Does Family Planning Reduce Fertility? Evidence from Rural Ethiopia*

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Abstract

Although reproductive health advocates consider family planning programs the intervention of choice to reduce fertility, there remains a great deal of scepticism among economists as to their effectiveness, despite little rigorous evidence to support either position. This study explores the effects of family planning in Ethiopia using a novel set of instruments to control for potential non-random program placement. The instruments are based on ordinal rankings of area characteristics, motivated by competition between areas for resources. Access to family planning is found to reduce completed fertility by more than 1 child among women without education. No effect is found among women with some formal schooling, suggesting that family planning and formal education act as substitutes, at least in this low income, low growth setting. This provides support to the notion that increasing access to family planning can provide an important, complementary entry point to kick-start the process of fertility reduction.
Keywords: Family planning, fertility, program evaluation, Ethiopia, timing of births, program placement

JEL codes: J13, O12, O22, I15, H40

1 The Challenge of Measuring the Effects of Family Planning

Many countries, especially in Africa, continue to have high fertility rates and most of the predicted increase in the world's population until 2100 comes from these high-fertility countries (United Nations 2011). High fertility has potentially significant implications for women and children's health as well as for economic development more broadly. Motivated by these concerns, policy discussions often focus on the role of family planning programs in helping individuals manage their fertility. Standard economic models of fertility decisions suggest, however, that many people in developing countries have little incentive to reduce the number of children. The opportunity cost of women's time is low and children are potentially productive on the family farm or can serve as old age security. Furthermore, there is a lack of empirical evidence that family planning programs are effective.[1] As a result, rather than focusing on the supply of family planning, economists instead emphasize factors that influence fertility demand such as household poverty and girls' schooling (Pritchett 1994; Das Gupta, Bongaarts, Cleland and Joshi 2011).

The lack of convincing empirical evidence that family planning programs reduce fertility may be attributed to the challenge of measuring their impact. First, studies of family planning programs have often covered periods of rapid economic development and fertility decline, making it difficult to isolate the effects of family planning programs. Second, existing studies have largely ignored heterogeneous impacts, especially with regard to how family planning affects women with different education levels. Evidence from the US shows that although better-educated women are not more efficient users of modern contraceptives than less-educated women, better-educated women are more efficient at using "ineffective" contraceptive methods such as withdrawal or rhythm (Rosenzweig and Schultz 1989). The effect of family planning is therefore conceivably stronger the lower the education levels and family planning may thus substitute for education in reducing fertility at lower education levels. Finally, rigorous study is hampered by the challenge of non-random program placement (Rosenzweig and Wolpin 1986; Pitt, Rosenzweig and Gibbons 1993). On one hand, if the government places programs in areas that are more "receptive" to reducing fertility,

[1] For a discussion of the evidence – and lack of it – from developed countries, see Kearney and Levine (2009).

simply comparing fertility in areas with and without family planning may overestimate the impact of expanding the program. On the other hand, if the government places programs in high fertility areas and information on initial fertility is not available, comparing fertility across areas may underestimate the effectiveness of the program. Without information on the placement process it is difficult to assess the direction of the potential bias, although the early literature suggests that the effect of family planning programs is likely to be underestimated (Rosenzweig and Wolpin 1986; Pitt et al. 1993).

Technically, randomising the allocation of programs and comparing the outcomes of interest between treatment and control areas could overcome the non-random program placement problem. Although theoretically superior, such experiments have a number of drawbacks in practice. First, there are conceptual concerns about the external validity of experiments, which are often small in scale. Second, because of the cumulative nature of fertility, an experiment has to run for a substantial period of time before one can assess the effect on fertility. Short-run effects may simply reflect changes in spacing-patterns rather than changes in the overall number of children. When run for too short a period, experiments may also be prone to short-term health scares such as the one experienced by an experiment in Zambia (Ashraf, Field and Lee 2009).

Probably the best-known example of a family planning program experiment comes from Matlab, Bangladesh. It began in 1978, and by 1984, fertility was 24 percent lower in the villages that received the intensive family planning program compared to the villages that received only the standard family planning program (Phillips, Simmons, Koenig and Chakraborty 1988). More recent work using the same villages with data until 1996 finds a decline in fertility of about 15 percent in the program villages compared with the control villages (Sinha 2005; Joshi and Schultz 2007). These results reflect, however, a level of program intervention and intensity unlikely to be sustainable (Pritchett 1994). Per woman reached, the program cost 35 times more than the standard government family planning program and each averted birth cost USD 180 in 1987, 1.2 times GDP per capita at the time.

In short, although potentially superior from an analytical point of view, it is difficult to run family planning program experiments for a sufficiently long period and on a sufficiently large scale to generate the necessary external validity. At the same time, non-randomised family planning programs have been in place for a substantial period of time in many areas and it is cost-effective to make optimal use of the information that can be derived from these programs. If longitudinal data have been collected in parallel with the introduction of the program, program effects can be estimated using fixed effects, provided there are a sufficient number of areas that receive a program between the (minimum) two data points and provided the period between the surveys is long enough. Examples include studies of the family planning programs in Indonesia that found a negative (but not statistically significant) effect on fertility, responsible for only 4 to 8 percent of the decline in fertility from 1982 to 1987 (Pitt et al. 1993; Gertler and Molyneaux 1994).

Often longitudinal data are not available or cover too short a period, in practice limiting researchers to using cross-sectional data for analysing the effects of family planning programs.[2] To address program placement challenges in such contexts, one approach is to use variables that influence program placement but are unrelated to individual fertility as done for Tanzania (Angeles et al. 1998). A woman in Tanzania exposed to family planning throughout her fertile lifespan is found to have 4.13 children compared with 4.71 children in the absence of family planning programs.[3] Lingering concerns remain, however, that some of the variables used to identify placement (such as child mortality levels and the presence of other family planning services) may also be correlated with unobservable variables that influence both placement and fertility decisions.[4]

To address non-random program placement when evaluating the effect of family planning programs in Ethiopia, this study exploits detailed information on area characteristics and the geographical allocation decisions of the family planning programs. The identification strategy is novel in that it draws on the insight that areas compete for limited resources and that ordinal rankings

[2]There are also additional problems with using fixed effects, such as measurement error bias. For a discussion of this and other problems in the study of family planning see, for example, Angeles, Guilkey and Mroz (1998).

[3]For Indonesia, Angeles, Guilkey and Mroz (2005) report using the same approach, but found no differences between standard OLS and IV results, which was interpreted as a lack of evidence of non-random placement of family planning programs.

[4]Also using cross-sectional information Miller (2010) found that Columbia's family planning program, Profamilia, reduced lifetime fertility by around half a child, equivalent to only 10 percent of the sharp decline in fertility over the period the program was implemented.

(as opposed to cardinal scores of the ranking criteria) are often used to discern between competing demands for services.[5] To fix ideas, assume that there are only three areas, A, B, and C, which compete for resources from the government. Using the extent of urbanisation as an example, we expect that the degree of urbanisation of area A will affect fertility in area A, but that the degree of urbanisation of areas B and C will have little or no effect on fertility in area A.[6] Because the three areas compete for resources the *relative* degree of urbanisation may, however, affect the program placement decision.[7] This opens up the opportunity to use rankings as identifying variables (as opposed to levels). Imagine that urbanisation is highest in area A, followed by B and C, and that the more urbanised an area is, the more likely it is to receive a program. Identification is achieved because the *rank* of an area primarily depends on other areas' absolute value of the ranked variable. Specifically, assume that the underlying value for area B increases. Unless it increases enough to surpass area A the ranking will not change even though the increase in the value of the ranked characteristics may directly affect fertility.

