Family Planning and Fertility: Estimating Program Effects using Cross-sectional Data*

Claus C Pörtner
Department of Economics
University of Washington
Seattle, WA 98195-3330
cportner@u.washington.edu

Kathleen Beegle
1818 H St, NW
The World Bank
Washington, DC 20433
kbeegle@worldbank.org

Luc Christiaensen
1818 H St, NW
The World Bank
Washington, DC 20433
lchristiaensen@worldbank.org

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Abstract

This paper uses a novel method of identifying the effects of a family planning program when there is endogenous program placement and only cross-sectional data are available, which is a common situation in many developing countries. Using data from Ethiopia we find that access to family planning reduces cumulative fertility by about 0.5 children for women younger than 30, while there is less of an effect for older women. This effect is statistically significant and in line with what studies have found in other countries. Correspondingly we also find a significantly lower probability of having had a birth within the last twelve months. Clearly, the reduction in fertility is not overly large when compared to the high total fertility rate in Ethiopia. We do, however, find other positive effects of access to family planning program. Firstly, women are generally older when they have their first child in areas with family planning service, which may have a beneficial effect on child health and the health of the mother. Secondly, it appear that the risk of an unwanted pregnancy decreases, especially for older women, then there is access to family planning.

Keywords: Family planning, fertility, program evaluation, Ethiopia

JEL codes:

1 Introduction

Despite years of concern about rapid population growth and the promotion of family planning many African countries still have high fertility rates. A good example is Ethiopia as described in World Bank (2006). During the period 1990 to 2005 Ethiopia's total fertility rate declined only by about one child despite an large increase in the availability of family planning, while the use of contraceptives tripled from 5 percent to 15 percent, with a most of the increase coming from modern methods, especially injectables (Central Statistical Authority [Ethiopia] and ORC Macro 2006).[1] Furthermore, the average land holding per rural person was estimated at only 0.21 ha in 1999, down from 0.5 ha in the 1960s, indicating that land pressure is reaching critical levels. This has contributed to a (rapidly growing) core group of five to seven million who are chronically food insecure. In addition, the spatial resettlement of about two million people from the highlands to the lowlands, adopted as one of a series of policy measures by the Coalition for Food Security Commission to tackle the problem of chronic food insecurity in many highland weredas, is unlikely to provide a sustainable solution in light of the estimated annual increase of Ethiopias population by two million people. In light of these developments and concerns attention naturally turns to the role of family planning program in helping individual manage fertility. It is, however, a still underresearched question how effective family

[1] Ethiopia's current total fertility rate is estimated at 5.4.

planning programs are in reducing fertility. Hence, this paper examines the effectiveness of demographic program interventions in Ethiopia.

One of the main problems when evaluating the impact of a program intervention is that the government, or more general the responsible organisation, is likely to respond to characteristics of an area when deciding whether to implement a program there and that some of these characteristics may be unobservable to the researcher and correlated with the outcomes of interest. Say a government is interested in reducing fertility and that the programs are placed in areas that are more deemed more "receptive" to the family planning idea. Then simply comparing places with and without family planning may overestimate the effects of the program for a given level of fertility before the program was implemented.[2] A good illustration of these problems can be found in Pitt, Rosenzweig, and Gibbons (1993); they show using data from Indonesia that not taking account of the non-random placement of programs leads to substantial biases in the estimated program effects.

The most straight-forward way of overcoming the problem of non-random placement is to randomize the allocation of the programs and then compare the outcomes of interest between the treatment and control areas.[3] Probably

[2]This is just one example. It is entirely possible that the researcher may instead end up underestimating the effect. If family planning programs are placed in the areas with the highest fertility and this prior fertility is unobserved by the researcher. Assuming that the program does reduce fertility, then naively comparing areas with and without family planning program may not show any effect of the program depending on the fertility patterns before the program and the size of the effect.

[3]For a discussion of randomized experiments in development economics see, for example, Duflo and Kremer (2003).

the best known example of a family planning program experiment is Matlab, Bangladesh. It began in 1978 when about half of the villages were assigned a very intensive family planning program, while the other half continue to be served by the standard government family planning program. Phillips, Simmons, Koenig, and Chakraborty (1988) found that fertility was 24 percent lower in the villages that had received the intensive family planning program than in the other villages. Pritchett (1994), however, argued that these results reflect a level of program intervention and intensity unlikely to be sustainable, since the program was exceedingly expensive. Per woman reached the program cost 35 times more than the standard government family planning program.[4] A more recent study of the Matlab family planning program is Joshi and Schultz (2005). They analyse the same 141 villages in Matlab, Bangladesh from 1974 to 1996 and find that village and individual data show a decline in fertility of about 15 percent in the program villages compared with the control villages.

While experiments appear to offer an attractive means to avoiding the problems of non-random placements there are a number of drawbacks to this approach. Firstly, given the substantial lag in fertility decisions, an experiment would have to run for a substantial period of time before one was able to assess the effect on fertility. Any short-run effects may simply reflect changes in spacing-pattern rather than actual changes in the overall

[4]Pritchett (1994) calculates that each averted birth cost USD 180 in 1987, which was equivalent to 120 percent of Bangladeshs GDP per capita at the time.

number of children. Secondly, it is not clear to what extent an experiment in, say, Bangladesh can inform the creation of programs in Ethiopia given the substantial differences in the structure of the economies and the issues facing the population. Finally, in many areas family planning programs have been in existence for a substantial period of time and not using the information that can be derived from these programs is unattractive.

An alternative approach is to use longitudinal data. If these are available it is, in principle, straight-forward to estimate the effect of a program using fixed effects estimation, which removes the problem of unobservable characteristics influencing the program placement. There are, however, two caveats to this approach. Firstly, there must be a sufficient number of areas which acquire a program between the (minimum) two data points. Secondly, the time period between the surveys must be long enough for the program to have an effect. If these conditions are not fulfilled it is difficult to identify the program effects with any precision.[5] Two example of studies that have used longitudinal data to identify program effects are Rosenzweig and Wolpin (1986) for the Laguna province in the Philippines and Pitt, Rosenzweig, and Gibbons (1993) for Indonesia. In both the cross-sectional estimates show substantial bias compared with the fixed effects estimates. Only Pitt, Rosenzweig, and Gibbons (1993) directly examine the effect of family planning programs on fertility. They find that although there does appear to be a negative effect, it

[5]There are also additional problems with using fixed effects in situations like this, such as more substantial bias from measurement errors than in cross-section estimations. For a discussion of this and other problems see, for example, Angeles, Guilkey, and Mroz (1998).

is very imprecisely estimated. In Rosenzweig and Wolpin (1986) the family planning programs do have a significant and positive effect on child health as measured by both (standardised) weight and height.

For the above reasons and the scarcity of available experimental or longitudinal data researchers are often faced with using cross-sectional data for analysing interesting questions when examining program effects. Two recent examples, which use very different approaches to overcome the problem of non-random program placements, are Angeles, Guilkey, and Mroz (1998) and Miller (2005). Although the method in Angeles, Guilkey, and Mroz (1998) is not strictly speaking a standard instrumental variable approach the underlying idea behind their method is very similar. First, they estimate the selection process used to determine program placement. Second, they estimate the program effects using a semiparametric, random-effects estimator which allows for correlation between unobservables that influence program placement and the outcomes of interest. Identification comes from variables that are claimed to influence program placement, but are unrelated to the individual fertility decision. The main issue is that some of these variables are likely to be correlated with unobservable variables that influence both placement and fertility decisions, such as child mortality levels and the presence of other family planning services. Using data from Tanzania, they find that family planning programs do have a negative effect on fertility, although this effect varies with the type of and distance to outlet and how old a woman was when the program was introduced. They find that a woman exposed

to family planning would have 4.13 children instead of 4.71 children in the absence of family planning interventions.

Miller (2005) does not use an instrumental variable approach. Instead, he argues that the hap-haphazardly implementation of the family planning program in Colombia, PROFAMILIA, essentially implies that non-random program placement is not an issue. One potential problem with this approach is that even if (available) observables do not affect placement, it is still possible that unobservables do, in which case the results are still subject to bias. Interestingly, the results Miller (2005) corresponds closely to those of Angeles, Guilkey, and Mroz (1998). He finds that PROFAMILIA led to a reduction in lifetime fertility on the order of half a child. Furthermore, it appears to have a led to a substantial postponement of first birth, which in turn have led to higher education for young women. Miller (2005) finds, however, that only around 10 percent of the sharp decline in fertility in Colombia can be explained by the family planning programs.

