The Determinants of Fertility in Rural Peru: Program Effects in the Early Years of the National Family Planning Program

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The Determinants of Fertility in Rural Peru: Program Effects in the Early Years of the National Family Planning Program

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I. Introduction

After several attempts over a 20-year period, Peru enacted its National Policy on Population in July 1985. Using data from the 1991 Peru Demographic and Health Survey (PDHS91), a linked Peru Situation Analysis (PSA92) community and facility data set collected in 1992, and a unique region-level data set gathered specifically for this analysis, this paper examines the determinants of fertility in rural Peru before and after this important date. Particular attention is paid to assess the effect of family planning services on fertility. The empirical model that is used combines a model of the timing and spacing of births with a model of the timing of the placement of family planning (FP) services in communities. This modeling strategy allows us to control for the non-random placement of FP services that could potentially bias the measures of program impact.

An illustration of the potential relationship between fertility and FP services can be seen in Figures 1 and 2. Figure 1 presents age-specific fertility rates (ASFR) for the period 1972-1991 from the fertility histories for women in the rural sample of the PDHS91. For all age groups except the youngest, fertility appears to be declining, and the rate of the decline seems to have accelerated in the 1980's. Figure 2 depicts the expansion of FP services within 5 kilometers of the rural PDHS communities for different type of providers. Public FP services were virtually non-existent in rural Peru during the 1970's and the expansion in services really started after the passage of the National Policy on Population in 1985. The timing and extent of the fertility decline appear to coincide with the growth of the government provision of FP services. Our data set allows us to estimate the determinants of the annual probability of a birth for every year between 1972 and 1991 and so we completely span this period of marked change. Clearly, any change in FP policy will not have an immediate impact on fertility. One of the goals of this paper will be to measure the lag in program impact if, in fact, there is an impact at all.

The next section of this paper presents a brief review of Peru's family planning program. This context will be important in the interpretation of our empirical results. Section III discusses estimation difficulties that arise when programs are not randomly implemented and our estimation strategy that overcomes these difficulties. Section IV presents the data used to estimate the model, and Section V discusses the results. We conclude in Section VI.

II. Peru's Family Planning Program

Prior to the 1960's, the governments of Peru were in favor of increased population size. The 1961 census showed that the population had increased tremendously between 1940 and 1961 from 6.6 million to almost 10 million (see Population Action International, 1993). In 1968, a Center of Population and Development Studies was established with the goal of promoting smaller family sizes. However, its activities were curtailed when a pronatalist military government seized power in 1968. During this period, privately funded FP clinics were also closed but they gradually started re-opening in the 1970's and early 1980's.

The most significant milestone for Peru's FP program was the passage of the National Population Law in 1985. "This law guarantees couples the right to freely determine the number and spacing of their children, and it directs the State to promote responsible parenthood as a development and health priority. The law recognizes all voluntary contraceptive methods with the exception of surgical contraception" (USAID/Peru Population Sector Strategy, 1990). A commission was formed in 1987 to draw up specific recommendations. A target fertility rate of 2.5 births per women was set for the year 2000 (the rate in 1985 was 4.3, and in 2000 it was 2.9). It also set specific targets for increased use of FP methods – from 28% in 1986 to 42% in 2000. The election of President Fujimori in 1990 provided further impetus to the program and encouraged alliances with groups such as the International Planned Parenthood Federation. By 1991, the sources of FP services were almost evenly split between public and private sources (INEI et.al.,1992).

Only 20% of Peru's public FP expenditures were covered by public funds, and the government relied heavily on international donors for support (USAID/Peru Population Sector Strategy, 1990). USAID has been the principal donor to the FP effort, providing about 75% of all foreign assistance (USAID/Peru Population Sector Strategy, 1990). The major components of the program include direct support to the Ministry of Health for FP programs, a contraceptive social marketing program, and support through the Private Voluntary Family Planning Project.

The efforts of Peru's government and international donors seems to have paid off in increased use of modern contraceptives. In 1977, modern methods were employed by only 35% of all users. This percentage increased to 41% in 1981 and to 50% by 1990 (USAID/Peru Population Sector Strategy, 1990). The TFR declined from a level of 5.0 in 1980 to 4.3 in 1985 and to 3.6 in 1991 (INEI, 1995). In the sections that follow, we will attempt to determine whether the FP program efforts have been a contributor to Peru's decreasing fertility rate.

III. Empirical Model and Estimation Strategy

Figure 2 clearly shows that there has been a rapid expansion in FP services in rural Peru in the later part fo the 1980's. However, these services are far from being universally available. In fact the most prevalent source was only available in about 30% of the rural areas in our sample in 1991. To assess the effects of FP services on fertility outcomes it is important to consider that services might have not been randomly allocated across communities, as a non-random distribution of services could cause simple methods to yield incorrect measures of program impacts.

As an example of this issue, consider the case of a country with two groups of people living in two different areas: one group with high fertility, and the other with low fertility. These two groups also differ in characteristics that influence fertility, such as preferences for family size, with the group with high fertility having preferences for large families. The government decides to implement a FP program with services targeted to the group with preferences for large families. Over time, access to FP services produce effects and fertility starts to decline in the high fertility areas. To evaluate the impact of the program, cross sectional information on individuals and communities is collected; using standard methods, the analyst relates inter-area variation in the levels of fertility to the inter-area variation of program services. Because program services were placed in the areas with preferences for large families and that have high fertility, the estimates will tend to underestimate the effect of services. In fact, if the post-program fertility levels in the communities that received the program services are still above the levels of the low fertility communities (that did not receive the services), the estimates could indicate a positive relationship between program services and fertility. In this case, the presence of the program will be associated with higher levels of fertility. A cursory interpretation would be that the program increased fertility which is, of course, incorrect. From this example it is clear that it is necessary to control for the nonrandom, or selective, placement of services to estimate program impact correctly. The basic point to consider is that when there are factors that determine both fertility and program placement, and these factors are either unmeasured or omitted from the analysis, one will tend to obtain biased estimates of the program's impact. The direction of the bias is a priori undetermined but the most likely case is that simple methods tend to underestimate program impact.

