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Abstract

This paper analyzes how family structure and fertility alter children quality in Colombia. Reduced form models to determine marital status of women and number of children ever born are estimated considering factors that affect women's bargaining powers inside the marriage. Tentative estimates of structural interdependence between these variables and children outcomes are outlined, revealing that marriage has a positive link with child quality and fertility has a negative link with child quality. Colombian national household survey data at rural and urban levels are used for the estimations.

1. Introduction

There are many reasons to imagine that a woman's marital status, lifetime fertility and the average attributes of her children are to some degree jointly determined, being impacted by common factors including her preferences and unobserved characteristics. Most analyses of the interrelationships among these three outcomes

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are based on the strong assumptions that the stochastic elements of these events are independent partly because the events happen at different times over the lifetime, and that those that tend to come first such as marital status and fertility exert an independent effect on the attributes of the women's children. However, it is likely that the stochastic elements that affect the marital status decision are correlated with the stochastic elements affecting fertility or child quality. In that case, the partial correlations obtained are only a suggestion of the interrelationships and not precise causal effects. To get beneath the surface to the causal connections would require unusual events or unanticipated shocks that reverberate though a lifetime, impacting predominantly on one outcome such as fertility or marital status, and thereby causing modifications in other outcomes that follow, such as child attributes. Information of that kind of shocks, however, is scarce.

This paper analyzes the linkages between socioeconomic characteristics and the marital status and fertility of women in Colombia, using cross sectional data and matching them with data from external sources. The final goal is to quantify the association between these two decisions with the quality of children aged 7 to 15. A hypothesis that is tested in this paper is that living with an intact couple of parents is beneficial for the children. The paper shows strong evidence that in Colombia's urban areas children with a married mother are better off than the average, and children whose mother is in a free union (not legally married) are worse off than the average, in terms of their school achievement. In rural areas it is found that children with a separated or divorced mother have lower school achievement than the average and children with a married mother are better off than the average. A second hypothesis tested in the paper is the complementarity between quantity and quality of children, as postulated by Becker (1991). The association between having more children in the household and child quality is found to be negative.

I develop a simple model where it is assumed that family planning services extended in Colombia differentially across regions of the country assisted some women more than others to reduce their unwanted births and thereby impacted the schooling of their children. I assume that the balance of males and females in a region affects the likelihood that a woman will be married, and thereby influences her expected fertility and the schooling of her children. To assess how important these exclusion restrictions are to the magnitude of the interrelationships estimated between marital status, fertility and child schooling, I begin by considering the data as others have done, as if the former two events were exogenous to the

child schooling outcome. Then I propose a model that allows me to identify the parameters of the interrelationships that motivate this paper and I estimate the reduced forms for this model that may have the most credibility. Ultimately, neither the OLS or instrumental variable estimates of the interrelationships may be satisfactory, but they provide a probable range within which the real relationships may lie.

Regardless of how much weight one assigns to the estimates of the decision structure, the reduced form equations should suggest the total effects of the family planning programs and local sex ratio on the three jointly determined outcomes. Given the variety of social policies that can help reduce unwanted fertility and modify the attractiveness of marriage compared with divorce and lone parenting, the significance and magnitude of these individual and family relationships may be of social interest in Colombia and elsewhere.

The paper is organized as follows. The rest of Section 1 presents a brief review of the literature and discusses the indicators used for the analysis. Section 2 includes a description of the data. Section 3 outlines the model of fertility and presents the results of its empirical estimation. In Section 4 the model of marital status and its estimation are included. Section 5 studies the links between marital status and fertility with child quality. Section 6 summarizes the conclusions of the study.

1.1. Literature review

The rapid changes in family patterns in the last three decades have motivated a number of studies on economics of the family. As introduced by Becker, a choice-theoretic framework has been used to analyze marriage, divorce and fertility decisions. On one hand, there is empirical evidence of the relationship between individual characteristics and marital status. In India, Rosenzweig et al (1999) find that men prefer more educated brides. Moffit et al (1998), comparing the choices of marriage and cohabitation in the U.S., find that more educated women tend to be married, while human capital is negatively related to cohabitation.

