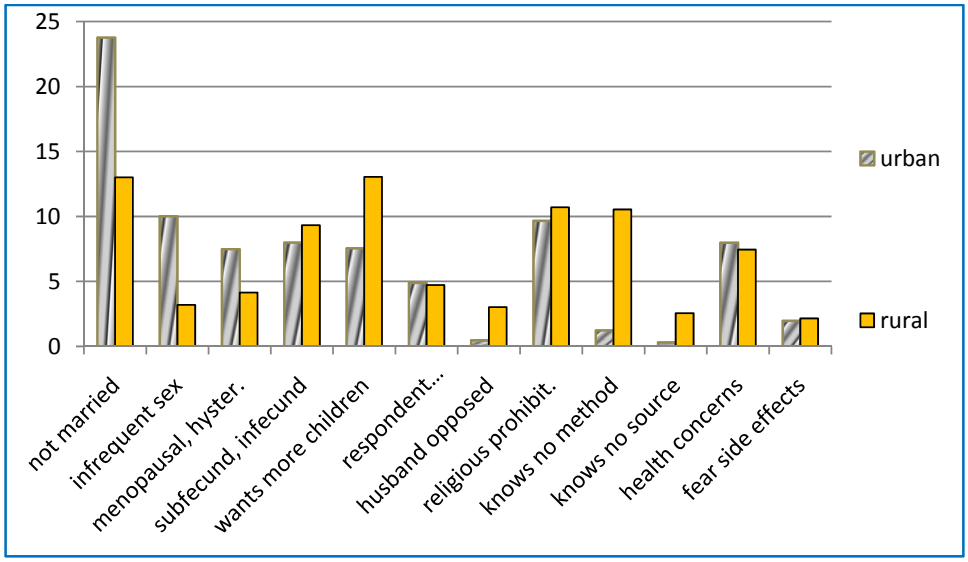


Source: Authors' calculations from EDHS (2005).
Note: 1st quintile is poorest quintile

There is a generally a low contraceptive use among women with only 18 percent of women using any method. The majority of these women using contraceptives are living in urban areas. Close to 37 percent of urban dwellers use traditional or modern contraceptive methods while only 15 percent of women in rural areas use contraceptive methods. In Figure 2 we look at the reasons for not using contraceptives across rural and urban areas. Netting out not being married, the

main differences are as follows. First, rural women are frequently ignorant of contraceptive methods (over 10% relative to just over 1% of urban women). A second reason is the desire to have more children (consistent with Table 5). And finally, small differences include not knowing any source and opposition on the part of the husband. Interestingly, religious prohibition is a significant factor in both rural and urban areas, as is lack of fecundity and health concerns (although it is not clear what those concerns are).

Figure 2: Reasons for not using contraceptives by place of residence



Source: Authors' calculations from EDHS (2005).

4.2. Regression results

Table 6 reports the results for the national level regression. The results are reported both for the number of children born and desired number of children; and for both dependent variables we disaggregate into the ever-married group and the whole sample. Following Garrett and Ruel (1999) all the explanatory variables are interacted with the urban dummy to see whether the socioeconomic variables have different impacts across urban and rural households. Interactions that are not significant were dropped and are therefore not reported in the results in Table 6.

Turning the signs and magnitudes of the coefficients, the regressions show fairly consistent results across dependent variables, although there are some exceptions. Age consistently has a positive but non-linear effect that is stronger for children-born relative to the desired number of children (as expected). The positive effect of age on desired fertility may suggest that younger Ethiopia women desire fewer children, but since this indicator could be biased by the number of children already born to a woman, we are hesitant to make strong inferences.