Targeted, or nonrandom, program placement has been widely recognized as a source of estimation bias in the program evaluation literature (Strauss and Thomas, 1995). However, there have been few empirical studies that control for it (Rosenzweig and Wolpin, 1986; Pitt, Rosenzweig, and Gibbons, 1993; Gertler and Molyneaux, 1994; Frankenberg, 1992; Angeles, Guilkey, and Mroz, 1998). Most of these studies use a version of the fixed effects estimator as the estimation procedure. The fixed effect estimator approach has the disadvantage of being very restrictive in the specification of the unobservables; it also can be inefficient. Despite its disadvantages, the fixed effect estimator has been used in previous studies because it is relatively simple to implement. It does not require a model of the process of program placement, and one need not collect additional data for modeling the determinants of the placement of these programs. While we present results for a fixed effects estimator, our main estimation strategy is a random effects maximum likelihood estimation approach where we explicitly model the selection process that determines the distribution of services across communities. Angeles, Guilkey, and Mroz (1998) successfully applied this strategy to the analysis of fertility in Tanzania. They found that not controlling for selective distribution of services significantly underestimated the impact of FP health centers on fertility. The specification of the empirical model is detailed below.

Fertility

The main equation of interest is the fertility equation. The log-odds of an annual conception is specified as:

$$\ln\left[\frac{P(B_{ijt}=1|X_{ijt},C_{jt},Z_{1jt},\mu_{1j},\omega_{ij})}{P(B_{ijt}=0|X_{ijt},C_{jt},Z_{1jt},\mu_{1j},\omega_{ij})}\right] = X_{ijt}\delta + C_{jt}\alpha + Z_{1jt}\gamma + \mu_{1j} + \omega_{ij} \quad . \tag{1}$$

where the subscripts denote woman i from community j at time t. The dependent variable, B_{ijt}, takes the value of 1 if a birth occurs and 0 otherwise. At each point in time, the woman's fertility event is influenced by observed personal characteristics (X_{ijt}), such as her age and education, the presence of FP services in the community (C_{jt}); and other observed community characteristics (Z_{1jt}). Fertility can also be influenced by individual characteristics that are unobserved by the researcher. The term ω_{ij} is included to capture time invariant individual heterogeneity. It represents woman-specific unobserved factors that affect the birth propensity through time (the degree of fecundability, for example). Additionally, there may be community characteristics, like group preferences for large or small families or the degree of support for family planning by community leaders, that also influence woman's fertility but are not observed by the researcher. They are represented by μ_{1j} . It is possible that some community factors that determine fertility vary over time, but we ignore these in this analysis. The empirical model we estimate does, however, incorporate time effects in order to capture systematic changes associated with time.

Estimation of equation (1) by simple methods is complicated by the potential endogeneity of the variable representing FP services in the community (C_{jt}). As discussed above, it is likely that the placement of FP services is influenced by characteristics of the communities. If these community characteristics also influence women's fertility and they are unobserved by the researcher, there is a systematic correlation between the program variable (C_{jt}) and the term μ_{1j} , which is one of the unobserved error components in equation (1). In consequence, estimation of equation (1) by simple methods leads to biased and inconsistent estimates of FP program impact on women's fertility, α . To control for this problem, the process of FP service placement across communities is modeled explicitly.

FP Service Placement

The FP service placement equation controls for the potential endogeneity of the FP program variable in the fertility equation. FP service placement is modeled using a discrete time hazard model. In order to simplify the exposition, only one equation for the placement FP service is presented in this section. The actual empirical model we estimate includes equations for the placement of three different types of FP service provision: health centers, dispensaries, and community based distributors (CBD).

We model the log-odds of the FP service placement equation as:

$$\ln\left[\frac{P(C_{jt}=1\,|\,C_{jt-1}=0, Z_{2jt}, \mu_{2j})}{P(C_{jt}=0\,|\,C_{jt-1}=0, Z_{2jt}, \mu_{2j})}\right] = Z_{2jt}\beta + \mu_{2j} \quad . \tag{2}$$

where the dependent variable C_{jt} is equal to 1 if FP services began being offered in community j at time t, and equal to 0 if no FP services are offered by time t. In this hazard model framework, we model only the date that FP services were first offered through a particular service delivery channel in the community; we assume the FP services remain after introduction. Observed community characteristics (Z_{2jt}), such as the level of health expenditures and the relative population size of the area, influence the introduction of FP services. The term μ_{2j}, represents the community characteristics that influence the introduction of FP services in the community but remain unobserved to the researcher. We assume that the unobserved factors are time invariant.[1] The dependence between the fertility outcomes and the presence of FP services comes from the correlation between the unobserved community characteristics influencing women's fertility, μ_{1j}, and those influencing the presence of FP services, μ_{2j}.

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[1]A more general specification of this model could allow the community unobserved factors to be time-varying. As in the fertility equation, the actual empirical model we estimate includes time effects.

Equations (1) and (2) are jointly estimated using maximum likelihood estimation techniques. The validity of the estimates depends crucially on the treatment of the terms representing the unobserved community characteristics, μ_{1j} and μ_{2j} . We could, in principle, impose a parametric joint distribution for these factors. This approach has the drawback that the distribution assumed by the researcher is arbitrary and it could misrepresent the actual distribution of the unobservables. An alternative approach is to approximate the joint distribution of the unobservables using a semi-parametric discrete factor method (Heckman and Singer, 1984; Mroz and Guilkey, 1992; Mroz, 1999). This method uses a step function with a finite number of jump points to approximate the distribution of the unobserved factors. The discrete factor method has the advantage that the parameters that determine the step function are estimated jointly with the other parameters of the model. In that sense, the distribution of the unobserved factors influencing fertility and FP service placement is estimated using all the information available on these processes. This study uses the non-linear version of the discrete factor method which allows for greater flexibility in the treatment of the unobservables (Mroz, 1997). In particular, it allows for the possibility of different sets of unobservables influencing the fertility process and the service placement process, and it allows for any pattern of dependency between these sets of unobservables influencing the different outcomes being modeled. The likelihood function for the observed random variables and more details on the method can be found in Angeles, Guilkey, and Mroz (1998).