On the other hand, external factors from the environment where the woman lives can affect her choices of marital status or fertility. The sex ratio (number of adult males over number of females in the population) has an impact on marital status (Chiappori et al (1997)). Grossbard-Schechtman (1993), analyzing the demographic time trends since the mid-century in the U.S., has shown that the

sex ratio can have an impact on relative labor supply of men and women and on several aspects of marriage. Longitudinal data confirm that a relatively larger number of males in a marriage market is associated with a lower incidence of divorce and cohabitation among women. Moffit et al (1998), with a sample of U.S. mothers aged 22 to 29, found that the state sex ratio increases the likelihood of being married and decreases the likelihood of the mother cohabiting, relative to single mothers. Nerlove and Schultz (1970) find that in Puerto Rico the higher the sex ratio more frequent are free unions but marriages are not strongly affected.

Ruggles (1997) studied the impact of labor market variables on divorce and separation in the U.S. He finds that female participation measured at the district level increases the likelihood of divorce, while male participation has the opposite association. A measure of low female employment decreases the probability of divorce or separation, while non-farm employment increases it.

Regarding the impact of social programs on marital status in the U.S., Moffit et al (1998) find that the level of welfare benefit in the state has a negative impact on the probability of being married with respect to being a single mother. Ellwood and Bane (1985) find that the program Aid for Families with Dependent Children (AFDC) increases the likelihood of divorce and Schultz (1994) finds that AFDC and Medicaid benefits are associated with fewer women being currently married, though the effects are modest in size.

A large literature on fertility in developing countries is based on data from India. Rosenzweig and Evenson (1977) and Mukhopadhyay (1994) reported that more highly educated women as well as better paid women tend to invest more intensively and less extensively in children, concluding that policies oriented to encourage female schooling and employment are positive to reduce the demand for children. Rosenzweig (1982) finds that in farm households more exposed to new technologies associated with the "green revolution" fertility was significantly reduced, while the level of investment in human capital was increased. His empirical estimates show the existence of a substitution between the number of children and their quality, similar to the one reported by Rosenzweig and Wolpin (1982). Rosenzweig and Wolpin (1982) find that family planning programs appear to reduce fertility and have an indirect positive effect on child schooling.

Schultz (1994) estimated fertility equations in the U.S. unconditional on the women marital status, finding that higher market wages for women have the effects of less frequent marriage and lower fertility (or postponement of childbearing), and that higher non-labor incomes are associated with lower fertility and lower

probability of living with a husband for white women older than 35.

The relationships between these two aspects of family structure (marital status and fertility) and the "quality" of the family members has been analyzed in other countries. According to Barros et al (1995), the well-being and development of children tend to be adversely affected by living in female headed households in Brazil. Francesconi and Ermisch (1998) analyzed the impact of family structure on children outcomes in England making use of panel data. They find that living in a single parent household during childhood increases the chances of an early birth, distress levels and smoking among young adults. McLanahan (1985) shows that in the U.S. daughters who live in single-parent households are more likely to become female heads themselves and go on welfare than offspring who live in two parent households. Aan et al (1993) show that low mother's education, welfare participation of the mother and parental separation, increase the likelihood of out of wedlock births among teenagers. With data from the U.S. and South Africa, Case et al (2000) find that those households where a child is raised by both biological parents spend more on food than the households where a child lives with a step, foster or adoptive mother, after controlling for household size, age composition and income.

1.2. The dependent variables

The first problem in analyzing economic issues is finding appropriate indicators of the conceptual variables. In this paper the economic measures used are not direct measures of family structure, fertility or child quality, but proxies of these variables.