There are two major advantages to this approach. First, the instruments are easy to create from readily available secondary data like a census or, possibly, even from the primary data set itself. Secondly, the instruments are intuitive in that they mimic expectations about the underlying resource allocation process. In other words, ranks likely reflect what policymakers care about when distributing family planning programs, but are not directly related to fertility.Furthermore, the process is agnostic about which characteristics actually determine placement.

The paper makes three contributions to the literature. First, it uses a novel but widely available set of instruments to identify the effect of family planning on fertility. Second, it examines the effect of a family planning program of limited means in a very poor setting that experienced little economic growth during much of the period of study.[8] As seen above, the scant evidence in

[5]The approach closest to ours is by Pitt and Menon (2010), who used average characteristics of other areas, such as education level, for their instruments. A potential issue with their approach is that if network effects are important these averages might not serve as valid instruments. For the use of other approaches using relative characteristics as identifying instruments in other contexts, see Rummery, Vella and Verbeek (1999) and Galasso and Ravallion (2005).

[6]The cost of children may be higher in more urbanised areas reducing fertility.

[7]It may, for example, be less costly for the government to place programs in areas that are more urban because of easier access.

[8]Ethiopia's GNI per capita in PPP went from just over USD 300 in 1980 to USD 480 in 2003.

the literature so far comes from very ambitious, costly programs (Matlab) or dynamic macro-economics settings (Indonesia and Colombia). Yet, it is in more stagnant low-income settings (such as in Sahel countries) that high fertility often poses the more important obstacle to accelerating development. Third, this study focuses on how the effect of access to family planning is critically dependent on the education level of women.

We find that access to family planning in Ethiopia has a statistically significant and economically large impact on fertility of women with no schooling, whereas there are no discernible effects of family planning on fertility for women who have ever attended school. When averaging across all women irrespective of their education status, our estimated effect is not unlike those reported in other studies. This highlights the importance of disaggregating by education attainment. At more than 1 child the reduction in completed fertility is substantial for women without education. Furthermore, this effect kicks in more immediately than the effects of increasing girls' education, which tend to be much larger but only kicks in a generation later. These insights have important policy implications as 65 percent of women 30 years or older never attended school in Ethiopia (Central Statistical Authority of Ethiopia 2007).

2 Ethiopia – a High Fertility Country

In 2005 Ethiopia's current total fertility rate (TFR), the predicted number of children a woman will have during her reproductive life, was estimated at 5.4, in effect adding about 2 million people a year to Ethiopia's population of about 74 million in 2007.[9] Population growth resulting from such high fertility is believed to come at a high cost to living standards. Already in 1999, the average land holding per rural person was estimated at only 0.21 ha, down from 0.5 ha in the 1960s. This, coupled with lack of agricultural productivity growth, has contributed to a (rapidly growing) core group of five to seven million who are chronically food insecure. Spatial resettlement of about two million people from the highlands to the lowlands, adopted in 2003 as one of a series of policy

[9]There are substantial differences between Addis Ababa and the rest of Ethiopia. In Addis Ababa, the estimated total fertility rate is below replacement (Gurmu and Mace 2008).

measures to tackle the problem of chronic food insecurity in many highland weredas, is unlikely to provide a sustainable solution (World Bank 2007). The high fertility and population growth rates are not unique to Ethiopia. There are about 20 countries that have a TFR higher than 5, almost all very poor and with high proportions of women of child bearing age without formal education (World Bank 2010).

Cognizant of the challenge population growth posed, the government of Ethiopia adopted a population policy in 1993. The overall objective was to harmonize the country's population growth rate with that of the economy, specifically to achieve a TFR of 4 by 2015. One of the major strategies to do so was to increase the contraceptive prevalence rate to 44 percent by 2015 by expanding access to family planning (Transitional Government of Ethiopia 1993). Ethiopia has historically had among the lowest contraceptive prevalence rates in Sub-Saharan Africa. According to the first-ever national survey on fertility and family planning in 1990 only 4 percent of women of reproductive age were using some family planning methods and less than 3 percent were using modern contraceptives (Transitional Government of Ethiopia 1993). Results from the 2005 Demographic and Health Survey (DHS) show that this increased to 15 percent of married women using some method of contraception in 2005, with the majority relying on a modern method (Central Statistical Authority [Ethiopia] and ORC Macro 2006).[10] The most commonly used modern methods are injectable contraceptives at 10 percent and oral contraceptives at 3 percent. Use of other modern methods such as condoms, female sterilization, and IUD accounted for less than 1 percentage point each.

[10]Other studies have found use rates in line with the DHS number or higher (Pathfinder International Ethiopia 2004; Essential Services for Health in Ethiopia 2005). The Essential Services for Health in Ethiopia (ESHE) conducted three region-wide surveys in SNNP, Oromia, and Amhara regions between 2003 and 2004. The studies showed prevalence rates for modern contraceptives to be 14 percent, 16 percent and 14 percent in the Amhara, Oromia, and SNNP regions. In September 2004, Pathfinder International Ethiopia conducted a survey on family planning and fertility in Amhara, Oromia, SNNP, and Tigray regions. The use of modern methods was the highest in Oromia (24 percent) followed by Tigray (20.4 percent), Amhara (20.5 percent) and SNNP region (17.1 percent) (Pathfinder International Ethiopia 2004).

3 Empirical Methodology

We use three data sources to evaluate the impact of the availability of contraception on fertility: first, a contraceptive use survey collected under the auspices of Pathfinder International – Ethiopia (Pathfinder International Ethiopia 2005); second, a health facility survey collected to augment the Pathfinder survey; third, the 1994 census of Ethiopia. The Pathfinder survey was collected in September 2004 and covered Ethiopia's four largest regions, which together are home to 86 percent of the population:[11] Amhara, Oromia, SNNPR, and Tigray. It provides information on the level of knowledge, attitude, and practice of family planning. The survey used a stratified multi-stage sampling design in four regions combined with urban-rural residence for each region. Weredas (districts) constituted the primary sampling units. In total 58 weredas were sampled and 176 communities (PA/kebeles) within these districts were surveyed, 113 rural and 63 urban.

To collect information on health facilities, family planning services and Community Based Reproductive Health (CBRH) programs available in the 58 Pathfinder survey districts a Wereda Health Facility and CBRH (WHFC) survey was conducted in July 2005.[12] Health departments or social sector departments provided the information. In each wereda, general questions were asked regarding the entire wereda and specific questions were asked about the communities covered by the Pathfinder Survey. Communities that could not be accurately identified during field work were dropped, leaving 164 communities. Furthermore, uncertainty arose about whether some of the urban communities surveyed in the WHFC survey were accurately linked to the Pathfinder survey (24 in total) and, to be cautious, these were also dropped. After merging with the Pathfinder survey[13], the final sample consists of 109 communities (91 rural and 18 urban) and 2,700 women, of which just over 2,000 remain after excluding never married and never partnered women.

[11] Ethiopia is divided into 9 regions, with each region further divided into zones; there were 68 zones in Ethiopia at the time of the Pathfinder survey. Each zone is divided into weredas (or woredas, which correspond to districts). Each wereda is divided into a combination of Kebeles in urban areas and Peasant Associations (PAs) in rural areas. Kebeles and PAs are the smallest administrative unit of local government.

[12] Although the 2005 Ethiopia DHS covered a larger sample we did not have access to sufficient funds to collect a facility survey that matched with the DHS.

[13] Because of incompleteness in the WHFC survey and the census, another 25 communities could not be merged to the Pathfinder data and 6 were missing important information.