IV. The Data Set

The individual level data for this analysis come from the 1991 Peru Demographic and Health Survey (PDHS91). The PDHS91 is a nationally representative survey of women age 15-49 containing detailed information on fertility, health, family planning practices, and socioeconomic characteristics. The PDHS91 interviewed a total of 15,882 women age 15-49 who were living in 901 survey clusters. In this study, the analysis sample is restricted to the rural[2] sample of women who were age 15-34 at the time of the survey. The rural sample is used to simplify the specification of the FP service placement process and because people in rural areas are probably exposed to a simpler FP service environment than are people in urban areas. It is also possible that the reasons for placement of FP services differ by type of area. We have community characteristics for 1972-1991 and examine the fertility outcomes of women who turned 15 years old in 1972 or later. The sample consists of 2,752 women age 15-34 who were living in 225 rural communities.

The main outcome of interest is fertility, and the PDHS91 contains retrospective fertility information. Each woman was asked for the month and the year of birth of every birth she had. For each woman we construct a woman-year observation for every year from the year during which she turned 15 until the year of the survey, 1991. The dependent variable is an indicator variable that records whether the woman had a birth in a particular year. This indicator variable contains a total of 26,715 woman-year observations, in which a total of 5,659 birth events occurred. This retrospective information on the timing of the births enables us to implement a discrete hazard (renewal) model of birth events.

Other individual-level variables included in the model as determinants of fertility are: age, education, and two migration related variables. We backdated the information on age to determine the woman's age for every year from 1972 to 1991. This information was used to construct 19 single year age dummies which were included in the model using age 15 as the reference category. Similarly, education is included in the model using a set of dummy variables for five education categories. These education dummies were created by assuming that the women entered school at

[2]Rural is defined as areas with less than 5,000 habitants.

age 6 and remained there until the reported highest level of education was obtained. Women completing 10 years of education, for example, will be recorded as having 8 years of education at age 15, 9 years at age 16, and 10 years of education from age 16 onwards.

The two migration related variables include a dummy for whether or not the woman was living in her reference community (i.e., her 1991 community) in each year after reaching age 15 and a dummy indicating whether or not she had lived in her reference community when she was age 15. We construct these two variables using information on how long the woman has lived in the community she was interviewed in 1991. Unfortunately, the PDHS91 data set does not provide information on other individual characteristics that can be backdated.

Since later time periods are highly correlated with the expansion of FP services, it is necessary to control carefully for time period effects. We do this by including 19 single year dummies for each year in the fertility model, using 1972 as the reference year.

Information on the availability of FP services in the community is provided by the 1992 Peru Situation Analysis (PSA92). This data set is a cross sectional survey of FP service delivery points (SDP) that was conducted in the same clusters included in the PDHS91 sample frame. The PSA92 data describes the characteristics of the FP service environment in the communities, allowing one to examine the extent to which individual-level outcomes are influenced by exposure to the presence, and characteristics, of FP program services.

In rural areas, the PSA92 carried out a census of SDPs within 5 kilometers of each community and included several types of SDPs. For rural areas by 1991 a total of 26 out of 225 communities had FP services through health centers; 35 communities had FP services through dispensaries; and 70 communities had a CBD/health promoter offering FP by 1991. There were also 22 communities with pharmacies offering FP methods.

An important limitation of the PSA92 is that it did not ask for the year in which FP services started in the SDP. Because of this omission, it is impossible to measure exposure to the FP services over time without additional data. To remedy this shortcoming, the Carolina Population Center, with funding from the EVALUATION Project, conducted a survey of the same facilities included in the PSA92 sample. With this information, an indicator variable was created for every type of SDP for each year from 1972 to 1991. The program indicator variables take the value of one if FP services were offered to the community in a given year, and zero otherwise. In addition, we also interacted program availability with the year dummies starting with 1986 to see if there were changes in program impact during the years of the rapid expansion of the program after the passage of the National Population Policy.

Despite the fact that the PSA92 contains a census of SDPs within 5 kilometers of each community, there were few rural communities with more than one type of facility. Only two communities, out of 225, had more than one health center or more than one dispensary; and there were 17 communities with more than one community based distributor (CBD). In these cases, we use the oldest provider of each type to date the timing of the introduction of FP services, from that type of provider, to the community.

Thirty percent of the women in our sample lived outside of their 1991 (survey date) community before they reached age 15. Ideally, we would like to know the places they were residing before moving to their 1991 communities and to know about the availability of FP services in those communities during those years. The PDHS91 does not provide this information. The PDHS91, however, has limited information on migration: it provides the number of years each woman lived in the community when surveyed in 1991, and the type of area (whether urban or rural) of her previous residence. Therefore, for the migrant women the national average of FP availability for the type of area (urban or rural) in which they lived prior to moving was assigned to the years the woman was living outside her 1991 community.

For the specification of the FP service placement equations, we considered three types of FP service delivery points: health centers, dispensaries, and CBDs. There are two other possible sources of FP services: stores and pharmacies. They are privately owned and provide non-clinical FP methods but their primary purpose is not the provision of FP services. They are not considered part of the FP program and are considered as exogenous providers of FP services in this study. We grouped these two FP service sources together and refer to them as pharmacies.

In order to define the dependent variables for the placement equations, we constructed a set of community-year observations in which every community is followed from 1972 until the year the community began receiving FP services by a particular type of provider. The dependent variable is an indicator variable that records whether the community started having FP services through a particular provider type in a given year. We assume FP services continue being offered after their initiation.