The concept of family structure is relevant to this paper as it may affect child quality. A broad concept of family structure could include the number of members of the household, the age composition, their relationships, their labor supply, how they share child care responsibilities, whether they live with extended families, and the amount of resources they bring to the household. In this paper I use the marital status of a woman as a proxy for her family structure. I work under the assumption that a divorced/separated mother, a mother who is married, and a mother in a free union live in different family structures.

In the case of fertility the measure I use the number of children ever born for women between 15 to 40 years old at the time of the survey. In order to use total fertility the sample should be restricted to women older than 50 and this

would reduce the sample of women needed to analyze child quality. Moreover for older women a larger fraction of their children are outside of the household and unobserved.

Regarding child quality, an "ideal" measure could be the lifetime performance of each child as an adult in several aspects (labor market outcomes such as earnings, marriage market outcomes, or her health status). These measures, however, could be observed for children only if one had a long panel. In this paper, the indicator of child quality used is an average of the schooling attainment of the children of a woman given their ages.

2. The data

The data for this study come from the 1978 Colombian national household survey (ENH), that contains a fertility module. The sample used consists of 11,183 women between 15 and 40 years old (the age is restricted to focus on fertility and child quality), 69% of the sample is urban and the rest rural. An auxiliary sample of children aged 7 to 15, containing 6,795 observations, is used to define child quality. Other sources of information are a study of the comparative costs of various family planning programs applied in Colombia in 1970 and 1977 (Trias and Ojeda (1978)) and the Census summaries (DANE-DNP(1999)). This information was matched to the sample clusters defined in the ENH.

The family planning programs applied in the country in the early 70's were targeted in specific "municipalities". At the beginning most of them focused on large cities, but later other programs were developed that were directed to the rural population and also to marginal urban areas. The funds for these programs were collected by International Planned Parenthood Federation (IPPF)[1] and distributed to PROFAMILIA,[2] which assigned the resources to the various municipalities. Apparently the Colombian Government was not involved in this process, due to the open opposition from the Catholic Church.[3] The Asociación

[1] "IPPF and its members act as the conscience of the family planning movement and as catalysts in tackling issues which government services may be unwilling or unable to deal with, such as the distribution of new methods of contraception..." (http://www.ippf.org/about/what.html)

[2] The member (NGO) association of IPPF in Colombia, born in 1965. For more information see http://www.profamilia.org.co.

[3] This implies that the allocation of resources for family planning was independent from the allocation of resources for education.

Colombiana de Facultades de Medicina (ASCOFAME) collected the information used in this study. It was an active participant in the process, since the physicians who practice in rural or marginal urban areas helped providing information to the communities. The family planning programs information is described in Appendix Tables A3 and A4.

In Colombia there are three types of marital unions: catholic marriage (69%), civil marriage (4%) and free union (27%).[4] Given that 90% to 95% of Colombians are catholic, the catholic marriage is the most common form of marriage. Although free union is more common in lower social strata, the proportion for medium and higher strata is gradually increasing. The free union offers an option for individuals who want to enter a second or later marital union, given that divorce is not recognized by the Catholic Church.[5]

Table 1 presents descriptive statistics of the main variables of analysis. A higher percentage of rural women are in free union or married, whereas in urban areas a higher percentage of women are single. Fertility increases with age and with marriage (i.e. fertility is lower for single and divorced/separated women). Urban women 15 to 40 in 1978 had 1.5 children on average and rural women 2.7. Fertility tends to be higher in rural areas at all ages and marital status. The child quality indicator (defined in Appendix 1) is highest for married women, it decreases with fertility (after 2 children) and is lower in rural areas.

The individual variables used in the following sections are:

- Age.
- Migration (dummy variable =1 if the woman was born in a rural area and lives in an urban area). This is used only for urban residents, because migration from urban to rural areas cannot be accurately measured with the survey.[6]
- Non-labor income (includes transfers from government or other persons and income from pensions, rents, interests and dividends).

[4] Percentages are for persons in their first marital union born between 1935 and 1960 (Zamudio and Rubiano (1991)). There are other types of religious marriages, but the percentages are statistically equal to zero.