3.1 Estimation Strategy

Our approach is to first estimate the determinants of the decision on whether to place a program P in area k and then to estimate the effect of the program on the individual outcome y_i (fertility). The equations are:

$$P_k = X_k\alpha_1 + Z_k\alpha_2 + \nu_k, \quad (1)$$

$$y_i = X_k\beta_1 + X_i\beta_2 + P_k\beta_3 + \varepsilon_i, \quad (2)$$

where X_k is a vector of exogenous variables that are area specific, and Z_k is a vector of area specific exogenous variables that affect program placement but do not affect the individual fertility decision. Individual characteristics are captured by X_i. Whether a program is available in the area, P_k, is the main variable of interest and β_3 measures the program's impact on the outcome of interest. The main outcome of interest is the number of children ever born. In addition, to probe into the channels through which family planning affects fertility and to distinguish its effect from the presence of the health facilities through which the family planning services are provided, we estimate the effects of family planning on various measures of child mortality, recent birth or pregnancy, and whether last birth or pregnancy was wanted. Unfortunately, because the data lack birth histories we cannot examine how the timing of births responds to family planning.

Using a three step procedure, β_3 can be estimated under relatively relaxed conditions (Wooldridge 2002, Chapter 18, Procedure 18.1). The first step estimates the determinants of the placement decision using a Probit model. The second step calculates the predicted probabilities of having a program. In the final step, the individual decision equation is estimated by standard IV, using the predicted probabilities from the first stage for P_k, $\mathbf{X_k}$ and $\mathbf{X_i}$ *as instruments*. Identification comes from Z_k in the first stage. A major advantages of this procedure is that it has an important robustness property: the results are robust even if the placement equation is not correctly specified (Wooldridge 2002, p. 623). If we were to use the standard 2SLS approach of including the predicted probability of having a program directly in the second stage, instead of using them as instruments, the results would only be consistent if the program placement decision was correctly specified. When using this procedure the usual 2SLS standard errors and test statistics are asymptotically valid and the IV estimator is asymptotically efficient.

In addition to the instrumental variable results, for comparison we also present OLS results, where Equation (2) is estimated under the assumption that there is no correlation between program placement and unobserved area characteristics. All regressions take into account the multi-stage sampling design and apply sample weights. Access to family planning is measured for each of the 109 communities in which the women in the sample reside, and standard errors would be biased downwards if no correction is applied to account for this clustering (Moulton 1990). Standard errors for both OLS and IV regressions are therefore clustered at the community level.

3.2 Family Planning Programs and Placement

For sample communities we have information on whether a health facility is available, when the facility opened, whether family planning services are offered at the health facility and, if so, the year it began offering family planning services. There are health facilities that do not offer family planning, but family planning is never offered outside of health facilities during the period we study.

A community is considered to have access to family planning if there is either a facility with family planning in the community or the closest facility with family planning is less than 40 kilometres away. Although the distance may appear long, most women only visit the family planning program every three months, either to pick up more pills or renew the injection. Also, there is only one community that is 40 kilometres away from the closest family planning program; the second most remote community is 30 kilometres away. For urban communities the maximum distance to the closest facility is 3.5 kilometres. The average distance for communities without a health facility with family planning is around 10 kilometres. Women in rural communities are assumed to have access to family planning the year family planning services were first offered in that administrative area. For urban areas we use the year the closest health facility began offering family planning services whether or not the health facility is located in the urban area or a neighbouring area.

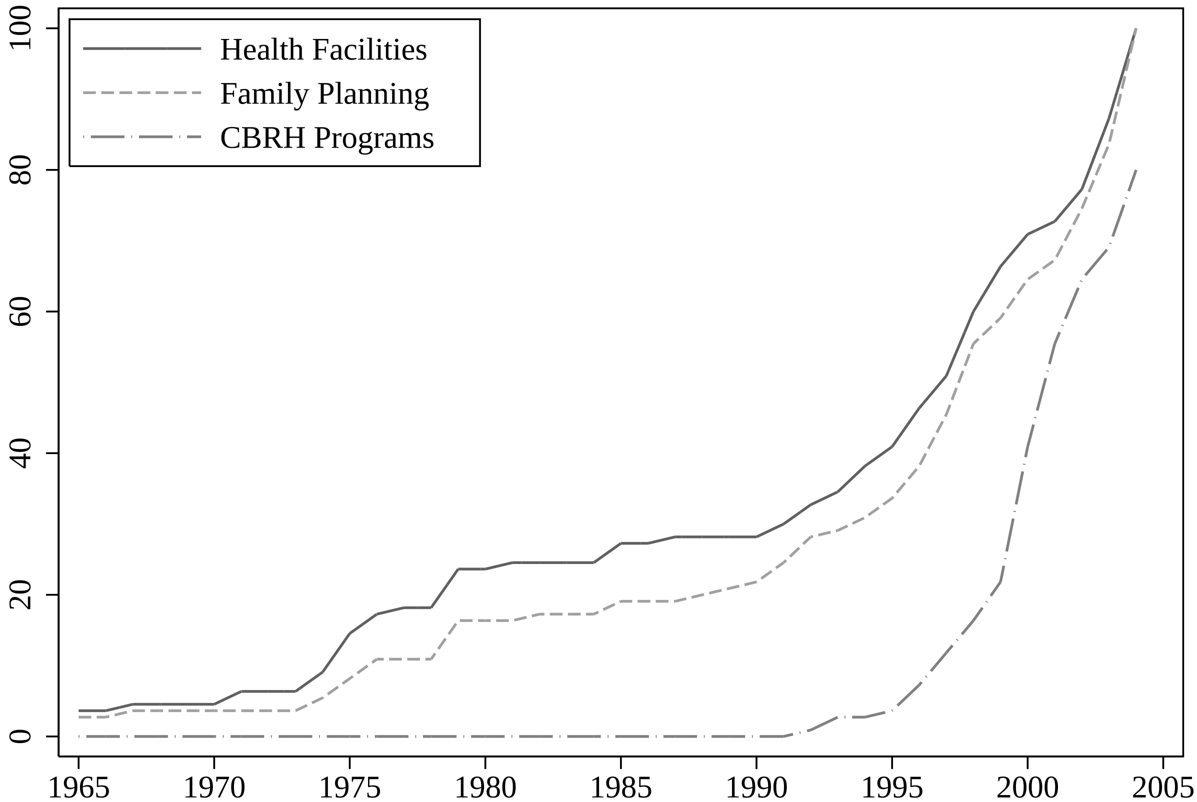
The definition of access leads to two potential issues. First, it is not possible to estimate the extent to which distance to a family planning program is an important factor in use. Although our conversations with providers indicate that many of their clients do, indeed, travel substantial distances to receive family planning services, nonetheless, increasing distances must at some point lower use rates. If our definition leads to the inclusion of family planning facilities that are not actually used because they are too far away the result will be an underestimate of the effect of access. Secondly, we only have information on access to the closest family planning program. Some areas may be coded as only having had family planning services for a relatively short period if a new health centre recently opened in the area, even though the neighbouring area already offered family planning services. Similarly, it is possible that changes in facility type might not be reflected in the start date, i.e. a change from clinic to centre that results in access to a wider set of services. These issues are also likely to result in a downward bias of the estimated effect of access.

Figure 1 shows the development in access to health facilities, family planning services, and CBRH programs over the 30 years prior to our household survey.[14] We focus on the effects of having access to family planning services in 1990, when approximately 25 percent of all communities in the sample had access to a family planning program.[15] The prevalence of programs was essentially constant the decade before 1990. A majority of the women who had access in 1990 therefore have been exposed to the program for up to 25 years (depending on the woman's age) at the time of the survey allowing sufficient time to identify long-term effects on fertility.

There was a substantial expansion in access to health facilities and family planning programs after 1990 with coverage going from 50 to 100 percent from 1997 to 2005. That is, almost all our "control" or untreated women with respect to family planning access had access by 2004. On average, the communities of these women had 5 years of access by 2004 compared with 25 years

[14]The introduction of CBRH programs is an interesting development, but happened too recently and in too many areas simultaneously to allow for an analysis of long-term effects on fertility. Access to health facilities and family planning services track each other closely. There is therefore not enough independent variation to estimate whether there is an independent effect of access to health facilities.