The covariates included as determinants of placement are: gross domestic product per capita by Departamento (a Departamento is the equivalent of a state in the U.S.), government expenditures on health by Departamento, the fraction of the national population living in the Province, and a dummy variable indicating year 1987 or later. The gross domestic product per capita came from time series information on gross domestic product by Departamento that was reported by the INEI (the Peruvian Institute of Statistics). The population by Departamento and Province are reported in the national censuses. The government expenditures on health per capita variable are expenditure information collected from government budget reports and other government documentation, divided by the census population measures. The expenditures considered are the actual amounts disbursed, excluding expenditures made on central administration. The figures are expressed in real terms. To control for time effects in the placement of the facilities offering FP, we examined preliminary estimations with generous configurations of time effects. Initially, we included single year dummies for 1986 to 1991. The dummies for 1987 to 1991 were all significant and of approximately the same size, and so we reduced the set of dummies to one, a singe dummy variable indicating 1987 or later. Note that 1987 corresponds to the year of the development of specific FP planning guidelines.

Table 1 presents descriptive statistics for the variables included in the model.

V. Results

The complete model jointly estimates the fertility equation and three FP service placement (hazard) equations. The community-level unobserved factors are specified as random effects and their distribution is estimated simultaneously with the rest of the model. Table 2 presents the estimated parameters of the unobserved heterogeneity distribution. Tables 3 and 4 presents the estimated parameters for the fertility and the FP service placement equations respectively. To assess the effects of the controls for endogeneity, we also estimate the fertility equation using the simple logit estimation procedure and a fixed effects specification. The simple logit procedure, unlike the random effects and fixed effects approaches, does not control for the endogeneity of program placement. The results from these estimation procedures are included in Table 3 as well.

Unobserved Heterogeneity

Table 2 presents the parameters of the step function that approximates the underlying distribution of the community-level unobservables that influence both fertility and each of the FP service placement processes. To estimate this function, it is necessary to estimate the model with an increasing number of points of support until the likelihood function value improves by less than the number of additional parameters (Mroz, 1999). We found significant improvement in the likelihood function value through 4 points of support. Note that a constant term and one of the mass points are not separately identified and so we arbitrarily set the first mass point in each equation to zero.

The lower panel of Table 2 presents the estimated distribution of individual-level unobservables influencing the fertility equation. No improvement in the likelihood function was found beyond two points of support. It is interesting to note that 97.6% of the weight is set on the zero mass point and 2.4% of the weight is placed on the second mass point which has a large negative value (combined with the constant the value is -5.9). It appears that the introduction of the individual level heterogeneity simply controls for a small group of relatively infecund women in our sample. Given the large value for the mass point, this small group of women, approximately 2.4% of them, have a near zero probability of a birth in each year regardless of their other characteristics.

A Wald test of the joint significance of the 13 mass points yields a chi squared statistic of 116 which has a corresponding p value of basically zero, indicating the strong joint significance of these parameters.[3] However, as is clear form the tables, most of the heterogeneity is in the fertility equation (both cluster level and individual level). A joint test on the 4 mass points in this equation yields a 40 chi squared statistic with a p value of approximately zero. A joint test on the 9 free mass points in the placement equations yields a chi squared statistic of 16 which has a p value of .07. Note that none of the individual mass points is precisely measured in the placement equation and this fairly large chi squared statistic is due to strong negative covariances between the estimated heterogeneity parameters in three placement equations. If we compare the heterogeneity corrected

[3]The likelihood ratio test statistic is 123 which, of course, yields the same result.

results for the fertility equation to simple logit on this equation, the results are quite similar. Thus, the evidence seems to suggest that joint estimation of the fertility and placement equations is not needed to obtain correct estimates of program impact. More will be said on this point later.

The Fertility Equation

Table 3 presents the estimated parameters of the fertility equation using three different estimation procedures. The first column presents the results from simple logit that does not control for any potential endogeneity of the regressors. The simple logit procedure yields consistent estimates only if there are not common unobservables influencing both fertility and FP service placement. In order to control for autocorrelation due to multiple women living in the same communities plus multiple observations on the same woman, the standard errors were corrected using a Huber-White approximation to the covariance matrix.

The second column presents the estimated results from a fixed effect specification of the fertility equation. We use 224 community-level dummy variables to control for fixed community unobservables influencing fertility. The fixed effects model is a general specification, but the estimates are consistent only if the number of women per community is large. In our case, the number of women per cluster ranges from 3 to 22, with several clusters having less than 10 women. The third column of Table 3 presents the estimates from the model that estimates fertility and FP service placement simultaneously by the random effect discrete factor model.

An inspection of the results across estimation methods reveals very little difference in the results. This is not surprising because the tests on the heterogeneity parameters show little evidence of simultaneous equations bias. Given such small differences, we focus our discussion on the discrete factor estimation results. The estimates for the age and year effects (dummies) are presented in Appendix Table 1A. While these effects are not a major focus of the paper, the year effects indicate that fertility is higher in all years after 1972 and that the age pattern of fertility follows an inverted U shape.

The education results presented in Table 3 are similar to those in most studies that treat education as exogenous. Women with 1 to 4 years of education are not significantly different than women with zero years of education in terms of impact on fertility, while women with 5 or more years of education have significantly lower fertility with the impact increasing as women move to higher education categories.

Women who were residents of their 1991 (survey date) community when they were age 15 have significantly higher fertility than women who moved to the community after age 15. Migrant women, however, had significantly lower fertility in the years prior to moving into their 1991 community. Unfortunately, the PDHS91 does not provide any information on where the women were living when they lived outside their current community and so it is difficult to provide an interpretation for these results.

The results for the program variables are the last set of results presented in Table 3. We see that the main effect for health centers with FP with 5 kilometers is negative. This coefficient measures the effect of their being a health center in a woman's community in years prior to 1986. Do note that only 9 of the 225 communities had a health center with FP prior to 1986 and that there were no health centers with FP prior to 1978. The effects of a health center within 5 kilometers in each year after 1985 is given by the sum of the main health center effect and the interaction term measuring how the health center effect varies across years. Each of these interaction terms is positive. For three of these six years the coefficients on the interaction of the year dummies and the presence of a health center offering family planning services are larger in magnitude than the main effect, suggesting that the presence of family planning programs leads to higher fertility. This result is counter to expectations, but only the 1991 interaction is significantly different from zero at a 10% level of significance. For most years after 1985, when the negative main effect is combined with the positive interaction terms, the total effect is close to zero. Overall there appears to be little significant impact of health centers on fertility for the 1986 to 1991 period, with a marginally significant negative effect for earlier years. The results for CBD are also small and imprecisely estimated.