[5] "Of all the individuals divorced from a catholic marriage that are in a second union, 94% are in free union, 3% had an anullment and remarried and 3% got a civil marriage in another country." (Zamudio and Rubiano (1991))

[6] A large percentage of rural individuals may have been born in health centers located in urban areas, without implying that they are "migrants" from urban areas.

– Education (measured in years of schooling).

The community variables that account for the labor demand of the local economy, the family planning public programs, the marriage markets and the geographic location are the following:

– Proportion of individuals employed in industry in municipality.[7]

– Proportion of females 15 to 40 years old that are employed in the municipality relative to all females in municipality aged 15 to 40. This measure of women's opportunities outside the home may be related to the cost of children.

– Fixed costs for family planning clinics in municipality in 1970 (only urban). This is measured in pesos of 1970 and normalized by the number of females 15 to 40 years old in the municipality in 1970.

– Budget for community programs of distribution of pills and condoms per municipality in 1977 (only rural). This is measured in pesos of 1977 and normalized by the number of females 15 to 40 years old in the municipality in 1977.

– Sex ratio=$\frac{\text{number of males in departamento aged 15 to 49}}{\text{number of females in departamento aged 15 to 49}}$. The age is restricted assuming that only individuals aged 15 to 49 are in the marriage market. This information is taken from the Census (DANE projections for 1978 based on 1973 and 1985 Census).[8,9,10]

– Geographic location: Distance from municipality to the capital of the departamento in kilometers.

Table 2 reports the means and standard deviations of the variables for the urban and rural samples.

[7] This measure of industrialization is calculated considering the urban and rural parts of the municipality. Only 2.4% of rural workers are employed in industry.

[8] Other authors (Chiappori et al (1997), Brien (1997)) have used race to define sex ratio. In Colombia, due to racial mixing, racial issues apparently are not so relevant for marital decisions and the surveys do not provide race.

[9] Other sex ratios used were the total number of males over the total number of females in the municipality and in the departamento, obtained from the ENH. The results were similar, but the Census indicator covers a wider sample.

[10] It is assumed that the sex ratios are not affected by selective migration, i.e., that neither men or women migrate to regions because they offer marriage market opportunities.

3. The model of fertility

According to Becker (1991) the demand for children is a derived demand from the maximization the parents utility function: $U = U(n, q, Z)$, where n is the number of children, q is the quality of the children and Z is an aggregate consumption good. Children are produced by each family by using time of the parents, particularly the mother. An increase in q raises the relative costs of raising each child. The optimal quantity of children depends on full income and the price of children (relative to the price of Z), determined by the costs and benefits of rearing children. The higher fertility in rural areas is explained because food and housing for children are usually cheaper on farms.

The cost of rearing children depends on the opportunity cost of the mother's time. When a woman expects higher market wages (which is the case when a woman has high education or when female opportunities are strong) it is more costly to rear children. In this case, fertility is expected to be negatively related with the woman's education and female opportunities. In principle a high non-labor income implies a high full income that could result in higher fertility. However, the interaction between quantity of children and child quality could explain why the price of children rises with income and fertility and income can be negatively related. In this paper, fertility is assumed to be determined by the mother's socioeconomic conditions, the marriage market and labor markets in the region, and by family planning programs.

One would think that fertility depends on marital status, as the majority of people get married and then have children. However, in cross section analysis, the estimation of fertility functions conditional on marital status (a fertility function for married women and another for unmarried women), suffers from selection bias (Schultz (1994)). The error term in a marriage selection function is likely to be correlated with the error terms in the conditional fertility functions, since the unobservables that determine marital status may also determine the demand for children. In the next section, reduced forms for fertility functions including all women are estimated for Colombia.