[15]Unfortunately, there is not enough power to predict years of community access as opposed to dichotomous access in 1990. We do test robustness of the results to other cut-off years.



Source: The World Bank Wereda Health Facility and CBRH survey.

Figure 1: Percent Communities with access to Health Facilities, Family Planning or CBRHA

for our "treated" communities. The effect of this increase in program coverage is to bias downward the estimated effect of the program.

Table 1 shows the descriptive statistics for the dependent variable and the explanatory variables used for estimating program placement. There are two categories of explanatory variables. The first consists of variables that affect both placement and individual fertility decisions. The second is the set of identifying variables that are assumed to affect the program placement, but not the individual fertility decision.

The first set includes the zone's population size, the percent of the zonal population that lives in urban areas, and the percent of the zonal population with 1-6 years of education and district level variables: the average yearly rainfall and its square, and the elevation of the district and its square.

Table 1: Descriptive Statistics for Program Placement

	Mean	Standard Error	Min	Max
Dependent Variable				
Family planning program in 1990 (ratio)	0.19	0.39	0.00	1.00
Zone characteristics				
Zone population size / 10,000	140.04	64.77	6.49	260.54
Percent of zone's population in urban areas	8.65	4.24	1.64	100.00
Percent with 1-6 years of education in zone	11.62	5.24	2.05	37.45
District characteristics				
Avg. yearly rainfall (mm/100)	11.91	4.05	4.46	20.48
Avg. yearly rainfall squared $(mm/100)^2/100$	1.58	1.02	0.20	4.19
Elevation (m/100)	19.68	4.25	8.65	29.26
Elevation squared $(m/100)^2/100$	4.05	1.65	0.75	8.56
Community characteristics				
Market in area (rate)	0.35	0.48	0.00	1.00
Road access - all year (rate)	0.41	0.49	0.00	1.00
Road access - dry season (rate)	0.39	0.49	0.00	1.00
Community population / 1000	3.23	5.28	0.35	96.94
Ranking of Zones (Nationally)				
Zone Percent with 1-6 years of education rank	17.21	9.73	1.00	36.00
Ranking of Communites (Within Zones)				
Community population rank within zone	2.27	1.40	1.00	10.00
Number of communities		109		

Notes. Estimated means and standard errors based on sample frame and weights. The ranking of zones is based on the sample, with 1 assigned to the smallest value and equal observations are assigned their average rank to ensure that the sum of the ranks is preserved. For communities the ranking is based on the sample within a zone, with 1 assigned to the smallest value and ties are assigned their average value.

At the community level the variables include a dummy for whether there is a market in the area, the population size of the community, and accessibility of the area captured by two variables: whether the area can be reached by car all year or only during the dry season (the excluded category is no road access).

We use the relative rank of zonal and community variables as instruments in the placement decision estimation. Each variable is ranked with 1 assigned to the smallest value and ties are assigned their average rank, so that the sum of the ranks is preserved. That is, for a given variable an observation's rank is 1 plus the number of values that are lower than that observation's value. One variable is ranked at the zonal level for the 36 zones in the sample and one variable is ranked within zones. For zones, the ranked variable is the percentage of adults with 1-6 years of education.

These ranks are all based on data from the 1994 Census. The mean of the ranking is not equal to 19 because not all zones have the same number of communities and because weights are applied to calculate the mean. The communities are ranked within each zone by their population size. The maximum number of communities within a zone is 10, while for 5 zones there is only one community in the survey. Although it would be advantageous to have more information at the community level, the set of possible variables is limited by the lack of information available at that level from published census reports.

3.3 Individual Data

As discussed earlier, we surmise that the effect of family planning on fertility is highly dependent on a woman's schooling. The lower a woman's education, the more likely she is to benefit from access to family planning services (Rosenzweig and Schultz 1989). This is especially so in Ethiopia where injectable contraceptives are the main method. Injectable contraceptives are ideal for women without education because they do not require any user action except the visit to a family planning clinic every 3 months.[16] In addition to the expected larger effect of family planning for women with no education, the age profile of fertility and the effect of other factors on fertility are likely to be different across education groups. Rather than assuming the appropriate specification given such interactions across education groups, the main sample is restricted to women with no formal education who have ever been married or lived together with a man. Among the original sample, 65 percent of women never attended school. Table 2 shows the descriptive statistics for this sample.[17]

The main dependent variable is the number of children a woman had given birth to at the time of the survey (children ever born) which averages just over 4. The large number of births reflects the high fertility rate in Ethiopia, especially considering that the average age of the women in the

[16]This also makes them attractive for women who do not want to reveal to their partner that they are using contraceptives (Ashraf et al. 2009).

[17]The descriptive statistics for the full sample is available on request.

sample is just over 28 years.[18]

Table 2: Descriptive Statistics for Women
Ages 17-49 With No Schooling

	Mean	Standard Error	Min	Max
Dependent Variable				
Children even born	4.33	2.80	0.00	14.00
Individual characteristics				
Age 17-22	0.17	0.37	0.00	1.00
Age 23-27	0.19	0.40	0.00	1.00
Age 28-32	0.22	0.41	0.00	1.00
Age 33-37	0.16	0.36	0.00	1.00
Age 38-42	0.16	0.36	0.00	1.00
Age 43-49	0.11	0.31	0.00	1.00
Orthodox	0.54	0.50	0.00	1.00
Muslim	0.26	0.44	0.00	1.00
Zone characteristics				
Zone population size / 10,000	129.37	62.51	6.49	260.54
Percent of zone's population in urban areas	8.57	4.09	1.64	100.00
Percent with 1-6 years of education in zone	11.22	5.44	2.05	37.45
District characteristics				
Avg. yearly rainfall (mm/100)	11.91	4.20	4.46	20.48
Avg. yearly rainfall^2/100	1.59	1.04	0.20	4.19
Elevation (m/100)	19.42	4.18	8.65	29.26
Elevation^2/100	3.95	1.63	0.75	8.56
Community characteristics				
Market in area	0.35	0.48	0.00	1.00
Road access - all year	0.40	0.49	0.00	1.00
Road access - dry season	0.42	0.49	0.00	1.00
Community population / 1000	3.10	4.95	0.35	96.94
Family planning program	0.18	0.38	0.00	1.00
Observations		1388		

Notes. Estimated means and standard errors based on sample frame and weights.

Age is captured by dummies for age groups. Because of substantial heaping of reported age around numbers ending with 0 or 5 we have centered the age groups around numbers ending in 0 and 5.[19] With the high population growth rate in Ethiopia younger cohorts are larger than older cohorts, but the percentage that have married or lived with a partner is smaller for young women

[18]For comparison the equivalent number for Guatemala is 2.8 and Guatemala has one of the highest total fertility rates in Latin America (Pörtner 2008). See also World Bank (2010) for TFR for other countries.

[19]Results using other age groups are available on request. They show qualitatively similar results.

compared to older women explaining the lower percentages of the two youngest age groups (17-22 and 23-27) in the sample.[20] Just over half of the women are Orthodox Christian, a quarter are Muslim, and the remaining women are mainly other Christian. The remaining variables are the same district and community characteristics as in Table 1 used for the first stage.

Because there is no information in our survey data on migration of women the definition of access to family planning implicitly assumes that a woman has spent her entire life in the area where she was found during the survey. This does not seem to be a problematic assumption. Data from the 2005 National Labour Force Survey show that 70 percent of women 15 to 45 have always lived in their current location and that another 15 percent have resided there for 10 years or more, presumably a move associated with marriage and the onset of the women's entrance into family formation.