The results for dispensaries and for pharmacies provide some evidence that FP services provided by these types of facilities do reduce fertility. For both types of facilities, the main effects are positive but very imprecisely measured, indicating no program effects prior to 1986. Starting in 1986 for dispensaries and 1987 for pharmacies,[4] all interaction terms are negative and both the precision and size of the estimates tends to increase with year. These results are consistent with the strengthening of some components of Peru's family planning program in reducing fertility in the years after the passage of the National Policy on Population.

The Family Planning Service Placement Equations

Table 4 presents the estimates for the three FP service placement equations in the random effects discrete factor model. These equations are not of primary interest in this paper but joint estimation of these three equations with the fertility equation controls for endogenous program placement. A joint test that the 12 coefficients excluding the constant terms are significantly

[4]Since pharmacies are private and not pubic, we did not control for their possible non-random placement. However, the argument could be made that private pharmacies could choose to locate in areas where they anticipate high demand for FP services. Methods that do not account for this possibility could overstate the effects of pharmacies. However, we note that the fixed effects results should control for non-random placement of pharmacies and the estimated coefficients from this regression are very similar to the random effects results.

different from zero yields a chi squared statistic of 116 which is significant at any conventional significance level. (The cut-off for a 0.01% test with 12 degrees of freedom is 39.1). Thus there is strong evidence that overall the four equation model is identified.

The substantive results about the determinants of program placement indicate that for health centers all variables except Departamento level gross domestic product per capita are positive determinants of a health center providing FP services. The two most significant determinants are fraction of national population in the province and the year dummy indicating 1987 or later. Dispensaries tend to be located in Departamentos with lower gross domestic product per capita but with higher government expenditures on health per capita. The year 1987 or later dummy is a significant predictor of placement for all three service types. The weakest placement equation is the one for CBDs.

VI. Conclusion

The mid-1980's were clearly a very important period in the development of Peru's modern family planning program. The descriptive evidence presented in Figures 1 and 2 shows a substantial fertility reduction around this time and a concomitant substantial increase in family planning services in rural Peru. Our regression models provide rigorous statistical tests for the impact of these program variables on fertility and it appears that both the presence of pharmacies and dispensaries within 5 kilometers of rural communities have statistically significant effects. While the pharmacies are private, it should be noted that contraceptive social marketing activities were a major part of Peru's program during this time period and pharmacies were used as channels to make contraceptives available.

One would not expect an immediate fertility response to a change in government policy and our regression model was designed to try and measure the lag in the program impact. The large number of estimated coefficients and interaction terms makes it difficult to quantify effects so we performed some simulations to aid in the interpretation. Using the estimated coefficients and heterogeneity parameters from the fertility equation, we predicted annual birth probabilities for a 25 year old woman with 7 to 9 years of education who had lived continuously in her current village since age 15. Figure 3 presents the results of these simulations where 3-year moving averages were used to smooth the predicted birth probabilities. The “no family planning” simulation assumes no family planning of any type in the woman’s community for all years, while the dispensary and pharmacy simulations assume the continuous availability of these types of services – one at a time with no other type of FP service available.

During the period from 1975 to 1985, the predicted probability of a birth was actually higher when FP services were available, but this portion of the simulation is based on imprecisely measured coefficients. In the later half of the 1980's and into the 1990's, we begin to see fertility reductions associated with these types of services – a reduction of the annual birth probability of between 3 and 5% by 1991. To put these results into perspective, we also simulated the impact of education by assuming no FP services in the woman’s community and moving through our education categories. The annual birth probabilities were 46% for women with no education or 1 to 4 years of education, 41% for women with 5 to 6 years of education, 35% with 7 to 9 years, 24% with 10 years, and 15% with 11 or more years. Thus, while we were able to measure somewhat substantial program impacts, they are still small relative to the impact of female education.

We close by noting that it would be interesting to see how the impact of the program has changed during the 1990's. Unfortunately, later demographic and health surveys in Peru did not provide a link between population-based data and facility data and so the type of analysis performed in this paper is not possible.