3.1. Estimation of reduced form model of fertility

The total fertility equation estimated empirically is:

$$n_{fj} = \gamma_1 + \gamma_2 a_{fj} + \gamma_3 l_{fj} + \gamma_4 e_{fj} + \gamma_5 y_j + \gamma_6 r_j + \gamma_7 p_j + \gamma_8 (e_{fj} * p_j) + \theta_{fj}; \quad (3.1)$$

where the number of children ever born to a woman (n_{fj}) is assumed to be a function of her individual characteristics a_{fj} (age, migration, geographic location), non-labor income (l_{fj}), education (e_{fj}), and the regional characteristics of labor demand (y_j), marriage market (r_j) and family planing programs (p_j). The error term θ_{fj} is assumed to be zero mean and uncorrelated with the explanatory variables. The subscript f stands for the individual female and j stands for the urban/rural area where she lives. An interaction term between the family planning programs and education is included to capture the possibility that the family planning program has a differential effect depending on the woman's education. A positive sign of γ_8 combined with the expected negative signs of γ_4 and γ_7 would indicate that increments in the family planning program would be more effective in reducing the fertility of women who are less educated and therefore less aware about birth control technologies.

There is empirical evidence of the negative relationship between education and fertility. Age is expected to be associated with higher fertility because of secular decline over cohorts and biological accumulation of children over a lifetime. On the other hand, the family planning programs are supposed to have a negative impact on fertility by lowering the cost of avoiding unwanted births.

The reduced form OLS regressions of number of children ever born are included in Table 3 separately for women in urban and rural regions. Age has a positive impact on the number of children ever born to a woman. According to Becker (1991), educated women have a lower demand for children because education raises the opportunity cost of having children. My results confirm a negative relationship of schooling with the number of children ever born. Rural women who live further away from a closest major urban center have more children, controlling for individual, labor market and marriage market characteristics. Better labor market indicators are related to lower fertility, and a higher sex ratio is related to higher fertility. If there are more men in the region relative to women, women may marry earlier increasing the likelihood of births.

The family planning programs are significant and exhibit negative coefficients in the urban and rural samples respectively.[11] When education is interacted with the family planning program both variables are highly significant with a positive

[11] The other programs applied in 1977 did not show significance in the estimations of equation

interaction in the urban model, indicating that the urban program was more effective for less educated women (it is likely that women with more education may control their fertility without relying on the public programs). In the rural estimates the interaction term is not significant.

An interaction term between the family planning program and the distance between a municipality and the capital of the departamento was included in the rural model to assess the complementarity between these two variables. The interaction term, however, was not significant (this is not reported).

According to the estimates, an increase of one year of schooling in the female population is associated with a decrease in the fertility rate of approximately 0.13 in urban areas and 0.14 in rural areas, as long as the other variables in the model are kept are their mean values.

Simulations of the models show that doubling the "fixed expenditures for family planning clinics in urban municipalities in 1970" (i.e. spending 12 cents of $US 1970 per woman aged 15 to 40 on average, instead of 6 cents of $US 1970 per woman aged 15 to 40 on average that were spent on this program) would have a differential effect for different education groups. By keeping all the other variables evaluated at their means including education, this exercise would be associated with an increase in the fertility rate, due to the positive effect of the interaction between the family planning program and education. By keeping all the other variables evaluated at their means and varying education, this exercise would be associated with reductions in the urban fertility rate of 0.17 for women with zero years of schooling, 0.11 for women with two years of schooling and 0.03 for women with five years of schooling. The effect of the duplication of this program would be positive on fertility for women with more than six years of schooling.

A similar exercise indicates that if the budget of the rural community program of pills and condoms was doubled (i.e. spending 33 cents of $US 1977 per woman aged 15 to 40 on average, instead of 17 cents of $US 1977 per woman aged 15 to 40 on average that were spent on this program), the mean rural fertility rate could have been reduced by 0.07 (from 2.71 to 2.64), keeping all the other variables evaluated at their means.