4 Results

Table 3 presents the results from our estimation of the determinants of family planning program placement, corresponding to Equation 1. The dependent variable is whether the community was within 40 kilometres of the nearest family planning program in 1990. Most of the explanatory variables have the expected signs. Communities that belong to more populous zones or are more urban, are significantly more likely to have a family planning program. Elevation and its square also have a statistically significant effect on placement, consistent with the higher population density of Ethiopia's highlands. Areas that have a market or have easy access, as measured by whether there is road access by car all year, are more likely to have a program, although these effects are not statistically significant.

The main variables of interest are the rank variables that identify program placement. Both instruments are individually statistically significant at 1 percent. The F-test for the instruments

[20]The low number of young women who are married or partnered also explains why we exclude women who are 15 or 16 years of age. In addition, very few of the 15 or 16 year olds who are married or partnered have given birth yet. The data set has information on 14 women either 15 or 16 years of age and partnered, of which 4 have ever had children.

Table 3: First Stage Probit –
Determinants of Family Planning
Program Placement

Variable	Program available in 1990[a]
Avg. yearly rainfall (mm/100)	−0.173
	(0.263)
Avg. yearly rainfall^2 $(mm/100)^2/100$	0.807
	(1.047)
Elevation (m/100)	0.855**
	(0.351)
Elevation^2 $(m/100)^2/100$	−2.503***
	(0.936)
Market in area	0.591
	(0.358)
Road access - all year	0.409
	(0.585)
Road access - dry season	−0.083
	(0.605)
Zone population size / 10,000	0.008***
	(0.002)
Percent of zone's population in urban areas	0.296***
	(0.100)
Percent with 1-6 years of education in zone	−1.081***
	(0.279)
Community population / 1,000	0.041
	(0.031)
Constant	−8.091**
	(3.947)
Rankings (instruments)[b]	
Zone percent with 1-6 years of education rank	0.577***
	(0.147)
Community population rank within zone	−0.374***
	(0.137)
All ranks equal to zero F(2,100)	9.90***
Observations	109

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Weighted probit with robust clustered standard errors in parentheses estimated using Stata's svy command.
[a] Dependent variable is whether family planning was available within 40 km of community in 1990.
[b] The ranking of zones is based on the sample, with 1 assigned to the smallest value and ties are assigned the same value, so that the sum of the ranks is preserved. For communities the ranking is based on the sample within a zone, with 1 assigned to the smallest value and ties are assigned the same value, so that the sum of the ranks is preserved.

being jointly equal to zero is 9.90. Despite the low number of observations, the F-test indicates that the instruments perform well. Using the critical values in Stock and Yogo (2002) for two-stage least squares, our first stage rejects the null hypothesis of weak instruments for a maximal size of 0.20 and above for a 5% Wald test.[21]

The first stage includes both level and rank (the instrument) for both the percent of adults with 1-6 years of education and the population size of the community. Increasing the percent of adults

[21] The bias test is not defined for less than 3 instruments and is therefore not applicable here.

in the zone that has 1-6 years of education decreases the probability of having a family planning program, holding the ranking constant. If we hold the percent with 1-6 years of education constant and increase the zone's ranking, the community is more likely to have a family planning program. Because we hold the education level of the zone constant an increase in ranking means that another zone must have fewer adults with 1-6 years of education (lowest value is given the rank 1). Our education level has not changed, but we are now *relatively* more educated and that leads to a higher likelihood of having a program. One interpretation of this result is that the government was actively trying to place family planning programs in areas that had relatively more people with some primary education, presumably because family planning was considered a complement to education.

Holding the community population rank among the communities in the zone constant, increasing the size of the population leads to a higher probability of having a family planning program. If we hold the size of the community population constant and increase its rank the likelihood of having a family planning program decreases. Hence, relatively smaller communities are more likely to have received government family planning programs compared with the larger communities (lowest value is given the rank 1). This is in line with the government focusing on areas that are less likely to be served through private providers of family planning services. Private providers are presumably more likely to focus on the relatively larger communities first.

4.1 Effect on Fertility

Table 4 presents the results for the effect of access to family planning in 1990 on the number of children ever born by 2004 for women without schooling.[22] Models I and II assume that program placement is exogenous and estimate the effect of family planning using OLS. Models III and IV treat program placement as endogenous and use the predicted probability of access to a family planning program from Table 3.[23] Models I and III estimate the average effect of access to family

[22]Table A-1 shows the full results.

[23]Choosing a different cut-off year does not substantially change the results for years immediately around 1990. The results for other years are available on request.

planning services on children ever born across all women without education. Because the effect of access is likely to vary by age, Models II and IV include interactions between family planning access and age group dummies.

Table 4: Effect of Family Planning Access on
Number of Children Ever Born for Women Without Schooling

	Children Ever Born			
	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Family planning	−0.707***		−0.924**	
	(0.208)		(0.452)	
Family planning × age 17-22		−0.683**		−0.737
		(0.267)		(0.487)
Family planning × age 23-27		0.211		−0.516
		(0.248)		(0.560)
Family planning × age 28-32		−0.913**		−0.909
		(0.373)		(0.741)
Family planning × age 33-37		−1.022***		−1.160*
		(0.382)		(0.605)
Family planning × age 38-42		−0.820*		−1.265*
		(0.452)		(0.754)
Family planning × age 43-49		−1.466**		−1.031
		(0.653)		(1.244)

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Robust standard errors clustered at community level in parentheses. Family planning indicates whether there was family planning available within 40 km in 1990. Additional variables not shown are dummies for religion (orthodox, muslim), average yearly rainfall and its square, elevation and its square, dummies for market in area, road access all year, and road access during the dry season, zone population size, percent of zone's population in urban areas, percent with 1-6 years of education in zone, community population, region dummies, and ethnic group dummies. Number of observations for all models is 1388. Results including other explanatory variables are in Table A-1.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.

The average effect of access to family planning on children ever born is negative and strongly statistically significant for both OLS and IV estimations. The OLS estimate indicates that providing family planning reduces the number of children ever born by 0.7 children. Taking account of program placement leads to an even larger estimated impact of access to family planning with fertility falling by 0.9 children. Given the sample's average number of children ever born, this effect is equivalent to an approximately 20 percent reduction in the number of children born per woman for women without schooling.

Because relatively few women give birth after age 40, the estimated effect for the oldest age groups is an indicator of the impact of family planning access on completed fertility. For women aged 38 to 42, the IV results are larger than the OLS results. According to the IV results access to family planning decreases completed fertility by 1.3 children among 38-42 old women without education. More precisely, women who received access to family planning later in their reproductive years are predicted to have approximately 6.5 children by the time they end child bearing, whereas women with access for 15 or more years will have approximately 5.2 children.[24]

For the oldest age group the effect of family planning is just over 1 child, although the IV estimate is imprecisely estimated. Two factors combine to explain the lack of statistically significance. First, there is a relatively small number of women in the sample aged between 43 and 49. Second, this group of women may have been well into their reproductive lives when the programs were made available. A woman who was 49 at the time of the survey would have been 34 at the 1990 cut-off and even though most of the places that had family programs in 1990 also had them in 1980, she would still be 24 at the time of the initial introduction of family planning. The predicted lifetime fertility for the oldest group is 6.9 children without access to family planning and 5.8 with access to family planning.[25]

The differences in effects across age groups suggest that long-term access to family planning services mainly leads to changes in fertility later in life. The effect of family planning is negative for the 3 youngest age groups but not statistically significant and then becomes larger and statistically significant as women move toward the end of their reproductive lives. This fits the a priori expectation that the cumulative effect becomes larger with increasing age. With access to family planning a woman can directly control both timing of births and when to stop having children.

Table 5 is restricted to the sample of women who have received schooling.[26] We find that for women who have passed first grade or above, there is no discernable impact of access to family planning on fertility. OLS results show that for women with 1 to 5 years of education access to family planning increases fertility by approximately 0.4, whereas access increases fertility by around 0.1 for women with 6 to 12 years of education. None of these effects are statistically

[24] Predictions are based on average values of all variables except for age and access to family planning.