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Figure 1

Age Specific Fertility Rates for Rural Peru

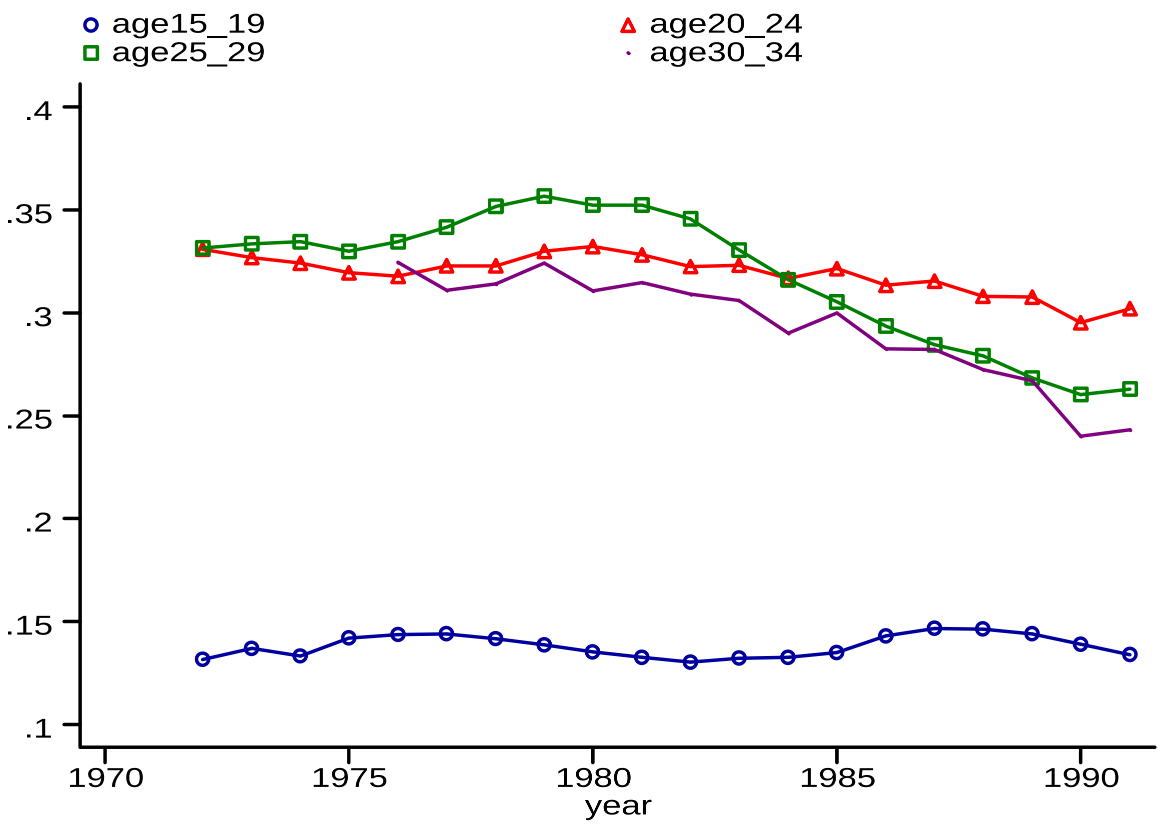

Figure 2

Expansion of Family Planning Services to within 5 Kilometers of Rural Communities

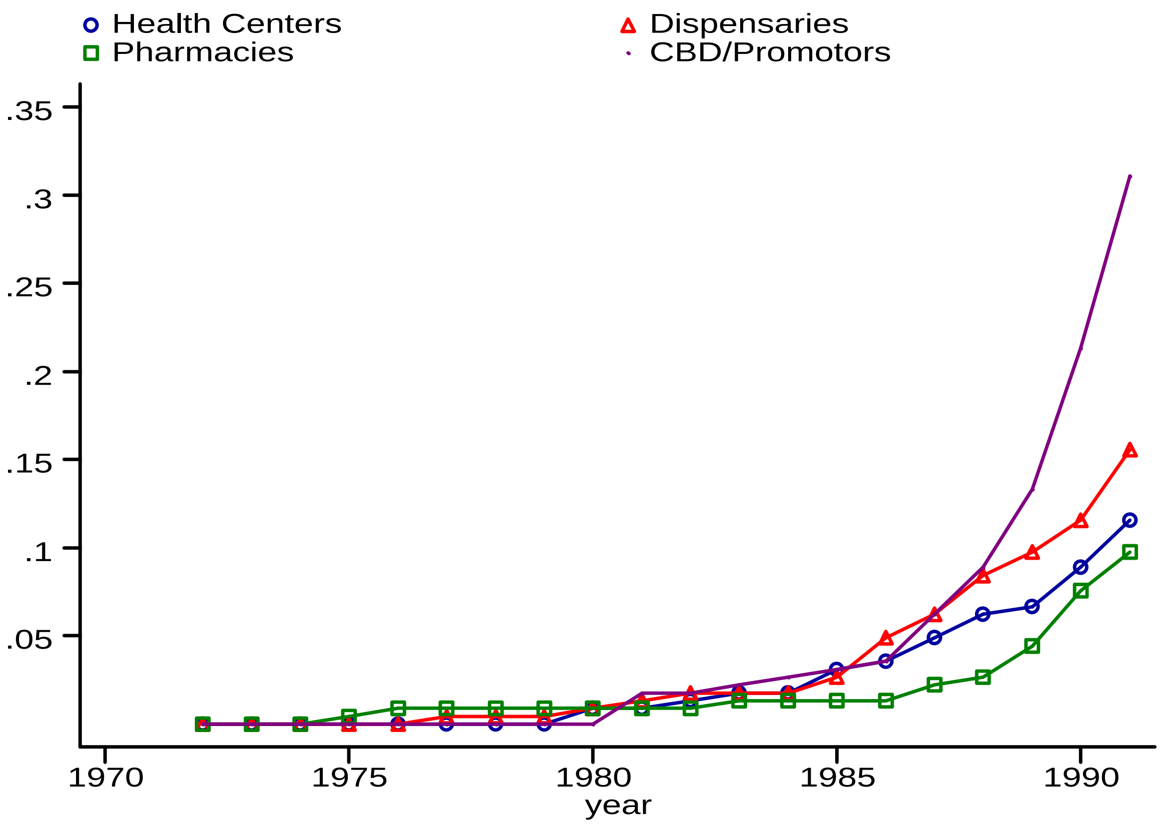

Figure 3

Simulated Annual Conception Probabilities with and without Dispensaries and Pharmacies
(25 year old woman with 7-9 years of school)