Given the issues with using randomized experiments to evaluation family planning programs and the lack of longitudinal data in most settings this paper focuses on the evaluation of family planning programs in Ethiopia using cross-sectional data. The method we use follows the basic framework laid out in Menon and Pitt (2001), who suggested that under certain circumstances area characteristics can be valid instruments for the placement decision. The advantages of these instruments are that they are easy to understand and likely to reflect what policy makers care about while not being directly related

to fertility and hat they are easy to create from readily available secondary data like a census or even from the primary data set itself. We find that access to family planning reduces the age specific fertility by about 0.5 children for women younger than 30, while there is less of an effect for older women. This effect is statistically significant and in line with what other studies have found. We also find a significantly lower probability of having had a birth within the last twelve months. Furthermore, we find other positive effects of access to family planning program. Firstly, women are generally older when they have their first child in areas with family planning service, which may have a beneficial effect on child health and the health of the mother. Secondly, it appear that the risk of an unwanted pregnancy decreases, especially for older women, when there is access to family planning.

2 Family Planning in Ethiopia

The government of Ethiopia adopted a population policy in 1993 with an overall objective of harmonizing the country's population growth rate with that of the economy, specifically to achieve a TFR of 4 children per women by 2015. One of the major strategies has been to expand access to family planning programs so that by 2015 contraceptive prevalence would reach 44 percent (Transitional Government of Ethiopia 1993).

Ethiopia has historically had a very low level of contraceptive use and has one of the lowest contraceptive prevalence rates in Sub-Saharan Africa.

According to the first ever national survey on fertility and family planning in 1990 only four percent of women of reproductive age were using some family planning methods and less than three percent were using modern contraceptives (CSA, 1993). In 2000 the CPR for currently married women had increased to six percent (Central Statistical Authority [Ethiopia] and ORC Macro 2001).

Recently a number of surveys indicate that the use of family planning has significantly increased since the 2000 DHS. Preliminary results from DHS 2005 show that 15 percent of married women use some method of contraception and that the majority of them rely on a modern method (Central Statistical Authority [Ethiopia] and ORC Macro 2005). Hence, use of modern contraceptive methods has more than doubled from 6 percent of currently married women in the 2000 DHS to 14 percent in the 2005 DHS. This is in line with what is reported in Essential Services for Health in Ethiopia (2005), but it appears that Pathfinder International Ethiopia (2004) overestimate the increase in contraceptive use, which is probably due to the oversampling of areas where Pathfinder is active.[6] It is worth noting that in spite of the

[6]The Essential Services for Health in Ethiopia (ESHE) conducted three regionwide 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, respectively. The average modern contraceptive prevalence rate for the three regions combined was 15 percent (Essential Services for Health in Ethiopia 2005). In September 2004, Pathfinder International Ethiopia conducted another 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).

increase in contraceptive use the TFR has only fallen 0.1 between the two DHS surveys (5.5 to 5.4), which may not be surprising given that we would expect a substantial lag between changes in contraceptive use and fertility.

Regional variation is clearly apparent in the preliminary results of the 2005 DHS. The use of modern contraceptive is 45 percent in Addis Ababa and 3 percent in the Somali Region. The three big regions, namely Oromia, Amhara and Southern Nations Nationalities Peoples (SNNP), which constitutes over 70 percent of the country's population, have contraceptive prevalence rates of 13.6, 16.1 and 11.9 percent, respectively.

There are also significant urban/rural, and poor/rich differences in contraceptive use. While CPR is 46.7 percent in urban areas, it is only 10.9 percent in rural areas. Unfortunately, data on the distribution by rich and poor is not yet available for the 2005 DHS, but in the 2000 DHS the differentials between the rich and poor were enormous, with 29 percent of rich women and only 2 percent of poor women using any method of contraception.

The 2005 Ethiopia DHS shows that the most commonly used modern methods are injectables (10 percent) and the pill (3 percent). The other modern methods are used substantially less: Condoms (0.1 percent), female sterilization (0.1 percent), IUD (0.2 percent) and any traditional method (0.8 percent).[7] For comparison the numbers for the 2000 DHS were injectables (3.1 percent), followed by the pill (2.5 percent), condom (0.3 percent), female

[7]These numbers are based on Table 4 in Central Statistical Authority [Ethiopia] and ORC Macro (2005) and are very imprecise given rounding errors.

sterilization (0.3 percent), IUD (0.1 percent) and any traditional method (1.7 percent). This means that over 80 percent of contraceptive prevalence in that year was accounted for by the injectables and pills.

It is widely believed that most family planning clients in Ethiopia prefer injectables to other methods because of its convenience as it is taken as a single shot to provide protection for three months. On the other hand, there are a number of deterrents to the uptake of long-term methods in the country. For example, an assessment of the reasons for the low use of IUD in Ethiopia concluded that inadequate information about the method, lack of access and unfounded rumors about the side effects of the method were the most important barriers to use the method (Pathfinder International Ethiopia 2003).

What is interesting is that lack of knowledge does not seem to be a major impediment to use. Among the reasons for not using contraceptives 12.5 percent mention lack of knowledge about methods, while 16.7 mention lack of knowledge about a source of contraceptives. A substantially number of women are not using because of fertility related reasons, which includes everything from not having sex to breastfeeding. Of more interest is that a relatively large number who mention health concerns (including possible side effects) among the reasons for not using contraceptives. This is clearly one area where more information might be beneficial.

3 Estimation Strategy

This section presents our strategy for estimating the effects of access to family planning programs. We first discuss the issue of non-random placement of family planning programs. Then we outline an econometric model that can account for endogenous program placement. Finally, we present the basic idea behind our instruments and discuss how they can help in overcoming the problems.

During our conversations with NGOs responsible for the introduction of community based reproductive health (CBRH) agents we asked them which factors influenced their decisions on where to place new programs. The main factors were access to a family planning clinic in the area and accessability to the area.[8] There was, however, also a third important factor, which is also the most interesting one: The extent to which an area was considered "receptive" to the family planning idea. The important difference between the two first factors and the third is that the former are, in principle, measurable, while the latter is generally unobservable.

Although we do not claim that the Ethiopian administration distributes health facilities and family planning program according to the same critia as the NGOs, it illustrates that it is likely that we are, in fact, dealing with two (related) decisions: Where to place family planning programs and whether

[8]The presence of a clinic is important since the agents can only distribute a limited set of contraceptives and instead refer clients with other needs to a health center or health post.

to use the services offered if available. These two decisions are, of course, made by different agents; the government/NGO decides where to place the programs, while the individual woman/family decides whether to use the programs. The main issue here is that there may be unobservable factors which influence both whether to place a program in an area and whether women in the area will use the services. These factors need not be directly related to the desire to use family planning services as in the above example. A government may, for example, favour areas or ethnic groups what supports it. As long as these areas or groups respond differently to the implementation of the program we need to find a way to avoid any bias that might result from these unobservable characteristics.

We first estimate the determinants of the decision on whether to place a program P in area k and secondly the program effect on the individual decision y_{ik}. The system of equations is then

$$P_k = \boldsymbol{X}_k\alpha_1 + \boldsymbol{Z}_k\alpha_2 + \nu_k, \quad (1)$$

$$y_{ik} = \boldsymbol{X}_k\beta_1 + \boldsymbol{X}_i\beta_2 + P_k\beta_3 + \epsilon_{ik}, \quad (2)$$

where $\boldsymbol{X}_k$ is a vector of exogenous variable that are area specific, $\boldsymbol{Z}_k$ is a vector of area specific exogenous variables that affect program placement but do not affect the individual fertility decision, the individual characteristics are captured by $\boldsymbol{X}_i$ and finally, the main variable of interest is P_i which measures the program's impact on the outcome of interest. As discussed by

Wooldridge (2002, Chapter 18) β_3 can be estimated under relatively relaxed conditions using a modified two stage method. The first stage estimates the determinants of the placement decision. In the second stage the individual decision equation is estimated by IV using the *fitted probabilities* from the first stage, $\mathbf{X_k}$ and $\mathbf{X_i}$ as instruments. An attractive feature of this approach is that the results are robust even if the placement equation is not correctly specified.

The major difficulty is finding a set of "instruments" that can be used to identify β_3 in (2). A promising possibility is to use relative characteristics of different areas as suggested in Menon and Pitt (2001). To fix ideas assume that there are only two areas, A and B, and that these two areas compete for resources from the government. We might expect the average education of women in area A to affect fertility in area A, but the average education of women in area B should not affect fertility in area A. Since the two areas compete for resources we do, however, expect that the relative distribution of education will affect the program placement decision. The government could, for example, be more inclined to place a family planning program in the area with lower average education.

Menon and Pitt (2001) used average characteristics of areas, such as education level, for their instruments. A potential issue with this approach is that if network effects are important these averages might not serve as valid instruments. One could use the ratio of these averages to the overall (national) average. The main drawback of this approach is, however, that

it requires a weighting of the characteristics based, for example, on distance between the areas. Furthermore, this weighting is essentially set outside the model by the researcher. It is possible to assign a unit weight to all characteristics and achieve identification, but if one increases the number of areas in the survey the matrix will eventually become of non-full rank. An alternative is to use the ranking of various variables which are believed to be important in determining the placement decision. The benefit of this approach is that it does not require weighting and that it makes intuitive sense. We use this method here.