[25] Predictions are again based on average values of all variables except for age and access to family planning.

[26] There are only 19 women in the 43 to 49 age group who have any education and we therefore drop this age group.

Table 5: Effect of Family Planning Access on
Number of Children Ever Born for Women With Schooling

	Children Ever Born			
	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Family planning	0.364		0.627	
	(0.249)		(0.583)	
Family planning × 6-12 years of education[b]	−0.245	−0.128	−0.536	−0.358
	(0.260)	(0.279)	(0.516)	(0.584)
Family planning × age 17-22		−0.016		0.044
		(0.288)		(0.411)
Family planning × age 23-27		0.400		0.218
		(0.408)		(0.721)
Family planning × age 28-32		0.095		0.791
		(0.400)		(0.851)
Family planning × age 33-37		1.396***		1.847**
		(0.499)		(0.782)
Family planning × age 38-42		0.105		0.282
		(0.561)		(0.941)

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Robust standard errors clustered at community level in parentheses. Family planning indicates whether there was family planning available within 40 km in 1990. Additional variables not shown are dummies for having 6-12 years of education, religion (orthodox, muslim), average yearly rainfall and its square, elevation and its square, dummies for market in area, road access all year, and road access during the dry season, zone population size, percent of zone's population in urban areas, percent with 1-6 years of education in zone, community population, region dummies, and ethnic group dummies. Number of observations for all models is 693. Results for including other explanatory variables are in Table A-2.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.
[b] Excluded category is women with 1-5 years of education.

significant. Using the IV results, the effect for women with 1 to 5 years of education is a 0.6 increase and for women with 6 to 12 years of education the effect is still an increase of 0.1. As for OLS, none of these results are statistically significant. Interacting age groups with access to family planning as above leads to no consistent results.

4.2 Family Planning or Health Facilities?

An important question is whether the effects on fertility arise from access to family planning services or from other programs for which placement is affected by the same set of instruments. The main candidate here is the concurrent health services offered by health facilities. Both can reduce fertility, one directly through control of conception and the other indirectly through lowering mortality of offspring. In addition, in Ethiopia government family planning programs are offered only at health facilities and not as stand-alone clinics, which means that the placement decisions are potentially closely related.

As Figure 1 shows, there is a close correspondence between the presence of health facilities and family planning programs; in 1990, 18 percent of women had access to a health facility with family planning whereas an additional 6 percent had access to a health facility with no family planning services. The low number of women with access to health facilities with no family planning makes it impossible to estimate the effects of access to such health facilities with any degree of confidence. Substituting access to any health facility (regardless of the availability of family planning service) in the models above leads to smaller and less statistically significant effects on fertility using OLS with an average effect of -0.511.

Using the same IV estimation strategy as above leads to a first stage for health facility access that performs worse than for family planning access: the F-statistics for the instruments being jointly equal to 0 is 6.49. This indicates that the placement of health facilities, which is likely the placement decision most closely related to the placement of family planning, is not driven as strongly by our instruments as the family planning program placement decision is. The IV result for fertility is also of smaller magnitude (-0.708) than that for family planning and not statistically significant.[27] The same pattern of smaller magnitudes and statistically insignificant effects also show up for access to health facilities interacted with age dummies.

The smaller estimates is an indication that the effect on fertility is mainly due to access to family planning at health facilities and not access to health services as such. Both OLS and IV show an effect of health facilities that are 75 percent of the effects of family planning and 75 percent of the women who had access to health facilities in 1990 also had access to family planning.

Another approach to examining whether family planning or health facility access is most important is to look at child mortality along with the results on fertility. On the one hand, access to health facilities should directly reduce child mortality and that in turn allows parents to achieve a desired number of surviving children with fewer births (Sah 1991; Schultz 1997; Wolpin 1997).

[27] Results for both OLS and IV are available on request.

Table 6: Effect of Family Planning Access on Mortality of Children for Women Without Schooling

	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
	Any Children Died			
Family planning	−0.005		0.032	
	(0.049)		(0.088)	
Family planning × age 17-22		−0.034		0.125
		(0.054)		(0.129)
Family planning × age 23-27		−0.025		0.080
		(0.076)		(0.172)
Family planning × age 28-32		0.039		−0.014
		(0.068)		(0.105)
Family planning × age 33-37		−0.014		−0.049
		(0.105)		(0.114)
Family planning × age 38-42		0.053		0.036
		(0.086)		(0.149)
Family planning × age 43-49		−0.144		0.050
		(0.102)		(0.218)
	Number of Dead Children			
Family planning	−0.102		0.129	
	(0.093)		(0.227)	
Family planning × age 17-22		−0.136		0.045
		(0.094)		(0.181)
Family planning × age 23-27		−0.011		0.147
		(0.152)		(0.348)
Family planning × age 28-32		−0.116		−0.103
		(0.127)		(0.208)
Family planning × age 33-37		−0.199		0.162
		(0.265)		(0.392)
Family planning × age 38-42		0.071		0.271
		(0.244)		(0.462)
Family planning × age 43-49		−0.396		0.815
		(0.428)		(1.022)
	Share of Children that Died			
Family planning	0.002		0.054	
	(0.019)		(0.040)	
Family planning × age 17-22		−0.035		0.035
		(0.032)		(0.071)
Family planning × age 23-27		−0.017		0.057
		(0.027)		(0.071)
Family planning × age 28-32		0.020		0.009
		(0.030)		(0.040)
Family planning × age 33-37		−0.007		0.066
		(0.043)		(0.065)
Family planning × age 38-42		0.037		0.085
		(0.035)		(0.071)
Family planning × age 43-49		−0.010		0.147
		(0.062)		(0.118)

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Robust standard errors clustered at community level in parentheses. Family planning indicates whether there was family planning available within 40 km in 1990. Additional variables not shown are dummies for religion (orthodox, muslim), average yearly rainfall and its square, elevation and its square, dummies for market in area, road access all year, and road access during the dry season, zone population size, percent of zone's population in urban areas, percent with 1-6 years of education in zone, community population, region dummies, and ethnic group dummies. Number of observations for all models is 1298. Complete results including other explanatory variables are available on request.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.

On the other hand, the effect of family planning on child mortality is indirect: better ability to control spacing of births and more resources available per child because of reductions in fertility should lead to lower child mortality. Hence, although reductions in child mortality could in principle be the result of either family planning or health services, we would expect the effect of access to health services on child mortality to be larger than the effect of access to family planning. Similarly, we would expect the effect of family planning on fertility to be larger than that of health services, where the effect is more indirect. As a result, if we find little effect from our measure of access (which captures both access to health services and family planning) on child mortality, the reduction in fertility is likely due to family planning rather than health services.

Table 6 presents the estimated effects of family planning access on three measures of child mortality: whether any of a woman's children have died, the number of children who have died, and the share of children who have died.[28] For the sample of women who have had children, nearly 30 percent have had at least one child die, the average number of children who died is 0.57 and 10 percent of children born have died.[29]

None of the average effects are statistically significant and the IV results even indicate an increase in mortality. The reductions in whether a woman has had at least one child die by age group are small, statistically insignificant, and many have a positive rather than negative sign. The same is the case for the number of dead children and the share of children died. The small effects on child mortality indicate that it is unlikely that the reduction in fertility comes from a reduction in mortality as a result of access to health facilities. A more convincing explanation is that family planning services reduced fertility and that lead to slightly lower child mortality.

Another indirect approach to determining whether access to health facility services in general or access to family planning services specifically are responsible for the reduction in fertility is to examine two outcomes that are mainly influenced by family planning rather than health facilities: unwanted births or pregnancies, and recent birth or pregnancy. Even if lower child mortality leads

[28]The corresponding results using any health facility access are available on request, but lead to qualitatively similar results.