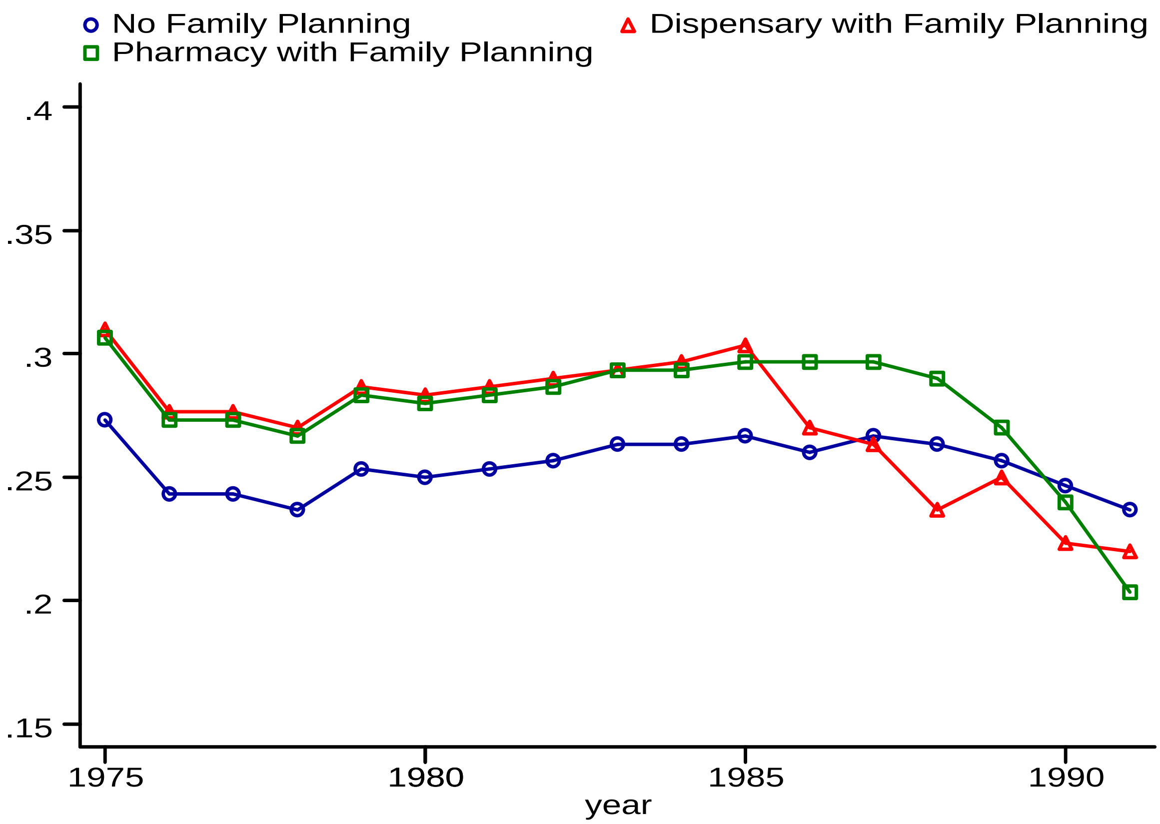

Table 1
Descriptive Statistics

	Mean	Standard Deviation
Birth: Dummy variable indicating woman had a birth during the year (N=26,715)	.212	.409
N = 2,752 *		
Woman's age	23.800	5.594
Dummy variable for years of education 1 to 4	.255	.436
Dummy variable for years of education 5 to 6	.334	.472
Dummy variable for years of education 7 to 9	.149	.356
Dummy variable for years of education equal to 10	.105	.307
Dummy variable for 11 or more years of education	.049	.217
Dummy variable for health center with FP within 5 km	.117	.321
Dummy variable for dispensary with FP within 5 km	.155	.362
Dummy variable for CBD within 5 km	.305	.460
Dummy variable for pharmacy with FP within 5 km	.108	.311
Dummy variable for currently living outside 1991 Community	0.00	---
Dummy variable for lived outside 1991 community at age 15	.304	.460

*: Values of covariates in 1991

Descriptive Statistics for the 225 Rural Clusters (1972-1991)		
Gross Domestic Product per capita, by Departamento in real terms lagged one year	.145	.096
Government expenditure on health per capita, by Departamento lagged one year	2.566	1.341
Fraction of the national population living in the Province	.006	.005

Table 2
Heterogeneity Parameters
(Standard errors in parentheses)

Community Level					
	Probability Weight	Fertility Equation	Health Center Placement Equation	Dispensary Placement Equation	CBD Placement Equation
Point of Support 1	.141	.000	.000	.000	.000
Point of Support 2	.605	-.261 (.198)	.443 (8.391)	-.445 (1.534)	1.761 (7.469)
Point of Support 3	.116	-.077 (.553)	4.296 (6.147)	-.114 (1.833)	-.064 (8.509)
Point of Support 4	.148	-.836 (.293)	2.387 (5.933)	-.572 (1.517)	1.438 (8.202)
Individual Level					
	Probability Weight	Fertility Equation			
Point of Support 1	.976	.000			
Point of Support 2	.024	-3.368 (1.164)			

Table 3
Fertility Equation
(Standard errors in parentheses)

Variable	SIMPLE LOGIT	FIXED EFFECTS LOGIT*	RANDOM EFFECTS LOGIT
Constant	-2.530 (.463)	-1.970 (.506)	2.238 (.640)
Education 1 to 4 years	-.029 (.048)	.023 (.053)	.008 (.051)
Education 5 to 6 years	-.276 (.048)	-.156 (.057)	-.195 (.055)
Education 7 to 9 years	-.459 (.065)	-.396 (.076)	-.438 (.075)
Education 10 years	-1.039 (.075)	-.909 (.085)	-.977 (.089)
Education 11 or more years	-1.595 (.115)	-1.452 (.126)	-1.539 (.120)
Lived Outside 1991 at age 15	.180 (.043)	.172 (.048)	.164 (.042)
Currently Living Outside 1991 Community	-.428 (.057)	-.498 (.060)	-.458 (.065)
Health center with FP within 5 km	-.203 (.169)	-.441 (.213)	-.344 (.212)
Health center x year 1986 dummy	.393 (.347)	.486 (.354)	.475 (.287)
Health center x year 1987 dummy	.364 (.305)	.438 (.314)	.420 (.294)
Health center x year 1988 dummy	.090 (.282)	.194 (.294)	.123 (.250)
Heath center x year 1989 dummy	.146 (.276)	.247 (.289)	.163 (.264)
Health center x year 1990 dummy	.179 (.260)	.258 (.274)	.208 (.273)
Health center x year 1991 dummy	.473 (.236)	.630 (.256)	.572 (.223)
CBD with FP with 5 km	.004 (.168)	-.050 (.198)	.041 (.176)
CBD x year 1986 dummy	.309 (.312)	.338 (.321)	.300 (.258)
CBD x year 1987 dummy	.055 (.257)	.138 (.269)	.075 (.303)

Table 3
Fertility Equation
(Standard errors in parentheses)