4 Data and Variables

This section first describes the data sources used. Secondly, we discuss the definition of the variables used for the estimation of the determinants of the program placement decision and their descriptive statistics. Finally, we do the same for the individual decisions.

We use three data sources. The first is a contraceptive use survey collected under the auspices of Pathfinder International – Ethiopia, the second is a facility survey collected by the World Bank to match the Pathfinder survey and finally we supplement with data drawn from the 1994 census of Ethiopia. We describe each in turn.

The Pathfinder survey was collected in September 2004 from the four largest regions: Amhara, Oromia, SNNPR and Tigray. The objective was to

provide information on the current level of knowledge, attitude and practice of family planning. The survey used a stratified multi-stage sampling design with four regional states combined with urban-rural residence for each of the regions. In each, the survey provided a representative sample. Weredas constituted the primary sampling units and a total of 58 weredas were sampled. A total of 176 PA/kebeles (113 rural and 63 urban) was included in the study.[9] Weights are provided to make the sample representative at the national level. We use these weights for all descriptive and regression analyses as well as take into account the sampling method.[10]

The Wereda Health Facility and CBRH (WHFC) survey of weredas was conducted in July 2005 with the intent to collect information on health facilities, family planning services and Community Based Reductive Health (CBRH) programs available in Ethiopia. The WHFC was designed to be used in conjunction with existing household survey data on fertility and reproductive health issues, specifically the Pathfinder Survey and therefore covered the 58 weredas surveyed by Pathfinder. The information came from health departments or social sector departments and in each of the sampled weredas general questions were asked regarding the whole wereda while detailed questions were asked of the PA/kebele in the wereda covered by the Pathfinder Survey. That is, the WHFC did not collect information specific to all PAs/kebele in the wereda.

[9]Pathfinder International Ethiopia (2005) provides more information on the survey.
[10]This is done using Stata's svy commands.

Unfortunately, it was not possible to locate all PA/kebeles which led to five PA/kebeles being dropped. Furthermore, after data collection was done there was some uncertainty about whether the towns surveyed in the facility survey were the same as in the Pathfinder survey. Hence, 26 additional kebeles were dropped. Furthermore, 9 PA/kebeles were dropped because essential information were missing, specifically the presence of health facilities and their introduction. Finally, 16 additional PA/kebeles were dropped because it proved either impossible to find census data for the areas or because other important information was missing. The sample used here consists of 50 wereda and 125 PA/kebele covering a total of just over 2700 women, which becomes just below 2200 after excluding never married and never partnered women.

4.1 Placement of Programs

The three main facilities or programs that might influence individual fertility decisions are health facilities, family planning services and CBRH programs. The main variable of interest here is obviously access to family planning. For all kebeles and PAs we have information on whether a health facility is available and if so when the facility was opened. Furthermore, we know if family planning services are offered at the health facility and when it first offered family planning services. A PA/kebele is coded as having access to a health facility or family planning program if there is either one in the PA/kebele or there is less than 40 kilometers to the closest one. Note that

kebeles are essentially districts of a town and identifying placement within a town is beyond the capability of our data and is also of less interest since most of these towns are small and travel within them should be relatively easy. The maximum distance to the closest facility in the case where a kebele does not have family planning services but where another kebele within the town had is 3.5 kilometers. For comparison the maximum travel distance to the closest health facility or family planning program for the rural Peasant Associations is 40 kilometers.[11] While this might appear to be a relative long distance the average distance at the time of the survey for those PAs that do not have health facilities is only around 10 kilometers. Furthermore, most people would only need to go the family planning program about three months, either to pick up more pills or renew the injection. Figure 1 shows the development in access to health facilities, family planning services and CBRH programs over time.

Of interest is not only if there is a health facility with family planning in the immediate area but also for how long family planning has been available. We therefore estimate the determinants of whether family planning was available at given points in time: 1990 and 1997 (which are 1983 and 1990 in Ethiopian calendar). For Peasant Associations we use the year family planning services was offered in that administrative area. For kebeles we use the year the closest health facility began offering family planning services

[11]There is only one PA/kebele where there is 40 km to the closest family planning program and the second-longest distance is 30 km.

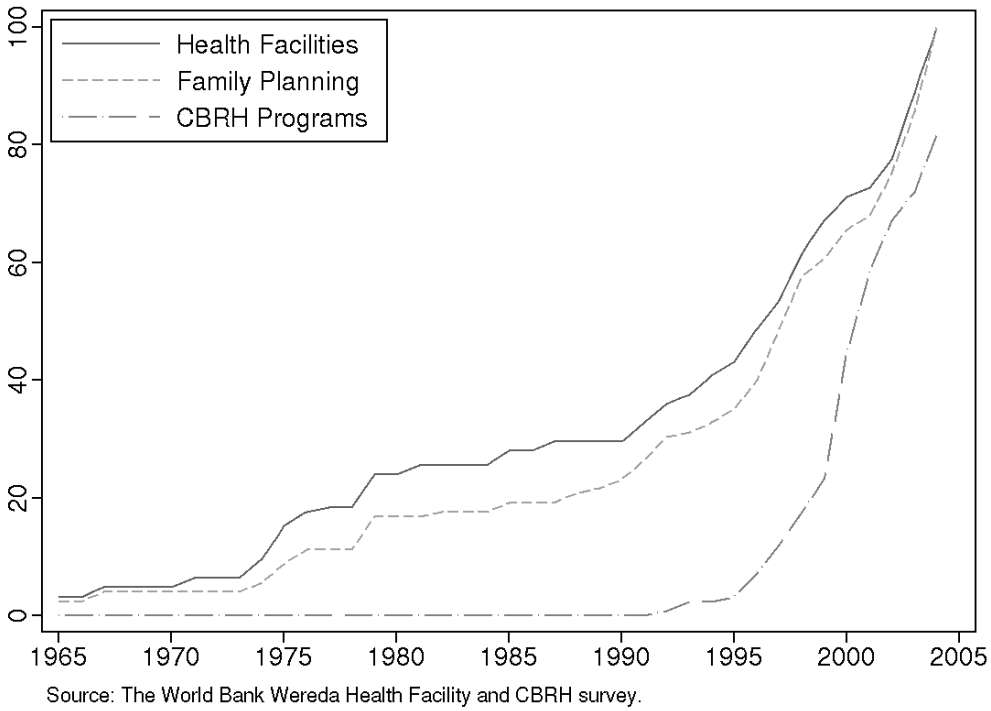


Figure 1: Percent PA/kebeles with access to Health Facilities, Family Planning or CBRHA (N=125)

whether or not the health facility is located in the kebele or a neighbouring kebele. The motivation for this difference is that, as mentioned, kebeles are essentially districts of a town and identifying placement within a town is beyond the capability of our data and is also of less interest since most of these towns are small and travel within them should be relatively easy. These two years are chosen to allow the program to have an effect on fertility, while still being relatively recent. If we chose a year closer to the survey date it is likely that we would see a lower effect of the program since it would not

have had time to affect most of the people in the survey. Unfortunately, we do not have birth histories, which means that we cannot examine how the timing of births responds to the introduction of family planning.

One issue with this definition is that including family planning programs that are not in the PA/kebele itself makes the estimation of the placement decision less precise, but the alternative, which is to ignore family planning programs outside the PA/kebele is likely to substantially bias downward the results of the fertility estimation. Another potential issue is that family planning services might have been available earlier in a neighbouring administrative area. We unfortunately do not have information about this. Similarly it is that possible changes in facility type might not be reflected in start date (i.e. change from clinic to center). It is therefore possible that some areas are coded as only having a had family planning services for a relatively short period since a new health center has just opened in the area, even though the neighbouring area offered family planning services for longer.

Table 1 shows the descriptive statistics for the two dependent variables and the explanatory variables. The explanatory variables can be divided into two categories. Firstly, those that affect both placement and the individual decisions. Secondly, the "instruments" or variables that are assumed to only affect the program placement.