Table 6: National level regression results

	Children born	Desired number of children
Age (years)	0.91***	0.18***
Age squared	-0.01***	-0.01***
Woman - primary education	-0.04	-0.37***
Woman - Secondary education	-0.70***	-0.47***
Woman - Higher education	-0.91***	-0.76**
Husband - primary education	0.15***	-0.06
Husband - Secondary education	0.13	0.04
Husband - Higher education	0.08	-0.52
Christian	-0.06	-0.64***
Other religion	-0.09	-0.23
Child mortality	0.58***	0.75***
Listens to radio	-0.02	-0.14
2nd wealth quintile	0.09	-0.05
3rd wealth quintile	-0.01	-0.08
4th wealth quintile	0.02	0.03
5th wealth quintile	0.18	-0.32
land owned (hectares)	0.26***	-0.18
land, squared	-0.03	0.09*
Professional occupation	-0.62***	-0.10
Clerical/sales occupation	-0.25***	0.12
Agriculture occupation	-0.28***	-0.39***
Other occupations	-0.16	-0.10
Travel time to health center (hrs)	0.02	-0.05
contraceptive knowledge (village level)	0.13	-1.55
Urban	-0.46**	-2.88***
land*urban	0.01	0.09
land, squared*urban	0.21	0.38
Travel time to health center*urban	0.07	0.22*
Child mortality*urban	2.19***	-2.30***
Christian*urban	-0.23	-5.86**
Other religion*urban	-1.55**	-2.26***
Regions		
Oromia	0.32***	-0.62***
Afar	-0.02	1.4***
Amhara	-0.07	-0.82***
Somali	0.19	2.14***
Benishangul-Gumuz	0.10	-0.82***
SNNP	0.26***	-0.61***
Gambela	-0.38***	-0.84***
Harari	-0.18	-0.08
Addis Ababa	-0.24*	-0.26
Dire Dawa	-0.09	0.80***
Prob>chi2	0	0
Number of observations	9419	8332

Sources: Authors estimates from EDHS data.
Notes: reported coefficients are marginal effects.
Asterisks indicate significance a 1 percent (***), 5 percent (**) and 10 percent (*). All variables are dummy variables unless the measurement unit is indicated in parentheses.

Of considerably more policy relevance is that primary education has no effect on desired or actual fertility, but secondary and tertiary education have quite sizeable effects. Relative to no education, secondary education reduces actual or desired number of children by 0.7 children, while tertiary education has very large effects on actual number of children (reducing the number by more than two children in the ever-married sample) but quite modest effects on desired number of children. Husband's education seems to have little effect on fertility. Female occupation has moderately large effects (and may, of course, be correlated with education), with the largest impact for professional occupation (which reduces observed fertility by around 0.62 children). Impacts of other occupations relative to not working at all are more modest (around 0.28 children fewer).

Table 7 reports the regression results and test for parameter stability across urban and rural areas for children born by a woman and desired number of children as a measure of fertility. According to the results from the regression with children born as a dependent variable, it is found that fertility is positively related with age while the negative sign pertaining to the variable age squared implies a quadratic relationship between age and fertility behavior to reflect the biological factors that may limit the fertility of women as they grow older. This finding is consistent with the CSA report (2005) which indicates that fertility is low among adolescents and increases to a peak of 241 births per 1,000 among women of age 25–29 and declines thereafter. Although the relationship between age and the dependent variable is positive and the quadratic relationship is the same for rural and urban areas, the test for parameter stability suggests a difference in urban and rural areas in the strength of association between age and fertility with high association witnessed in the rural areas.

Education has entered the model in level form, rather than by year of schooling. The reference category for analyzing the results is the variable 'no education'. Accordingly, for the two measures of fertility women's education is a significant determinant for both rural and urban areas. The test for parameter difference suggests structural differences across urban and rural areas in the association between education and number of children born by women. The weak relationship between primary education and fertility is also an observation worth noting. The

regression results suggest that only education above the primary level plays a significant role in reducing fertility.

This finding is in line with the argument of Bledsoe and Cohen (1993) which indicates that throughout the world, formal schooling for women is the single most consistent variable correlated with their low fertility. Women with no formal education are also less empowered to make their own decisions in their households. Fertility decisions may not always necessarily be the choice of the woman and could be imposed by the husband or other family members. Though the woman may not want to have additional number of children, the fact that she is dependent on her husband and other family members for her welfare forces her to adhere to their fertility choices. Hence, education, by increasing the status of women in a society, empowers women to make their own choices and decisions regarding their lives and matters in their households including fertility. Those women with education and their own source of income tend to be independent in making their own choices and are less likely to be influenced by others with regards to their fertility choices.