[29]It should be kept in mind that this includes mortality after age 5 and the sample consists solely of women with no schooling. For comparison the 2005 Ethiopian DHS show an under-5 mortality rate of 123 per 1000 live births for the 5 years before the survey, 141 per 1000 live births for the period 5 to 9 years before the survey, and 165 per 1000 live births for the period 10 to 14 years before the survey. In addition, the under 5 mortality rate for women with schooling for the 10 years before the survey was 139 per 1000 live births (Central Statistical Authority [Ethiopia] and ORC Macro 2006).

to lower desired fertility, it is hard to avoid unwanted pregnancies unless one has regular access to family planning services.

Table 7: Effect of Family Planning Access on
Unwanted Fertility for Women Without Schooling

	Last/Current Pregnancy Unwanted			
	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Family planning	−0.060		−0.009	
	(0.044)		(0.096)	
Family planning × age 17-22		−0.036		0.053
		(0.067)		(0.126)
Family planning × age 23-27		−0.007		−0.020
		(0.088)		(0.168)
Family planning × age 28-32		−0.024		0.027
		(0.068)		(0.140)
Family planning × age 33-37		−0.076		0.011
		(0.089)		(0.149)
Family planning × age 38-42		−0.047		0.024
		(0.079)		(0.142)
Family planning × age 43-49		−0.338***		−0.521***
		(0.061)		(0.164)

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Linear probability model with robust standard errors clustered at community level in parentheses. Family planning indicates whether there was family planning available within 40 km in 1990. Additional variables not shown are dummies for religion (orthodox, muslim), average yearly rainfall and its square, elevation and its square, dummies for market in area, road access all year, and road access during the dry season, zone population size, percent of zone's population in urban areas, percent with 1-6 years of education in zone, community population, region dummies, and ethnic group dummies. Number of observations for all models is 1388. Complete results including other explanatory variables are available on request.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.

Table 7 shows the effects of family planning on the last birth or current pregnancy being unwanted. The results should, however, be interpreted with caution because around 80 percent of women have had access to family planning services for at least two years at the time of the survey, whereas our family planning access measure reflects long-run access. In other words, the results show the difference between having long-term exposure to family planning and relatively short-term or no exposure. To capture control over fertility, women without children are coded as not having had an unwanted birth or pregnancy; women who have had no children have presumably been able to avoid a pregnancy at least in part because of access to family planning. The average effects indicate that longer exposure to family planning reduces the risk of an unwanted birth or pregnancy but the effects are small and not statistically significant. The results by age group show, however, that older women benefit from family planning in terms of avoiding unwanted fertility. For women aged 43 to 49 there is a substantial reduction in the probability of last birth or current pregnancy being unwanted and this effect is statistically significant. That there is a reduction in unwanted fertility among the older women indicates that the reductions in fertility is likely due to family planning access and not health facilities. These women also constitute a better comparison group because more will have stopped child bearing, or at least wanted to, before the substantial increase in program access.

Table 8: Effect of Family Planning Access on
Recent Birth or Pregnancy for Women Without Schooling

	Birth within last 12 months or currently pregnant			
	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Family planning	−0.067*		−0.063	
	(0.037)		(0.069)	
Family planning × age 17-22		0.090		0.360*
		(0.123)		(0.207)
Family planning × age 23-27		−0.092		−0.031
		(0.087)		(0.174)
Family planning × age 28-32		−0.111*		−0.157
		(0.063)		(0.110)
Family planning × age 33-37		−0.078		−0.137
		(0.093)		(0.119)
Family planning × age 38-42		−0.112*		−0.295***
		(0.067)		(0.085)
Family planning × age 43-49		−0.029		−0.110
		(0.044)		(0.107)

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Linear probability model with robust standard errors clustered at community level in parentheses. Family planning indicates whether there was family planning available within 40 km in 1990. Additional variables not shown are dummies for religion (orthodox, muslim), average yearly rainfall and its square, elevation and its square, dummies for market in area, road access all year, and road access during the dry season, zone population size, percent of zone's population in urban areas, percent with 1-6 years of education in zone, community population, region dummies, and ethnic group dummies. Number of observations for all models is 1388. Complete results including other explanatory variables are available on request.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.

Finally, Table 8 presents the estimated impact of long-term access to family planning on whether a woman has either had a birth within the last 12 months or is currently pregnant. As for Table 7, the results show the difference between having access to family planning for a substantial period of time and only having access for a relatively short period of time or not at all. In the OLS estimation, the average effect is negative and statistically significant. Although the IV result in Model III is not statistically significant it is of similar magnitude as the OLS results and indicates that a woman with long-term access to family planning is around 6 percentage points less likely to have had a birth within the last 12 months or be currently pregnant compared to a woman with short-term or no access to family planning. The average effect masks substantial differences across age groups. For women 22 or younger access to family planning *increases* the chance of a recent birth or pregnancy; the IV effect for women 17 to 22 is statically significant and positive, which may be the result of bunching of births if access to family planning delayed births for women less than 17 years old. For all other women the effect of access is negative. The IV results show large and statistically significant reductions in the probability of a recent birth or pregnancy with women 38 to 42 being 30 percentage points less likely with access to family planning. For the other age groups from age 28 and up, the effect is a reduction of between 10 and 15 percentage points in the likelihood of having recently given birth or currently begin pregnant. The reason for the lack of significance for the oldest age group is likely that few women give birth at that age making it difficult to isolate the effect of family planning with precision. Again, this evidence points to the direct role of family planning access on age differentiated fertility patterns as opposed to indirect effects of health services.

5 Conclusion

Despite an increasing recognition of the need to reduce population growth, especially in high fertility, low-income settings, family planning programs continue to receive only scant attention as a possible instrument to do so. This is partly due to the lack of reliable, empirical evidence about their effectiveness. The methodological challenges involved in controlling for non-random program placement of family planning programs make it particularly hard to reliably estimate their effect on the ground. Although experimental data provide a theoretically "clean" way to address these concerns, their application to fertility is complex given the time span over which fertility decisions are made. Therefore, in practice, only survey data are usually available.

This paper studies the effects of family planning on fertility in Ethiopia and to address potential non-random program placement uses a set of novel instruments: the rankings of area characteristics (as opposed to the levels). Such ranking of area characteristics are likely reflective of policy makers' actual decision process when allocating family planning programs, while not affecting fertility directly. They are intuitive and easy to generate from readily available secondary data like a census or even from the primary data set itself, enabling easy replication of the methodology in other settings. That the IV estimates are larger than the OLS estimates is in line with the results of earlier studies of family planning programs using longitudinal data (Rosenzweig and Wolpin 1986; Pitt et al. 1993). These studies found that fixed effects estimates were larger than OLS estimates indicating a downward bias in OLS estimates. The larger IV effect is an indication of a compensatory approach to allocation of programs, where resources are provided to less-endowed areas with higher fertility.

The results suggest that access to family planning reduces the total number of children born for Ethiopian women without education. The reduction in completed fertility is large at more than one child. Moreover, the actual impact is likely larger as the results are arguably underestimates. Our approach is conservative in attributing no access to women who have some access later in the study period. This biases our impact estimates downward. No effect of access to family planning was found among women with some education, suggesting that family planning may act as a substitute for education in reducing fertility. This is a crucial insight. It suggests that access to family planning may result in immediate effects in high fertility, low income settings, typically characterized by high proportions of women without formal education. It also highlights the importance of disaggregating the effects of family planning access by educational attainment, something that has been largely ignored so far in the literature.