As mentioned above we use rank variables as the main instruments in the placement decision estimation, with higher rank equal to a larger value of the underlying variable. The variables are ranked at two levels. Firstly, they

Table 1: Descriptive Statistics for Program Placement

	Mean	Standard Error
Dependent Variables		
Family planning program before 1990	0.19	0.04
Family planning program before 1997	0.36	0.05
Length of exposure to family planning	6.77	0.88
Zone variables		
Distance to Addis Ababa (km)	454.26	16.58
Wereda variables		
Average yearly rainfall	1183.69	39.58
Average yearly rainfall^2/1000	1566.47	102.26
Total area	14.36	0.99
PA/kebele variables		
Urban area	0.07	0.00
Market in area	0.36	0.05
Distance to town (km)	16.09	1.48
Distance to town^2	455.94	113.45
Road access - all year	0.43	0.05
Road access - dry season	0.37	0.05
Ranking of Zones (Nationally)		
Total population	22.33	0.88
Urbanisation	19.29	0.75
Percent orthodox	19.85	0.78
Percent muslim	19.05	0.88
Percent with 1-3 years of education	17.01	0.57
Percent with 4-6 years of education	18.09	0.71
Percent with 7-8 years of education	18.69	0.76
Percent with 9 or more years of education	19.68	0.86
Percent with non-regular education	19.79	0.85
Ranking of Towns/PA (Within Zones)		
Total population	2.34	0.13
Number of observations	125	

NOTE: Estimated means and standard errors based on sample frame and weights
The ranking of zones is based on the available sample, with 1 corresponding to the highest absolute value for a given variable. For towns and PA the ranking is based on the sample available within a zone.

are ranked between the 37 zones in the sample. Secondly, within zones the PA/kebeles are ranked. For zones the variables are the rank of the size of the population, rank of the degree of urbanisation (measured as the percent of the population who live in urban areas), the rank of the proportion of orthodox and the rank of the proportion of muslim between the areas and the rank of percentage of adults with various levels of education (1-3 years, 4-6 years, 7-8 years and 9 and above, and non-regular). These ranks are all based on data from the 1994 Census. The reasons that the means of the rankings are not all equal to 19 are that not all zones have the same number of PA/kebeles and that weights are applied to the calculate the means. The PA/kebeles are ranked within each zone by their population size. The maximum number of PA/kebeles within a zone is eleven, while for five zones there is only one PA/kebele in the survey. While it would be advantageous to have more information at the PA/kebele level the number of possible variables is limited by the lack of information at that level in the census.

The remaining variables for the first stage are variables that are likely to affect the placement decision, but might also have an effect on the individual decisions. At the zonal level the distance to Addis Ababa is the only variable.[12] At wereda level we have the average yearly rainfall and its square plus the total area of the wereda. Finally, at the PA/kebele level we have

[12]This distance is calculated as the mean of the distances from the weredas within each zone, which were collected in the WHFC survey.

a dummy for whether is it an urban area (or in other words, whether it is a kebele), and one for whether there is a market in the area, the distance to the closest town and the distance squared (with the distance being set to zero if it is a urban area). The accessibility of the area is 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).

4.2 Individual Fertility Decision

Table 2 shows the variables and their descriptive statistics for our estimation of the impact of family planning on fertility. The sample consists of all women how have evered been married or lived together with a man.[13] The dependent variable is the number of children born at the time of the survey, which is on average 3.4. Considering that the average age of the women interviewed is just over 28 years this is a relatively high number of children, which reflects the very high fertility rate in Ethiopia.[14]

There are six variables which are individual specific. Beside age and age squared (divided by 100), there are four dummy variables. The first two capture for whether the person has between one and five years of education and whether the woman has graduated primary school and/or gone to school further. The last two are dummies for whether she is orthodox or muslim.

[13]The results are fairly similar if singles are included in the sample. The results are available on request.

[14]For comparison the equivalent number for Guatemala is 2.8 and Guatemala has one of the highest total fertility rate in Latin America (Pörtner 2006).

Since the average education level is low, especially in the rural areas, we use a different grouping that than of the first stage to prevent cell sizes which are too small.

Table 2: Descriptive Statistics for Women Ages 15-49

	Mean	Standard Error
Number of children born	3.83	0.09
Age	29.90	0.29
$\text{Age}^2/100$	9.60	0.18
Education (1-5 years)	0.16	0.01
Education (6 or more years)	0.14	0.02
Orthodox	0.57	0.03
Muslim	0.23	0.04
Zone distance to Addis Ababa (km)	460.83	18.02
Market in PA/kebele	0.38	0.05
Area of wereda	14.85	1.06
Average yearly rainfall (mm)	1185.59	42.78
Average yearly $\text{rainfall}^2/1000$	1575.47	106.05
Lives in urban area	0.07	0.00
Distance to town (km)	16.30	1.44
$\text{Distance to town}^2$	454.42	98.90
Road access - all year	0.41	0.05
Road access - dry season	0.41	0.05
Family planning program before 1990	0.21	0.04
Family planning program before 1997	0.36	0.05
Predicted FP program before 1990	0.20	0.03
Predicted FP program before 1997	0.36	0.03
Number of observations	2169	

NOTE: Estimated means and standard errors based on sample frame and weights. Note that the average education level in the Pathfinder survey is higher than in the DHS.

There is unfortunately no information on the migration of the women which makes it difficult to determine for how long she has been exposed to

family planning. Hence, we essentially assume that the woman has spent her entire life in the area where she was found during the survey. This is obviously not a very attractive assumption, given the relocation policy in Ethiopia and marriage migration, but without any additional information most other assumptions would be just as arbitrary.

5 Results

In this section we begin by analyzing the determinants of where family planning programs are placed and how powerful our instruments are. This is the first step of the two-stage method described above. We then turn to the effect of the availability of family planning on the number of children. Finally, we investigate what drives the effect of family planning on fertility by looking at births within the last year, age at first birth and whether the last birth was unwanted.

5.1 Placement of Programs

Table 3 presents the results from the determinants of placement estimations. We focus on the results for 1990 since that is around the time where there is a substantial expansion in access to health facilities and family planning programs, while the prevalence was essentially constant for the decade before that. Hence, most of those women who had access in 1990 were likely to have

had access for a substantial amount of time before 1990.[15]

Most of the variables have the expected signs and are statistically significant. Urban areas and areas that have a market are more likely to also have access to family planning services. In the same vein, the more urbanised a zone is the higher is the likelihood that a given PA/kebele has less than 40 kilometers to the closest family planning program. Furthermore, areas with easier access, as measured by whether there is road access by car, also have statistically significant effects for both all year access and dry season access (with no road being the excluded variable).

For the rank variables most of them are again statistically significant.[16] The F-test for all instruments being jointly equal to zero is 3.17 for 1990 but only 1.21 for 1997. This indicates that our instruments have much more power for 1990 than for 1997, which is not surprising given the large number of areas which have a program by 1997. The larger the population of a zone is the more likely it is that there is family planning program accessible, although the effect is of the opposite sign for the size of the population at the PA/kebele level.[17] Interestingly, the two education ranking that have *positive* effects on placement are the percentage of adults with between four and six years of education and the percentage of adults without any educa-

[15]The results are broadly similar for the two years and although the svyivreg command does not produce standard R-square statistics, the same regressions, with weights, have an adjusted pseudo R-square of 0.65.

[16]Recall that a higher rank is equivalent to a larger underlying variable.

[17]It is worth noting that the actual size of the wereda has a negative and statistically significant effect.

Table 3: Probit – Family Planning Program in PA/kebele

Variable	Begun before	
	1990	1997
Distance to Addis Ababa	−0.001	−0.002
	(0.002)	(0.001)
Market in PA/kebele	0.658*	0.659**
	(0.358)	(0.302)
Total area of wereda	−0.099**	−0.098***
	(0.044)	(0.033)
Rainfall	−0.010***	−0.008***
	(0.003)	(0.003)
Rainfall^2	0.004***	0.003***
	(0.001)	(0.001)
Urban area	2.579***	1.101
	(0.767)	(0.672)
Distance to town	0.050	0.013
	(0.060)	(0.055)
Distance to town^2	0.001	0.001
	(0.001)	(0.001)
Road access - all year	1.160*	0.586
	(0.642)	(0.521)
Road access - dry season	0.294	0.326
	(0.498)	(0.449)
Ranking of Zones		
Total population	0.142***	0.039
	(0.028)	(0.025)
Urbanisation	0.141***	0.036
	(0.040)	(0.028)
Percent Orthodox	−0.016	0.009
	(0.030)	(0.030)
Percent Muslim	−0.052	−0.036
	(0.031)	(0.026)
Percent with 1-3 years of education	−0.229***	−0.122**
	(0.056)	(0.047)
Percent with 4-6 years of education	0.565***	0.258***
	(0.124)	(0.092)
Percent with 7-8 years of education	−0.362***	−0.114
	(0.109)	(0.077)
Percent with 9 or more years of education	−0.162**	−0.095
	(0.070)	(0.065)
Percent with non-regular education	−0.042*	−0.006
	(0.022)	(0.021)
Ranking of PA/kebeles within Zone		
Total population	−0.311**	0.062
	(0.123)	(0.106)
Constant	3.885	5.171**
	(2.816)	(2.293)
All ranks equal to zero F(10,108)	3.17***	1.21
Observations	125	125

NOTES: * sign. at 10%; ** sign. at 5%; *** sign. at 1%
Weighted probit with robust clustered standard errors in parentheses.
Dependent variable is whether there was a family planning within 40 km before the year indicated.

tion. One interpretation of the education rank variables is that the government is actively trying to place family planning programs in areas where the population is relatively less educated, presumably because those with more education are likely to live in areas where there are other means of obtaining family planning services or have lower desired fertility.

Contrary to expectations the distance to Addis Ababa does not seem to have a statistically significant effect on the placement of programs. The same is the same for the distance to town and its squared. Possible reasons for why theses two variables are not statistically significant can be the definition of access to family planning and that distance in itself might not matter so much as how easy it is to get to an area, which is already captured by the urban variables and the road access variables. Furthermore, neither of the two variables that capture the religious make-up of an area have any statistically significant effect.