CBD x year 1988 dummy	-.054 (.243)	.003 (.257)	-.053 (.208)
CBD x year 1989 dummy	.233 (.220)	.294 (.236)	.227 (.223)
CBD x year 1990 dummy	-.121 (.210)	-.032 (.229)	-.134 (.202)
CBD x year 1991 dummy	.114 (.197)	.240 (.218)	.153 (.192)
Dispensary with FP within 5 km	.217 (.139)	.244 (.176)	.176 (.113)
Dispensary x year 1986 dummy	-.473 (.276)	-.467 (.285)	-.442 (.294)
Dispensary x year 1987 dummy	-.191 (.243)	-.199 (.252)	-.172 (.232)
Dispensary x year 1988 dummy	-.278 (.222)	-.344 (.234)	-.291 (.204)
Dispensary x year 1989 dummy	-.064 (.215)	-.147 (.228)	-.086 (.180)
Dispensary x year 1990 dummy	-.431 (.215)	-.511 (.228)	-.462 (.218)
Dispensary x year 1991 dummy	-.250 (.193)	-.310 (.209)	-.265 (.183)
Pharmacy with FP within 5 km	.191 (.161)	.223 (.228)	.156 (.113)
Pharmacy x year 1986 dummy	.066 (.379)	.098 (.386)	.064 (.301)
Pharmacy x year 1987 dummy	-.073 (.352)	-.060 (.359)	-.086 (.366)
Pharmacy x year 1988 dummy	-.027 (.328)	.002 (.337)	-.034 (.336)
Pharmacy x year 1989 dummy	-.173 (.307)	-.019 (.321)	-.067 (.374)
Pharmacy x year 1990 dummy	-.511 (.274)	-.429 (.296)	-.466 (.341)
Pharmacy x year 1991 dummy	-.592 (.247)	-.503 (.275)	-.527 (.302)

* Dummy variable coefficients for 224 communities not presented.

Table 4
FP Service Placement Equations
Estimates from the Random Effect Discrete Factor Model
(Standard errors in parentheses)

Variable	Health Center	Dispensary	CBD
Constant	–9.112 (5.899)	-5.062 (1.430)	-6.610 (7.836)
Gross Domestic Product per capita	-5.093 (4.817)	-6.226 (2.884)	-1.715 (1.943)
Government expenditures on health	.351 (.235)	.483 (.130)	-.031 (.141)
Population fraction	1.033 (.659)	-.656 (.616)	.116 (.262)
Dummy variable indicating year 1987 or later	2.455 (.673)	1.489 (.346)	2.608 (.258)

Table 1A
Age and Year Results for Fertility Equation
(Standard errors in parentheses; Effects Relative to age 15 and Year 1972)

Variable	SIMPLE LOGIT	FIXED EFFECTS LOGIT*	RANDOM EFFECTS LOGIT
Woman age 16	.904 (.125)	.902 (.126)	.904 (.116)
Woman age 17	1.384 (.121)	1.387 (.121)	1.388 (.126)
Woman age 18	1.876 (.118)	1.888 (.118)	1.886 (.123)
Woman age 19	2.225 (.117)	2.244 (.117)	2.241 (.126)
Woman age 20	2.369 (.117)	2.390 (.118)	2.387 (.121)
Woman age 21	2.488 (.117)	2.512 (.118)	2.509 (.126)
Woman age 22	2.406 (.119)	2.427 (.120)	2.426 (.131)
Woman age 23	2.427 (.120)	2.452 (.121)	2.450 (.124)
Woman age 24	2.455 (.122)	2.481 (.123)	2.481 (.136)
Woman age 25	2.244 (.125)	2.270 (.126)	2.269 (.129)
Woman age 26	2.169 (.128)	2.196 (.130)	2.196 (.132)
Woman age 27	2.282 (.131)	2.315 (.132)	2.316 (.140)
Woman age 28	2.021 (.137)	2.048 (.139)	2.051 (.140)
Woman age 29	1.978 (.143)	2.009 (.145)	2.010 (.150)
Woman age 30	2.077 (.149)	2.108 (.151)	2.107 (.145)
Woman age 31	1.764 (.167)	1.786 (.170)	1.789 (.177)
Woman age 32	2.177 (.175)	2.222 (.177)	2.206 (.164)
Woman age 33	1.946 (.211)	2.010 (.214)	1.991 (.232)
Woman age 34	1.378 (.336)	1.452 (.340)	1.425 (.381)

Table 1A
Age and Year Results for Fertility Equation
(Standard errors in parentheses; Effects Relative to age 15 and Year 1972)

Variable	SIMPLE LOGIT	FIXED EFFECTS LOGIT	RANDOM EFFECTS LOGIT
Year 1973	-.211 (.546)	-.222 (.547)	-.218 (.516)
Year 1974	-.406 (.516)	-.432 (.518)	-.424 (.481)
Year 1975	-.422 (.499)	-.463 (.501)	-.445 (.508)
Year 1976	-.680 (.493)	-.730 (.495)	-.706 (.529)
Year 1977	-.420 (.485)	-.468 (.488)	-.443 (.493)
Year 1978	-.546 (.483)	-.598 (.486)	-.569 (.513)
Year 1979	-.439 (.481)	-.490 (.483)	-.459 (.524)
Year 1980	-.466 (.480)	-.514 (.482)	-.485 (.502)
Year 1981	-.480 (.479)	-.529 (.481)	-.501 (.516)
Year 1982	-.386 (.478)	-.435 (.480)	-.407 (.511)
Year 1983	-.378 (.478)	-.430 (.480)	-.402 (.505)
Year 1984	-.443 (.477)	-.498 (.480)	-.471 (.508)
Year 1985	-.315 (.477)	-.369 (.480)	-.343 (.509)
Year 1986	-.448 (.478)	-.517 (.480)	-.486 (.492)
Year 1987	-.371 (.478)	-.440 (.480)	-.409 (.499)
Year 1988	-.373 (.478)	-.436 (.481)	-.405 (.499)
Year 1989	-.586 (.478)	-.661 (.481)	-.626 (.500)
Year 1990	-.493 (.478)	-.575 (.481)	-.531 (.490)
Year 1991	-.473 (.478)	-.584 (.482)	-.540 (.501)