Looking at religious differences, compared to the omitted variable, which is whether the woman is Muslim or not, Christians and those with other religion are less likely to have more children. This is especially the case in the urban areas while these variables are not significant for the rural Ethiopia. The parameter stability test suggests significance difference in the coefficients across the place of residence. The fact that Muslim families tend to have more children (and desire more children) than other religions seems broadly consistent with the cross-country literature, which either shows higher fertility rates or slow reductions in fertility in Muslim populations (controlling for other factors).

With regards to village child mortality (a proxy for maternal expectations of mortality), the number of children who were born alive but died before the age of five affects fertility decisions for both urban and rural areas across the sample groups. The coefficient difference is also found to be significantly different across urban and rural areas. In the presence of expected child mortality the number of children a woman is likely to have is expected to be higher. For fear of ending up with lower number of children than desired due to child mortality, it is more likely

that women with higher expected child mortality will have higher number of children to cope with possible loss.

The relationship between economic status and the number of children born by a woman is not found to be significant in both urban and rural areas, while women's participation in jobs outside of their homes is negatively related in both urban and rural areas. The fact that women are engaged in income generating activities makes the opportunity cost of childrearing activities very high. Allocating a majority of time at the household could be viewed as a costly activity to the mother leading to a decision to limit her fertility. The parameter stability test shows no significant difference between the coefficients among the rural and urban areas. Moreover, the type of occupations for which the relationship is significant varies across urban and rural areas. Women engaged in clerical and sales occupations appear to have lower number of children than those who are not employed, and this holds for both rural and urban areas. Professional women are also likely to have lower number of children than those who are not working, all other variables constant, but this relationship is only significant in the urban areas. This is perhaps not very surprising since the proportion of women in professional occupations is generally low in rural areas. On the other hand, in the rural areas women engaged in work in agriculture outside of their home also have lower number of children than those who are not engaged in any work outside their home, while the relationship is insignificant for those in the urban areas.

Distance to the nearest health center and husband's education are not found to be significant in affecting fertility in both the urban and rural areas. The result with regard to husband's education is not particularly unusual in the literature. The fact that travel time to health centers has no effect on fertility rates is interesting in that it calls for further investigation whether availability of contraceptives actually has limited effect on fertility decisions assuming all health centers provide family planning services, or whether family planning services do not exist or are not provided sufficiently in the health centers.

We also observe relatively similar impacts with the desired number of children as the dependent variable. The direction of relationship between desired number of children and age, education, religion, and labor force participation (particularly the

case of agriculture for the rural areas) is similar as those observed in the case of actual children-ever-born by women. However, economic status does not seem to significantly affect the desired number of children in either urban or rural areas. Moreover, differences in coefficients across rural and urban areas are only observed for religion and occupation variables, while there is no statistically significant difference for the other variables.

One significant difference is that the marginal impact of "listens to radio frequently" is now significant in rural areas (but not in urban areas), and is predicted to reduce the desired number of children by 0.17. So while travel time to health centers has no impact on desired number of children in rural areas, the availability of radios does have some impact, even after controlling for asset ownership in general. Moreover, contraceptive knowledge proxied by the number of people in the village who have information about contraceptive use is found to significantly affect desired number of children.

Table 7: Estimation of children born and desired number of children by place of residence