5.2 Effect of Programs on Fertility

Table 4 shows the results for two different specifications for each of the two cut-off years. Models I and III include the endogenous variable capturing whether family planning services are available, while the two other models furthermore include the interactions between the availability of family planning and age, age squared, having one to five years of education and having

six years or more of education.[18] As discussed above the instrument for the presence of a family planning program is the predicted probability of an area having a program based on the first stage regressions. The instrument for each interactions is the predicted probability interacted with the variable in question.

As mentioned above the dependent variable is cumulative fertility. The two cut-off years allow us to examine between what can be considered the difference between the long and short run effects of access to family planning on cumulative fertility.[19] For the 1997 cut-off, for example, many women will have as little as seven years of exposure to family given the large increase in the number of programs just before 1997. Furthermore, an important caveat here is that many of the women who do not have access to family planning before 1990 will subsequently receive access. The results for both cut-off years are therefore likely to under-estimate the true effect of exposure to family planning programs.[20] There is unfortunately little scope for determining how severe the underestimation is since the Pathfinder data does not collect proper fertility histories.[21]

The main parameters of interest are the family planning ones. The first

[18]For comparison Table A-1 shows the equivalent results when the endogeneity of program placement is not taken into account.

[19]Choosing different cut-off years does not substantially change the results if the cut-off years are not too far from the ones used here. The first and second stages results for other years are available on request from the authors.

[20]In other words, many of those women who we count as "untreated" in 1990 will subsequently be "treated" and this might affect their fertility.

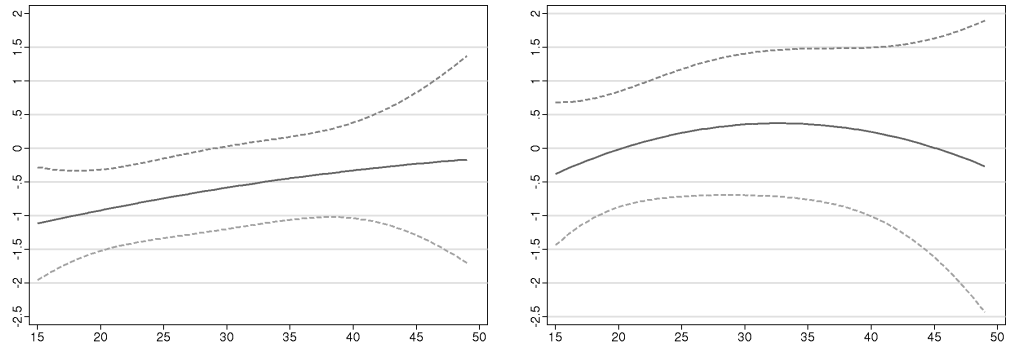
[21]If we had birth histories we would be able to calculate how many children each woman had in, say 1990, and thereby get a better estimate of "untreated" population.

Table 4: Effect of Family Planning on Fertility

	Before 1990		Before 1997	
	Model I	Model II	Model III	Model IV
Family planning[a]	−0.337	−1.835	0.304	−2.194
	(0.304)	(1.897)	(0.572)	(2.400)
Family planning × age[a]		0.054		0.157
		(0.136)		(0.175)
Family planning × age^2 / 100[a]		−0.040		−0.240
		(0.231)		(0.296)
Family planning × 1-5 years education[a]		0.943**		0.141
		(0.428)		(0.523)
Family planning × 6+ years education[a]		0.674		0.463
		(0.503)		(0.489)
Age	0.481***	0.471***	0.477***	0.424***
	(0.045)	(0.053)	(0.045)	(0.081)
Age^2 / 100	−0.414***	−0.405***	−0.409***	−0.328**
	(0.074)	(0.086)	(0.075)	(0.133)
Education (1-5 years)	−0.453***	−0.640***	−0.461***	−0.517**
	(0.132)	(0.161)	(0.127)	(0.247)
Education (6+ years)	−0.667***	−0.795***	−0.647***	−0.821***
	(0.115)	(0.173)	(0.117)	(0.230)
Orthodox	−0.281	−0.306	−0.313	−0.304
	(0.215)	(0.212)	(0.217)	(0.215)
Muslim	0.162	0.161	0.153	0.150
	(0.216)	(0.215)	(0.221)	(0.218)
Zone distance to Addis Ababa	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Market in PA/kebele	−0.031	−0.041	−0.111	−0.119
	(0.127)	(0.125)	(0.161)	(0.157)
Area of wereda	0.003	0.003	0.008	0.007
	(0.008)	(0.007)	(0.008)	(0.008)
Average yearly rainfall	−0.001	−0.001	0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Average yearly rainfall^2/100	0.000	0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Lives in urban area	−0.309	−0.270	−0.519*	−0.486*
	(0.215)	(0.217)	(0.265)	(0.271)
Distance town	0.000	0.004	−0.004	−0.002
	(0.012)	(0.013)	(0.015)	(0.015)
Distance town^2	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Road access - all year	−0.018	−0.012	−0.028	−0.031
	(0.178)	(0.173)	(0.195)	(0.194)
Road access - dry season	0.299*	0.314*	0.311	0.314*
	(0.174)	(0.171)	(0.191)	(0.189)
Constant	−5.237***	−4.945***	−6.044***	−5.113***
	(1.234)	(1.183)	(1.569)	(1.700)
All family planning equal to zero F(5,113)		1.62		0.54
Observations	2169	2169	2169	2169
Adj. R-squared	0.52	0.52	0.52	0.52

Note: * significant at 10%; ** significant at 5%; *** significant at 1%.
Weighted IV estimation with robust standard errors in parentheses.
Additional variables not shown are region dummies and ethnic group dummies.
Family planning indicates whether there was a family planning within 40 km prior to the year indicated.
[a] Endogenous variable. Instruments are predicted probability of a family planning program in area and the interactions with age, age squared, dummy for 1-5 years of education and dummy for 6 plus years of education.

impression is that most of these variables are not significant and the one which is statistically significant has the wrong sign. This conclusions, however, would be misleading. It is true that in Models I and III family planning does not have much of an effect on the cumulative number of children born and is far from being statistically significant, but these specifications ignore that not all age groups are likely to respond to family planning programs the same way. As mentioned above it is likely that most women who had access to a family planning program in 1990 also had access to the program in the ten years prior. That, however, still leave a substantial number of women who were well into their reproductive years by the time the family planning programs were introduced.



(a) Impact of family planning before 1990, by Age

(b) Impact of family planning before 1997, by Age

Figure 2: Marginal Effect of Family Planning on Fertility by Age Based on Models II and IV in Table 4

Figure 2 shows the marginal effects of access to family planning services by age together with the 90 percent confidence interval (calculated using

the delta method) from Models II and IV. For the 1990 estimation we now see that there is a statistically significant negative effect of access to family planning services until around age 27. After age 27 the effect is still negative, although it is no longer statistically significant. This is in line with the idea, discussed in Angeles, Guilkey, and Mroz (1998), that it is important that family planning is available at younger ages; it is clearly possibly that for older women the programs came too late to have much of an effect on their cumulative fertility. For the ages where the effect of family planning is significant the presence of a program is associated with a reduction in the number of children born of about 0.5.

Interestingly, many of the background variable are not statistically significant, although the direction of their impacts is as expected. Among those that are statistically significant are the education dummies. More educated women tend to have fewer children and this effect is stronger the more education they have received. Likewise, women who live in urban areas or in ares with a market have fewer children, although none of these effects are significant.

5.3 Explaining the Effect of Family Planning

While it is clear that there is a negative effect on the number of children born for those who have been exposed to a family planning program for for a substantial period of time, it is not clear exactly how this effect comes about. The remainder of this section is therefore dedicated to examining in

more detail how family planning affects aspects of the fertility decisions.

The first question is whether the effect really comes from family planning or whether it is due to health facilities that are always present at the same time. As can be seen from Figure 1 above for the years that we are examining there is a close correspondence between health facilities and family planning programs. In fact, the two are so close that estimations show little difference between the effect of family planning and the effect of having a health facility available. The main way that a health facility could reduce fertility would be through a reduction in child mortality, which in turn would lead to fewer births needed to achieve a certain number of children. Simply estimating the effect of the presence of a health facility on child mortality does, however, not isolate the effect of health facilities on fertility for two reasons. First, only women who have had children can have experienced child mortality. Since the women who are least likely to use family planning are probably also the most likely to suffer the death of a child then an estimation of the effect of health facilities will be biased upwards and this bias can be substantial.[22] Second, if the presence of a family planning program lead to longer spacing between children and more resources invested in each child then this will confound the estimate since the presence of family planning programs and health facilities are so closely connected.

Hence, it is not possible to directly separate the effect of family planning

[22]We do, in fact, find that the effect of health facilities on child mortality is positive, although consistently statistically insignificant. The results are available on request from the authors.

and health facilities we can examine other behaviours that are influenced mainly by family planning rather than access to health facilities. There are three questions in the Pathfinder survey which are of interest here: The age of the mother at first birth, whether a woman had a birth within the last year and whether the last birth was unwanted.