The available evidence further supports the conclusion that the reduction in fertility is attributable to the availability of family planning, and not the indirect result of the presence of health services per se. First, using access to health facilities as the program variable instead of family planning leads to smaller and statistically insignificant effects that are consistent with only family planning access having an impact on fertility. Second, if health facilities were responsible, one would expect a larger effect on child mortality than we find. Finally, the reductions in unwanted and recent pregnancies and births for the older age groups of women are direct evidence that access to family planning directly impacts fertility.

Despite the relatively large estimated effect of family planning, sceptics will rightly argue that it will by no means suffice to reduce fertility in Ethiopia to near replacement levels. Nevertheless, it does suggest a low cost and complementary entry point to reduce fertility and speed up the development process in such a setting. This is especially important in poor areas where low schooling level and high fertility rates prevail. As simulated in World Bank (2007), in addition to improving women's health and overall empowerment, the long term and self-reinforcing consequences of initiating such a process can be substantial. With the total fertility rate still exceeding 5 children per woman in more than 20 countries, the opportunities are clearly substantial.

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A Appendix

Table A-1: Estimated Effect of Family Planning Access on Children Ever Born for Women Without Schooling

	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Age 23-27	1.516***	1.377***	1.526***	1.487***
	(0.133)	(0.141)	(0.136)	(0.168)
Age 28-32	2.976***	3.022***	2.994***	3.018***
	(0.156)	(0.174)	(0.153)	(0.198)
Age 33-37	4.243***	4.310***	4.260***	4.332***
	(0.187)	(0.194)	(0.190)	(0.209)
Age 38-42	5.003***	5.029***	5.023***	5.121***
	(0.198)	(0.222)	(0.202)	(0.259)
Age 43-49	5.456***	5.588***	5.470***	5.513***
	(0.292)	(0.332)	(0.290)	(0.371)
Orthodox	−0.357	−0.358	−0.365	−0.357
	(0.258)	(0.258)	(0.261)	(0.264)
Muslim	0.083	0.082	0.090	0.098
	(0.233)	(0.232)	(0.230)	(0.232)
Avg. yearly rainfall (mm/100)	−0.075	−0.081	−0.109	−0.114
	(0.113)	(0.111)	(0.137)	(0.139)
Avg. yearly rainfall^2/100	0.289	0.319	0.441	0.466
	(0.485)	(0.476)	(0.594)	(0.607)
Elevation (m/100)	−0.017	−0.007	0.003	0.008
	(0.139)	(0.140)	(0.145)	(0.146)
Elevation^2/100	0.157	0.130	0.103	0.091
	(0.343)	(0.344)	(0.361)	(0.361)
Market in area	0.002	0.006	0.023	0.025
	(0.147)	(0.147)	(0.145)	(0.145)
Road access - all year	0.205	0.235	0.198	0.209
	(0.233)	(0.230)	(0.235)	(0.232)
Road access - dry season	0.349	0.368	0.334	0.335
	(0.227)	(0.225)	(0.230)	(0.230)
Zone population size / 10,000	0.000	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Percent of zone's population in urban areas	0.004	0.007	0.006	0.008
	(0.022)	(0.021)	(0.021)	(0.020)
Percent with 1-6 years of education in zone	0.011	0.013	0.010	0.011
	(0.027)	(0.027)	(0.027)	(0.026)
Community population / 1000	−0.020	−0.021	−0.018	−0.020
	(0.015)	(0.015)	(0.016)	(0.016)
Family planning	−0.707***		−0.924**	
	(0.208)		(0.452)	
Family planning × age 17-22		−0.683**		−0.737
		(0.267)		(0.487)
Family planning × age 23-27		0.211		−0.516
		(0.248)		(0.560)
Family planning × age 28-32		−0.913**		−0.909
		(0.373)		(0.741)
Family planning × age 33-37		−1.022***		−1.160*
		(0.382)		(0.605)
Family planning × age 38-42		−0.820*		−1.265*
		(0.452)		(0.754)
Family planning × age 43-49		−1.466**		−1.031
		(0.653)		(1.244)
Constant	2.135	1.985	2.085	1.949
	(2.427)	(2.370)	(2.406)	(2.365)
R^2	0.483	0.487	0.482	0.484
Observations	1388	1388	1388	1388

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Robust standard errors clustered at community level in parentheses. Family planning indicates whether there was a family planning within 40 km in 1990. Variables not shown are region dummies and ethnic group dummies.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.

Table A-2: Estimated Effect of Family Planning Access on Children Ever Born for Women with Education

	OLS		IV Model of Predicted Placement[a]	
	Model I	Model II	Model III	Model IV
Age 23-27	1.184***	1.093***	1.188***	1.173***
	(0.177)	(0.202)	(0.178)	(0.249)
Age 28-32	2.294***	2.284***	2.288***	2.102***
	(0.176)	(0.221)	(0.183)	(0.275)
Age 33-37	3.742***	3.388***	3.739***	3.283***
	(0.265)	(0.310)	(0.264)	(0.342)
Age 38-42	3.661***	3.640***	3.668***	3.611***
	(0.419)	(0.534)	(0.420)	(0.582)
6-12 years of education	−0.253	−0.265*	−0.181	−0.198
	(0.158)	(0.157)	(0.181)	(0.186)
Orthodox	−0.089	−0.088	−0.124	−0.075
	(0.255)	(0.268)	(0.231)	(0.245)
Muslim	0.087	0.087	0.041	0.094
	(0.329)	(0.337)	(0.310)	(0.308)
Avg. yearly rainfall (mm/100)	−0.068	−0.078	−0.046	−0.079
	(0.132)	(0.132)	(0.148)	(0.143)
Avg. yearly rainfall^2/100	0.258	0.289	0.164	0.290
	(0.550)	(0.552)	(0.664)	(0.633)
Elevation (m/100)	−0.072	−0.055	−0.089	−0.066
	(0.133)	(0.136)	(0.153)	(0.154)
Elevation^2/100	0.221	0.180	0.270	0.212
	(0.336)	(0.342)	(0.396)	(0.393)
Market in area	−0.049	−0.045	−0.066	−0.053
	(0.201)	(0.203)	(0.204)	(0.199)
Road access - all year	−0.014	−0.031	0.001	−0.043
	(0.239)	(0.238)	(0.246)	(0.237)
Road access - dry season	0.321	0.289	0.355	0.293
	(0.244)	(0.247)	(0.251)	(0.247)
Zone population size / 10,000	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.002)	(0.001)
Percent of zone's population in urban areas	0.030**	0.028**	0.030**	0.028**
	(0.013)	(0.014)	(0.013)	(0.013)
Percent with 1-6 years of education in zone	−0.065*	−0.063*	−0.065*	−0.063*
	(0.034)	(0.034)	(0.034)	(0.034)
Community population / 1000	−0.020**	−0.020**	−0.020**	−0.020**
	(0.008)	(0.008)	(0.009)	(0.009)
Family planning	0.364		0.627	
	(0.249)		(0.583)	
Family planning × 6-12 years of education	−0.245	−0.128	−0.536	−0.358
	(0.260)	(0.279)	(0.516)	(0.584)
Family planning × age 17-22		−0.016		0.044
		(0.288)		(0.411)
Family planning × age 23-27		0.400		0.218
		(0.408)		(0.721)
Family planning × age 28-32		0.095		0.791
		(0.400)		(0.851)
Family planning × age 33-37		1.396***		1.847**
		(0.499)		(0.782)
Family planning × age 38-42		0.105		0.282
		(0.561)		(0.941)
Constant	3.620**	3.508*	3.684**	3.568*
	(1.740)	(1.792)	(1.782)	(1.861)
R^2	0.452	0.459	0.451	0.453
Observations	693	693	693	693

Notes. * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Robust standard errors clustered at community level in parentheses. Family planning indicates whether there was a family planning within 40 km in 1990. Additional variables not shown are region dummies and ethnic group dummies.
[a] Weighted IV estimation using Stata's svy command with family planning access treated as endogenous.