	Children born			Desired children		
	Urban	Rural	Significance of parameter difference	Urban	Rural	Significance of parameter difference
Age (years)	0.51***	0.98***	***	0.21***	0.17***	
Age squared	-0.01***	-0.01***	***	-0.01**	-0.01***	
Woman - Primary education	-0.06	-0.03		-0.39	-0.35***	
Woman - Secondary education	-0.39**	-0.74***	*	-0.25	-0.69***	**
Woman - Higher education	-0.44**	-2.28***	*	-0.72**	-0.58	
husband- Primary education	0.35**	0.14**		-0.15	-0.08	
husband- Secondary education	-0.07	0.11		0.20	0.05	
husband- Higher education	0.04	0.17		0.43	-0.64	
Christian	-0.40**	-0.04	***	-1.49***	-0.58***	
Other religion	-1.39***	-0.08	*	-1.99***	-0.17	***
Child mortality	1.80***	0.58***	**	0.93	0.77***	
Listens to radio	0.17	-0.04		0.32	-0.17*	
2nd wealth quintile	-0.04	0.13		-0.63**	0.05	
3rd wealth quintile	-0.01	0.03		-0.41	0.01	
4th wealth quintile	0.25	0.04		-0.39	0.15	
5th wealth quintile	0.19	0.73		-0.55	-1.08	
Log of land owned (hectares)	0.28	-0.02		0.00	-0.01	
Log of land, squared	-0.03	0.09***		0.17	0.05	
Professional occupation	-0.44**	-0.57		-0.05	0.52	
Clerical/sales occupation	-0.32***	-0.21*		0.00	0.17	
Agriculture occupation	-0.06	-0.30	**	2.84	-0.42***	**
Other occupations	0.04	-0.30**		-0.07	-0.16	
Contraceptive knowledge (village	0.44	0.14		0.08	-1.43***	
Travel time to health center (hrs)	0.05	0.02		0.13	-0.05*	
Oromia	-0.14	0.36***	**	-1.17***	-0.50***	
Afar	-0.86***	0.03	***	-0.87***	2.16***	***
Amhara	-0.31*	-0.05	***	-1.01***	-0.81***	***
Somali	-0.03	0.23		-0.05	2.78***	***
Benishangul-gumuz	-0.16	0.13	**	-1.52***	-0.67***	**
SNNP	0.36*	0.24***		-0.49**	-0.59***	
Gambela	-0.39**	-0.47***		-0.85***	-0.85***	
Harari	-0.57***	0.27**	***	-0.74***	0.63	
Addis Ababa	-0.40***	-0.01		-0.53***	-0.74	
Dire Dawa	-0.57***	0.30*	***	0.05	1.02***	***
Prob>chi2	0.0000	0.0000		0.0000	0.0000	
Number of observations	2,157	7,262		1,994	6,338	

Note: reported coefficients are marginal effects
Asterisks indicate significance a 1 percent (***), 5 percent (**) and 10 percent (*)

5. Implications: Why fertility rates matter and how fertility reductions can be achieved

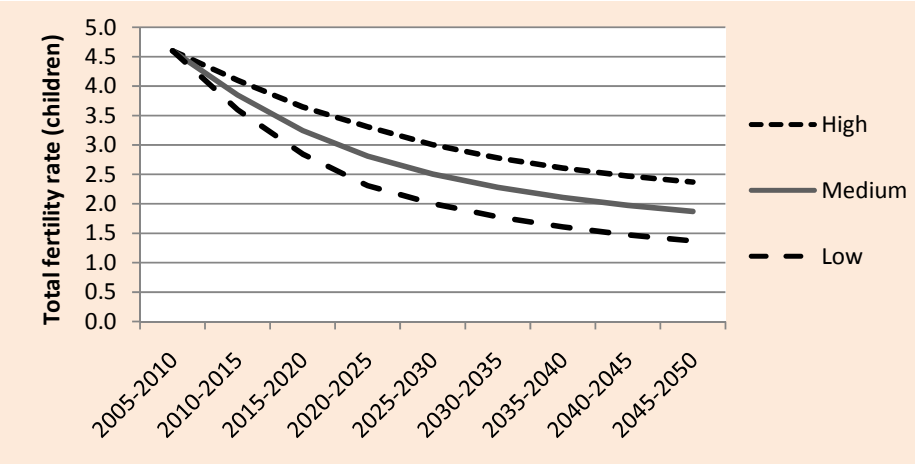
In the introduction to this paper we made allusion to some of the important benefits of reducing fertility relatively quickly, especially in a country like Ethiopia. In this concluding section we reflect on our findings regarding the causes of fertility rates, and examine the possible consequences of different fertility rates for Ethiopia's economic future based on new demographic projections from the United Nation's population division, and existing research on the impact of age dependency rates on saving rates and economic growth.