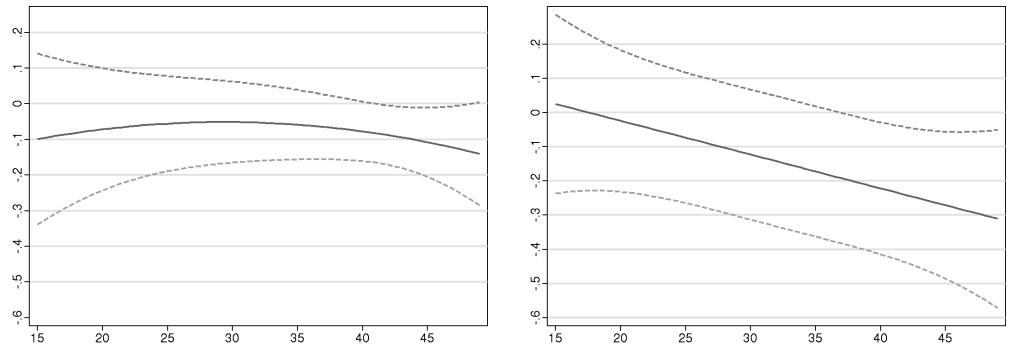
We begin with whether the respondent has had a birth within the last 12 months (since fall 2004). Figure 3 shows the marginal effect of access to family planning services on the probability of having a birth within the last year.[23] For the 1990 cut-off point the is a negative and statistically significant effect from around age 40 and older, while the effect becomes significantly negative around age 37. The estimated effects are relatively substantial. For 1990 the reduction is on the order of 15 percent, while it is even larger for the 1997.

The results for age at first birth are presented in Figure 4.[24] There is, however, a significant caveat to these results due to the censoring problem. Women who have not yet had a birth are coded as having a birth as their current age (no matter what that might be).[25] Hence, there is potentially a substantial down-wards bias in the effect of family planning on the age of first birth. This likely explains why the effect is positive (or at least close to)

[23] As for Figure 2 the 90 percent confidence interval is calculated using the delta method. The full estimation results for the linear probability model used to create the graphs are shown in Table A-4.

[24] The full estimation results are in Table A-5.

[25] Note that simply excluding those who have not yet had a birth lead to potentially even more bias, especially among the youngest.

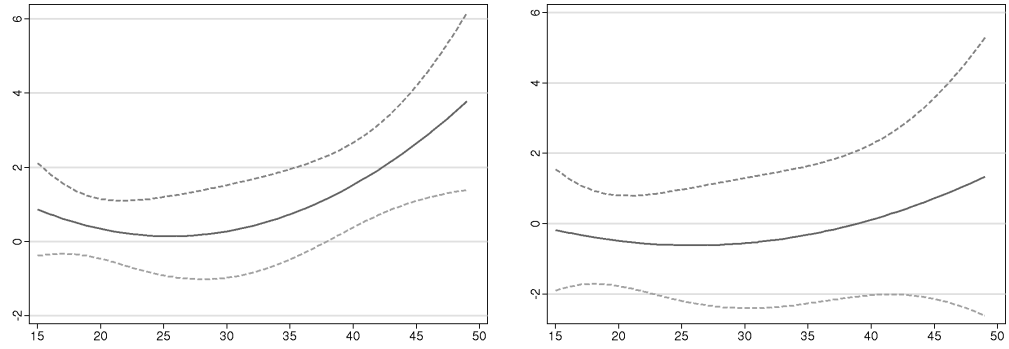


(a) Impact of family planning before 1990, by Age

(b) Impact of family planning before 1997, by Age

Figure 3: Marginal Effect of Family Planning on Birth within Last Year

but generally statistically insignificant.



(a) Impact of family planning before 1990, by current age

(b) Impact of family planning before 1997, by current age

NOTE: Sample consists of women who had their first child after a family planning program was introduced if one was present by the year indicated and those women without access to a family planning program by the year indicated.

Figure 4: Marginal Effect of Family Planning on Age of First Birth

Finally, one of the attractions of providing family planning is that is potentially provides women with more control over their fertility which is wel-

fare improving, even in the cases where it does not reduce fertility. We invert the question to capture whether a woman has had an unwanted pregnancy (i.e. family planning should ideally have a negative effect).[26] The advantage of this definition is that women who have not had any children are also included and they may presumably have been able to avoid a pregnancy exactly because of access to family planning. Figure 5 shows the results for the two cut-off years.[27] For 1990 there is generally a reduction in unwanted pregnancies, although the effect is only statistically significant for the older group. Hence, even though we do not find a significant reduction in fertility among the older group of women they also benefit from access to family planning through improved control over when their children are born. Ideally we would like to examine the effect of access to family planning on spacing of children, but that is unfortunately not possible using this data set since there are no birth histories.

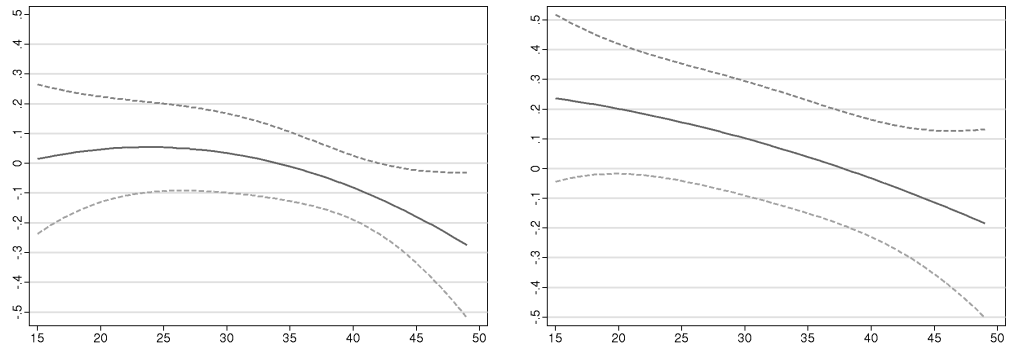
6 Conclusion

Despite a substantial interest in family planning programs there is relatively little research on their effectiveness. Given the long lag between implementation and effect researchers are generally forced to use survey data instead of standard experimental data.[28] This reliance on survey data requires meth-

[26] As before the estimation is done using a linear probability model and the results are available upon request.

[27] The complete estimation results are shown in Table A-6.

[28] The main exception to this is the case of Matlab discussed above.



(a) Impact of family planning before 1990, by Age

(b) Impact of family planning before 1997, by Age

Figure 5: Marginal Effect of Family Planning on Having an Unwanted Birth since 1990/1997

ods for dealing the problem of potentially endogenous program placement. This paper uses a novel set of instruments to estimate the effects of access to family planning on fertility and other related outcomes in Ethiopia. The advantages of the instruments, ranking of area characteristics, are twofold. First, they are easy to understand and likely to reflect what policy makers care about while not being directly related to fertility. Second, that they are easy to create from readily available secondary data like a census or even from the primary data set itself.

We find that access to family planning reduces the age specific fertility by about 0.5 children for women younger than 30, while there is less of an effect for older women. This effect is statistically significant and in line with what other studies have found.[29] Clearly, this reduction is not overly

[29]Corresponding to the reduction we also find a significantly lower probability of having had a birth within the last twelve months.

large when compared to the high total fertility rate in Ethiopia. We do, however, find other positive effects of access to family planning program. Firstly, women are generally older when they have their first child in areas with family planning service, which may have a beneficial effect on child health and the health of the mother. Secondly, it appears that the risk of an unwanted pregnancy decreases, especially for older women, when there is access to family planning.

One generally problem with analysing the effectiveness of family planning provision is the lack of good data sources. What is especially a problem is the scarcity of information on facilities. Although we do have more information than most surveys, there are still much to be done on this front. Having a facility survey which covers all surrounding PA/kebeles and which could be matched with the 2005 Ethiopian DHS would be a major improvement and would be sure to add substantially to our (as yet) limited knowledge of the effects of family planning programs.