5.1. Fertility trends influence the demographic window: when it opens and how far it opens

To give some idea of the expected impact of getting more women into secondary education, we combine the results in Table 6 with the UN's 2010 population revision forecasts of future demographic trends in Ethiopia based on alternative fertility scenarios (UN 2011). These new UN projections are a significant improvement on previous projections because of an improved Bayesian forecast model that incorporates a broader set of both country-specific and cross-country information on fertility rates (Raftery et al. 2009). Another advantage of this model is that the only variation to the entire demographic model is variations in fertility rates, which in turn influence overall population growth and age dependency rates. Figure 3 shows the new alternative fertility predictions based on high, low, and medium variants, while Figure 4 shows the impact of these alternative fertility paths on age dependency ratios. The alternative fertility paths are purposively set such that by 2020–2025 there is 0.5 child difference between the medium variant and the high and low variants (and hence a 1 child difference between high and low variants). Figure 4 shows that these fertility differences, though seemingly modest, have a sizeable difference on age dependency ratios. By 2025 the spread of age dependency ratios reaches its maximum (+/-7 percentage points between medium and high/low variants), and this is maintained until around the year 2060 when the age dependency ratios reach their minima. In other words, the speed at which fertility rates fall determines the size of Ethiopia's demographic window.

What about the predicted impacts of reduced fertility rates and age dependency ratios on economic growth? Long standing theories predict that as the ratio of working age adults to dependents increases, savings and investment increases (Coale and Hoover 1958), and human capital accumulation expands as parents opt for quality over quantity (Becker and Lewis 1973). Cross-country regression analysis has also showed that growth in the share of the working age population makes a substantial impact on economic growth, but also that this dividend is increasing in institutional quality (Bloom et al. 2007). The idea underlying this institutional nexus is fairly simple. A growing working age share has tremendous potential to increase savings, human capital, and innovation, but only if the right policies and institutions are in place. The "right" policies and institutions would generally include a business environment that is conducive to higher savings and investment—such as secure property rights, a well developed financial sector, and labor market regulations that encourage job creation—as well as public investment policies that enhance skills and competitiveness.

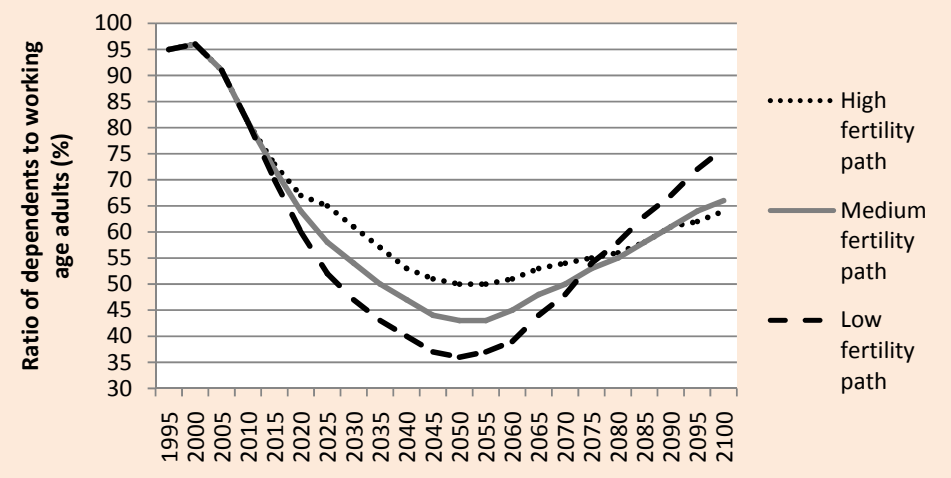
Figure 3: Alternative fertility predictions for 2010 to 2050



Source: 2010 Revision of *World Population Prospects* (UN 2010).

Notes: The total fertility rate is the average number of children a hypothetical cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality. It is expressed as children per woman.

Figure 4. The projected impact of alternative fertility paths on age dependency ratios



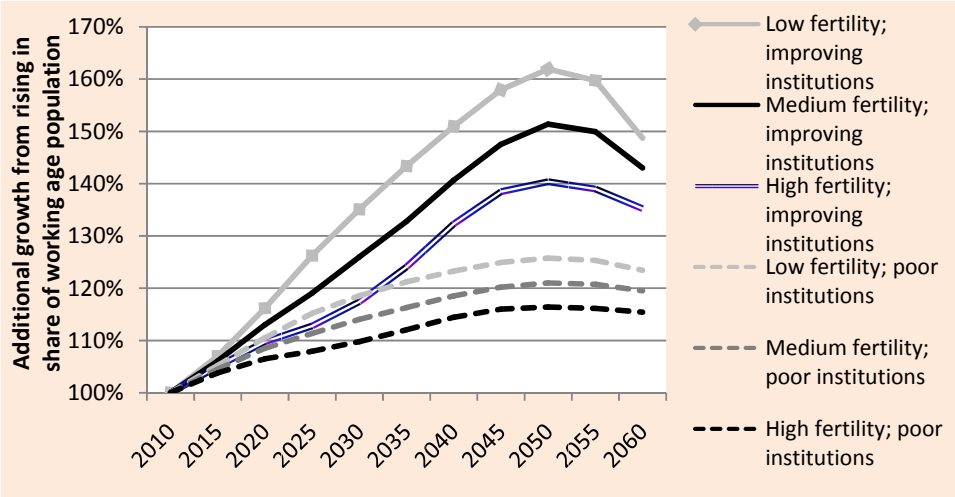
Source: 2010 Revision of *World Population Prospects* (UN 2010).

Using the cross-country regression estimates of Bloom et al. (2007) we can get some sense of the expected impact of alternative fertility paths on economic growth, conditional upon institutions. Specifically, we estimate the "demographic dividend" of each alternative fertility path under two scenarios: constant low institutional quality path (20%), and a consistently improving path (2 percentage points every five years). Figure 5 shows the growth impacts that result from the rising working age population shares from 2010 to 2060, which in turn are a function of the alternative fertility paths. These predicted growth impacts are additional to whatever baseline growth rates are obtained by Ethiopia over this period, so we are only presenting an additional growth impact, not a prediction of Ethiopia's overall growth rate. Also note that because the working age population share rises until 2050 and then start to decline thereafter, the growth dividend does the same (in other words, a declining working age population share becomes a drag on economic growth after 2050).

Bearing these nuances in mind, the main message in Figure 5 is that the demographic dividend of lower fertility rates is substantial, but only when institutional quality also improves. For example, in the low fertility scenarios income per capita in 2050 would only be 25% higher than in 2010 if institutional quality stayed low, whereas it would be around 60% if institutional quality doubled between 2010 and 2050. Moreover, the growth differential between the low and

high fertility scenarios is substantial even if institutions improve in both cases. In the low fertility–improving institutions scenario incomes in 2050 would be 60% higher than in 2010, whereas they would be only 40% in the high fertility–improving institutions scenario. So conditional upon institutional and policy improvements, it is clear that reducing fertility rates has important economic benefits.

Figure 5: Ethiopia's demographic dividend as a function of institutional quality



Source: Author's calculations based on UN (2010) fertility variants and econometric results from Bloom et al. (2007).

Notes: Under the "poor institutions scenario" Ethiopia's institutional quality stays constant at the sub-Saharan average (20%). Under the "improving institutions scenario" institutional quality improves by 1 percentage point every five years from 2010 onwards.

The aforementioned World Bank (2007) study also shows that lower fertility rates have sizeable economic benefits using a more sophisticated general equilibrium model. They show that a low fertility–low mortality path results in more rapid growth in per capita consumption (3.1% per annum) than in a higher fertility–higher mortality path (2.8% per annum). Numerically their more sophisticated model yields results that are actually quite similar to those observed in Figure 5,[15] although one potential weakness of their model is that it does not incorporate institutional quality.

[15] For example in their low fertility scenario per capita consumption grows by 16.5% from 2005 to 2030, whereas in our low fertility scenario per capita income grows 18.5% between 2010 and 2030.