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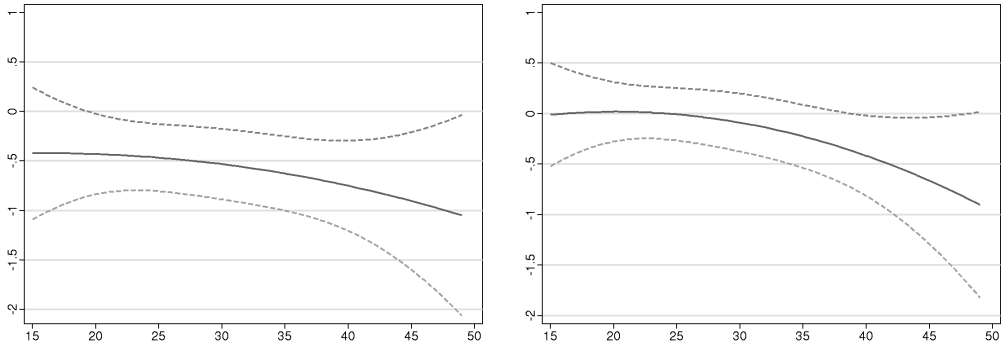
A Appendix



(a) By Age for 1990 (b) By Age for 1997

Figure A-1: Marginal Effect of Family Planning on Fertility by Age Based on Models II and IV from Table A-1 (OLS)

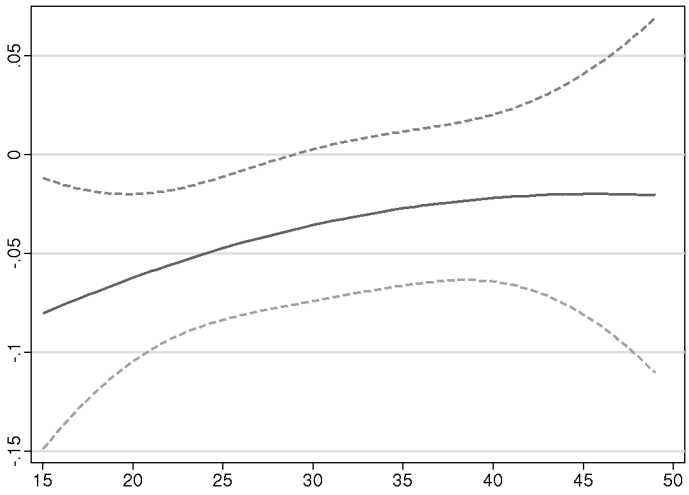


Figure A-2: Marginal Effect of Exposure to Family Planning on Fertility by Age Based on Models II from Table A-3

Table A-1: Effect of Family Planning on Fertility — OLS

	Before 1990		Before 1997	
	Model I	Model II	Model III	Model IV
Family planning	−0.347**	−0.579	−0.071	−0.429
	(0.159)	(1.474)	(0.131)	(1.224)
Family planning × age		0.019		0.045
		(0.100)		(0.085)
Family planning × age^2 / 100		−0.059		−0.111
		(0.162)		(0.141)
Family planning × 1-5 years education		0.760**		0.287
		(0.309)		(0.272)
Family planning × 6+ years education		0.513**		0.252
		(0.254)		(0.236)
Age	0.481***	0.476***	0.478***	0.464***
	(0.044)	(0.048)	(0.044)	(0.057)
Age^2 / 100	−0.414***	−0.400***	−0.411***	−0.375***
	(0.073)	(0.082)	(0.073)	(0.095)
Education (1-5 years)	−0.452***	−0.611***	−0.463***	−0.567***
	(0.131)	(0.139)	(0.129)	(0.154)
Education (6+ years)	−0.667***	−0.786***	−0.673***	−0.772***
	(0.115)	(0.138)	(0.115)	(0.145)
Orthodox	−0.281	−0.300	−0.296	−0.299
	(0.217)	(0.216)	(0.219)	(0.219)
Muslim	0.163	0.156	0.133	0.126
	(0.218)	(0.218)	(0.223)	(0.222)
Zone distance to Addis Ababa	0.000	−0.000	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Market in PA/kebele	−0.030	−0.042	−0.054	−0.065
	(0.126)	(0.124)	(0.126)	(0.125)
Area of wereda	0.002	0.003	0.003	0.003
	(0.008)	(0.008)	(0.008)	(0.008)
Average yearly rainfall	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Average yearly rainfall^2/100	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Lives in urban area	−0.306	−0.281	−0.404*	−0.382*
	(0.201)	(0.202)	(0.204)	(0.203)
Distance town	0.000	0.002	−0.001	−0.000
	(0.013)	(0.013)	(0.013)	(0.013)
Distance town^2	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Road access - all year	−0.018	−0.000	−0.008	−0.009
	(0.179)	(0.173)	(0.179)	(0.178)
Road access - dry season	0.299*	0.303*	0.320*	0.304*
	(0.177)	(0.171)	(0.183)	(0.179)
Constant	−5.231***	−5.097***	−5.297***	−5.070***
	(1.253)	(1.209)	(1.289)	(1.314)
All family planning equal to zero F(5,113)		2.17**		1.06
Observations	2169	2169	2169	2169
Adj. R-squared	0.52	0.52	0.52	0.52

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Weighted OLS estimation with robust standard errors in parentheses
Additional variables are region dummies and ethnic group dummies.
Family planning indicates whether there was a family planning within 40 km before the year indicated.

Table A-2: Tobit – Exposure to Family Planning Program in PA/kebele

Variable	Exposure
Distance to Addis Ababa	−0.012
	(0.011)
Market in PA/kebele	0.899
	(2.592)
Total area of wereda	−0.403**
	(0.170)
Rainfall	−0.044**
	(0.019)
Rainfall^2	0.016**
	(0.008)
Urban area	12.975***
	(4.414)
Distance to town	0.114
	(0.237)
Distance to town^2	0.003
	(0.003)
Road access - all year	5.219
	(4.282)
Road access - dry season	4.214
	(3.980)
Ranking of Zones	
Total population	0.413**
	(0.175)
Urbanisation	0.509**
	(0.209)
Percent Orthodox	0.170
	(0.220)
Percent Muslim	−0.196
	(0.203)
Percent with 1-3 years of education	−0.968**
	(0.373)
Percent with 4-6 years of education	2.373***
	(0.734)
Percent with 7-8 years of education	−1.077*
	(0.623)
Percent with 9 or more years of education	−0.908*
	(0.504)
Percent with non-regular education	−0.240
	(0.158)
Ranking of PA/kebeles within Zone	
Total population	−1.103
	(0.709)
Constant	32.882**
	(16.026)
All ranks equal to zero F(10,108)	2.03**
Observations	125

Notes: * sign. at 10%; ** sign. at 5%; *** sign. at 1%
Weighted Tobit with robust clustered standard errors in parentheses.
Dependent variable is years an area has had a family planning program. before the year indicated.

Table A-3: Effect of Exposure to Family Planning on Fertility

	Model I	Model II	Model III
Exposure[a]	−0.020	−0.160	0.069
	(0.022)	(0.152)	(1.703)
Exposure squared[a]			−0.005
			(0.041)
Exposure × age[a]		0.007	0.003
		(0.010)	(0.029)
Exposure × age^2 / 100[a]		−0.009	−0.003
		(0.017)	(0.045)
Exposure × 1-5 years education[a]		0.045*	0.036
		(0.025)	(0.072)
Exposure × 6+ years education[a]		0.042	0.047
		(0.033)	(0.046)
Age	0.481***	0.432***	0.472
	(0.045)	(0.087)	(0.307)
Age^2 / 100	−0.414***	−0.351**	−0.409
	(0.074)	(0.141)	(0.451)
Education (1-5 years)	−0.466***	−0.780***	−0.717
	(0.131)	(0.238)	(0.537)
Education (6+ years)	−0.688***	−0.992***	−0.972***
	(0.112)	(0.292)	(0.347)
Orthodox	−0.278	−0.307	−0.254
	(0.214)	(0.208)	(0.421)
Muslim	0.137	0.121	0.229
	(0.226)	(0.226)	(0.796)
Zone distance to Addis Ababa	−0.000	−0.000	0.001
	(0.000)	(0.000)	(0.009)
Market in PA/kebele	−0.012	−0.018	−0.219
	(0.130)	(0.130)	(1.496)
Area of wereda	0.001	0.001	0.004
	(0.008)	(0.008)	(0.023)
Average yearly rainfall	−0.001	−0.001	0.001
	(0.001)	(0.001)	(0.016)
Average yearly rainfall^2/100	0.000	0.001	−0.000
	(0.000)	(0.000)	(0.006)
Lives in urban area	−0.271	−0.202	−0.590
	(0.233)	(0.233)	(2.816)
Distance town	0.001	0.005	−0.009
	(0.012)	(0.013)	(0.105)
Distance town^2	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.001)
Road access - all year	−0.009	−0.007	0.087
	(0.178)	(0.173)	(0.685)
Road access - dry season	0.314*	0.342*	0.232
	(0.179)	(0.175)	(0.855)
Constant	−4.875***	−3.797**	−6.667
	(1.255)	(1.572)	(21.233)
All family planning equal to zero		1.82	1.37
Observations	2169	2169	2169
Adj. R-squared	0.52	0.52	0.50

Note: * significant at 10%; ** significant at 5%; *** significant at 1%
Weighted IV estimation with robust standard errors in parentheses
Additional variables are region dummies and ethnic group dummies.
Exposure is number of years there has been a family planning program within 40 km of the PA/kebele.
[a] Endogenous variable. Instruments are predicted probability of a family planning program in area and the interactions with age, age squared, dummy for 1-5 years of education and dummy for 6 plus years of education.