5.2. The best way to reduce fertility rates appears to be via secondary education, particularly for rural women

Our results clearly show that a number of direct and indirect policy related factors can substantially influence fertility rates. Perhaps foremost among the factors at work is female education. Controlling for all other factors and relative to no education, some secondary education reduces fertility rates by 0.63–0.81 children, while some tertiary education reduces fertility rates by 1.51–2.07 children (see Table 6). The World Bank (2007) study also finds similarly large effects of secondary education using the 2000 DHS. Like us they also show that secondary and tertiary education levels in Ethiopia are currently so low that there are potentially huge demographic gains to be reached by getting more girls into secondary and tertiary institutions. In the 2005 DHS, just 11.9% of women aged 15-49 had secondary or tertiary education, but this masks a huge rural-urban divide: 51% of urban women had some secondary education against 3.5% of rural women.

Given that rural fertility rates are much higher than urban rates and that we uncover evidence suggesting that secondary education reduces fertility in rural areas more so than in urban areas (see Table 6), the most "fertility-effective" education strategy would therefore be to target secondary education investments towards rural areas. However, cost considerations are also important. In general, providing secondary education in rural areas is more expensive than in urban areas (especially after controlling for quality), and social and economic constraints could also inhibit female enrollment in rural areas (e.g. gender attitudes, on-farm labor requirements, weak transport infrastructure). In the medium term it will probably be more cost-effective to concentrate education infrastructure in population dense rural areas where the relative returns to female education—and hence potential enrollment—are higher. It also true that facilitating more rapid urbanization could make a positive contribution to fertility reduction, especially migration out of isolated areas where infrastructure investments are less cost-effective.

The emphasis on secondary education and gender equity in enrollment is also emphasized by the government of Ethiopia in its 5-year growth and transformation plan (GTP). The plan aims to raise secondary school gross enrollment from 38 percent in 2010 to 75 percent in 2015. However, while the government has the goal

of gender parity for primary school enrollment, no such goal exists for secondary school enrollment, and there are no explicit rural and urban targets either. Another constraint is that education is almost certainly underfunded. Table 8 shows trends in the share of federal government expenditures allocated to education and defense in eight African countries. Despite rapid increases in enrollment rates in the 2000s (and hence the need for rising expenditure), Ethiopia's education budget share remains one of the lowest in Africa (9.2%), with only Nigeria (7.6%) maintaining a lower level. In the other six countries the education budget grabs 15 to 28% of the total budget. The result of increased enrollment with such a modest education budget is obviously relatively low quality, which has been confirmed by very low literacy scores.

Table 8: Trends in federal government budget allocations 2000-2007

Country	Agriculture	Education	Health	Trans/ Comm	Social	Defense	Other
Ethiopia	9.4	9.2	1.9	4.4	9.9	18.3	46.8
Ghana	0.5	15.1	4.7	1.2	0.0	2.1	76.3
Kenya	4.3	27.7	6.0	5.6	5.6	7.8	43.1
Malawi	5.0	18.2	12.2	4.1	7.0	2.6	50.9
Mozambique	5.1	20.1	12.9	15.4	N.A.	N.A.	46.2
Nigeria	2.9	7.6	4.6	2.4	2.5	6.2	73.8
Uganda	3.9	18.7	10.7	9.6	2.9	10.0	44.1
Zambia	10.8	16.6	7.9	1.0	0.4	12.4	50.9

Source: Authors' calculations from IFPRI (2011) data.

5.3. Some persistent knowledge gaps

While our results do not shed much evidence on the role that contraceptive availability and family planning plays, existing evidence suggests that contraceptive demand exceeds supply and that family planning services are effective and seemingly quite cost-effective (World Bank 2007). In some of our results we find that access to a radio (and hence radio messages on family planning) also had some positive effect on reducing fertility. We await the new Ethiopia Demographic Health Survey (forthcoming in 2011) to see what the progress has been made on contraceptive use, and what impact other family planning interventions, including

the relatively new health extension worker (HEW) program, are having on fertility rates.

In addition to these knowledge gaps we must acknowledge that while some of our regressions appear to satisfactorily explain the large urban effect on fertility rates (i.e. in terms of parameter heterogeneity of explanatory variables), there are still some persistent puzzles regarding Ethiopia's fertility rates. In particular, there is still substantial regional variation, with Addis Ababa's fertility rates seemingly much lower than other urban centers.

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