Table A-4: Effect of Family Planning on Probability of Having a Birth within the Last Year

	Before 1990		Before 1997	
	Model I	Model II	Model III	Model IV
Family planning[a]	−0.062	−0.250	−0.126	0.173
	(0.062)	(0.388)	(0.109)	(0.418)
Family planning × age[a]		0.014		−0.010
		(0.023)		(0.026)
Family planning × age^2 / 100[a]		−0.023		−0.000
		(0.034)		(0.040)
Family planning × 1-5 years education[a]		0.034		0.028
		(0.073)		(0.086)
Family planning × 6+ years education[a]		−0.017		0.003
		(0.132)		(0.126)
Age	0.072***	0.070***	0.072***	0.076***
	(0.007)	(0.009)	(0.007)	(0.011)
Age^2 / 100	−0.080***	−0.076***	−0.080***	−0.081***
	(0.011)	(0.013)	(0.011)	(0.016)
Education (1-5 years)	0.062**	0.054*	0.060**	0.051
	(0.026)	(0.033)	(0.027)	(0.040)
Education (6+ years)	0.103***	0.107**	0.094**	0.092*
	(0.035)	(0.043)	(0.038)	(0.054)
Orthodox	−0.019	−0.021	−0.017	−0.018
	(0.038)	(0.038)	(0.040)	(0.041)
Muslim	0.029	0.027	0.017	0.016
	(0.039)	(0.039)	(0.045)	(0.044)
Zone distance to Addis Ababa	0.000	0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Market in PA/kebele	−0.015	−0.014	−0.002	−0.006
	(0.026)	(0.027)	(0.036)	(0.035)
Area of wereda	−0.002**	−0.002**	−0.004**	−0.003**
	(0.001)	(0.001)	(0.002)	(0.002)
Average yearly rainfall	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Average yearly rainfall^2/100	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Lives in urban area	0.055	0.056	0.072	0.071
	(0.051)	(0.051)	(0.062)	(0.061)
Distance town	−0.001	−0.001	−0.000	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Distance town^2	0.000**	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Road access - all year	−0.002	−0.000	0.006	0.006
	(0.035)	(0.035)	(0.036)	(0.035)
Road access - dry season	−0.046	−0.044	−0.039	−0.046
	(0.029)	(0.029)	(0.031)	(0.030)
Constant	−0.592***	−0.550**	−0.379	−0.478
	(0.222)	(0.231)	(0.326)	(0.337)
All family planning equal to zero F(5,113)		0.85		1.51
Observations	2169	2169	2169	2169
Adj. R-squared	0.16	0.16	0.15	0.15

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Weighted IV linear probability model with robust standard errors in parentheses
Additional variables are region dummies and ethnic group dummies.
Family planning indicates whether there was a family planning within 40 km before the year indicated.
[a] Endogenous variable. Instruments are predicted probability of a family planning program in area and the interactions with age, age squared, dummy for 1-5 years of education and dummy for 6 plus years of education.

Table A-5: Effect of Family Planning on Age at First Birth

	Before 1990		Before 1997	
	Model I	Model II	Model III	Model IV
Family planning[a]	0.369	5.740	−0.423	11.452
	(0.657)	(5.216)	(1.096)	(8.680)
Family planning × age[a]		−0.437		−1.014
		(0.388)		(0.668)
Family planning × age^2 / 100[a]		0.821		1.936*
		(0.668)		(1.163)
Family planning × 1-5 years education[a]		0.042		1.441
		(0.976)		(1.355)
Family planning × 6+ years education[a]		−0.676		−1.241
		(1.541)		(1.272)
Age	0.298***	0.350***	0.319***	0.480***
	(0.104)	(0.122)	(0.114)	(0.152)
Age^2 / 100	−0.316*	−0.415**	−0.329*	−0.648***
	(0.178)	(0.209)	(0.198)	(0.242)
Education (1-5 years)	0.138	0.156	0.113	−0.280
	(0.299)	(0.333)	(0.300)	(0.527)
Education (6+ years)	0.627**	0.834**	0.577**	1.095**
	(0.290)	(0.388)	(0.272)	(0.463)
Orthodox	0.093	0.071	0.018	−0.130
	(0.407)	(0.405)	(0.453)	(0.463)
Muslim	−0.524	−0.491	−0.693	−0.704
	(0.459)	(0.463)	(0.504)	(0.508)
Zone distance to Addis Ababa	0.000	0.000	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Market in PA/kebele	0.976***	0.998***	1.061***	1.146***
	(0.282)	(0.282)	(0.327)	(0.324)
Area of wereda	−0.028*	−0.028*	−0.041**	−0.042**
	(0.017)	(0.016)	(0.017)	(0.017)
Average yearly rainfall	0.003	0.003*	0.000	0.001
	(0.002)	(0.002)	(0.003)	(0.003)
Average yearly rainfall^2/100	−0.002**	−0.002**	−0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Lives in urban area	−0.030	−0.015	0.261	0.283
	(0.401)	(0.412)	(0.485)	(0.504)
Distance town	0.013	0.012	0.026	0.021
	(0.026)	(0.029)	(0.030)	(0.032)
Distance town^2	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Road access - all year	0.162	0.121	0.236	0.172
	(0.368)	(0.376)	(0.411)	(0.439)
Road access - dry season	−0.776*	−0.778*	−0.786*	−0.734
	(0.400)	(0.406)	(0.449)	(0.474)
Constant	9.351***	9.055***	10.538***	9.832***
	(3.182)	(2.788)	(3.616)	(2.845)
All family planning equal to zero F(5,113)		0.63		1.88
Observations	2127	2127	1938	1938
Adj. R-squared	0.09	0.10	0.10	0.11

Note: * significant at 10%; ** significant at 5%; *** significant at 1%
Weighted IV estimation with robust standard errors in parentheses
Additional variables are region dummies and ethnic group dummies.
Sample consists of women who had their first child after a family planning program was introduced if one was present by the year indicated and those women without access to a family planning program by the year indicated.
Family planning indicates whether there was a family planning within 40 km before the year indicated.
[a] Endogenous variable. Instruments are predicted probability of a family planning program in area and the interactions with age, age squared, dummy for 1-5 years of education and dummy for 6 plus years of education.

Table A-6: Effect of Family Planning on Probability of having an Unwanted Birth

	Before 1990		Before 1997	
	Model I	Model II	Model III	Model IV
Family planning[a]	0.034	−0.268	0.116	0.309
	(0.068)	(0.478)	(0.104)	(0.467)
Family planning × age[a]		0.031		0.000
		(0.031)		(0.030)
Family planning × age^2 / 100[a]		−0.066		−0.019
		(0.048)		(0.048)
Family planning × 1-5 years education[a]		−0.071		−0.124
		(0.115)		(0.106)
Family planning × 6+ years education[a]		0.114		0.139
		(0.128)		(0.119)
Age	0.024***	0.019**	0.026***	0.028*
	(0.008)	(0.009)	(0.008)	(0.014)
Age^2 / 100	−0.025**	−0.014	−0.028**	−0.026
	(0.013)	(0.015)	(0.013)	(0.023)
Education (1-5 years)	−0.033	−0.019	−0.030	0.017
	(0.028)	(0.033)	(0.028)	(0.050)
Education (6+ years)	0.023	−0.012	0.032	−0.022
	(0.031)	(0.041)	(0.031)	(0.057)
Orthodox	0.040	0.045	0.039	0.048
	(0.034)	(0.033)	(0.034)	(0.035)
Muslim	0.083*	0.081*	0.096**	0.097**
	(0.048)	(0.049)	(0.048)	(0.048)
Zone distance to Addis Ababa	−0.000	−0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Market in PA/kebele	−0.005	−0.008	−0.019	−0.026
	(0.029)	(0.029)	(0.038)	(0.038)
Area of wereda	0.003	0.002	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Average yearly rainfall	−0.000	−0.000*	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Average yearly rainfall^2/100	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Lives in urban area	−0.023	−0.023	−0.046	−0.046
	(0.052)	(0.054)	(0.061)	(0.063)
Distance town	−0.001	−0.000	−0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Distance town^2	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Road access - all year	−0.045	−0.043	−0.050	−0.051
	(0.051)	(0.051)	(0.050)	(0.049)
Road access - dry season	−0.011	−0.015	−0.011	−0.021
	(0.054)	(0.054)	(0.054)	(0.054)
Constant	−0.102	−0.083	−0.356	−0.459
	(0.308)	(0.311)	(0.385)	(0.439)
All family planning equal to zero F(5,113)		0.85		1.51
Observations	2167	2167	2151	2151
Adj. R-squared	0.09	0.09	0.08	0.08

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Weighted IV linear probability model with robust standard errors in parentheses
Additional variables are region dummies and ethnic group dummies.
Family planning indicates whether there was a family planning within 40 km before the year indicated.
Dependent variable is whether the has had an unwanted birth.
[a] Endogenous variable. Instruments are predicted probability of a family planning program in area and the interactions with age, age squared, dummy for 1-5 years of education and dummy for 6 plus years of education.