3.1. This may be because they were only beginning to be implemented when the survey was taken (June 1978).

4. The model of marital status

Let m_{fj}, u_{fj}, d_{fj}, w_{fj} and s_{fj} be dummy variables that take the value one when a given woman f in region j is respectively married, in a free union, divorced/separated, widow or single. The woman's choice to be in one of these marital statuses is estimated with a Multinomial Logit model.[12] In this model it is assumed that each woman maximizes utility and that the utility derived from choosing alternative kth, U^*_{fjk}, can be represented as:

$$U^*_{fjk} = U_{fjk} + \epsilon_{fj} = \sum_l \gamma_l v_{fjl} + \epsilon_{fj}, \tag{4.1}$$

where U_{fjk} is the deterministic part of the utility and ϵ_{fj} is a random disturbance term with a distribution $\epsilon_{fj} \sim Weibull\ (0,1)$. The variables $v_{fj} \in \{a_{fj},\ l_{fj},\ e_{fj},\ r_j,\ y_j,\ p_j\}$ represent the characteristics of the individual decision maker, and γ is a vector of unknown parameters. For each woman the available characteristics included as explanatory variables are a_{fj} (age, migration, geographic location) and non-labor income (l_{fj}), her education (e_{fj}), and the regional variables given by the sex ratio (r_j), the labor demand (y_j) and family planing programs (p_j). These variables determine the decision to be in one marital status by varying the "reservation utility" of another marital status.

It is theoretically appealing to consider wealth variables (such as non-labor income) as determinants of the probability of remaining single or getting divorced. It has been shown that a woman with more non-labor income has more bargaining power inside the household and may be more likely to divorce (Weiss and Willis (1993)). Similarly, several marriage market theories (Grossbard-Schechtman (1993)) propose that the more males to females in the marriage market, the more likely a woman is to be married and the less likely she is to stay single. They also provide a rationale for younger women to be single, and more educated women to stay single longer. Therefore, one would expect the following relationships to hold:

$$\frac{\partial \Pr(d_f = 1)}{d(l_f)} \geq 0, \frac{\partial \Pr(m_f = 1)}{dr_f} \geq 0, \frac{\partial \Pr(s_f = 1)}{dr_f} \leq 0, \tag{4.2}$$

[12] Since the percentage of widows is very low (1.33% in urban areas and 0.72% in rural areas), I make the strong assumption that a woman "chooses" to be widow.

$$\frac{\partial \Pr(s_f = 1)}{da_f} \leq 0, \frac{\partial \Pr(s_f = 1)}{de_f} \geq 0.$$

4.1. Reduced form models of marital status

Table 4 reports the estimation of equation (4.1) separately for urban and rural areas. The analysis of the relative risk ratios indicates that in urban areas a marginal increase in non-labor income is negatively related to the probabilities of being in a free union or married relative to being single, and positively related to the probabilities of being separated or divorced or widow, relative to being single.[13] The results are similar for rural areas, but are significant only for the probabilities of being married or widow. In urban and rural areas, the probability of being married, in a free union, divorced/separated or widow increases with a marginal increase in age, relative to being single. A one year increase in education is related to an increase in the probability of being single relative to any of the other marital status in urban and rural areas, but the association between schooling and divorce is significant only in urban areas.

In accordance with (4.2), the sex ratio is positively associated with the probability of being in a free union (as it was found in Puerto Rico by Nerlove and Schultz (1970)), widow, married and separated or divorced relative to the probability of being single in urban areas. In rural areas the sex ratio is significant only for the probability of being in a free union relative to being single. These results contradict the Grossbard-Schechtman (1993) hypothesis that lower sex ratios imply higher female employment and consequently higher divorce.

It has been suggested that family planning programs could delay marriage.[14] In this estimation the family planning indicators are significant for the probability of being married, in a free union or widow both in urban and rural areas, but the relative risk ratio is very close to one, which implies that a marginal increase in the family planning programs would leave these probabilities unchanged.

[13] Unfortunately, this survey does not specify the sources of non-labor income. If the main source were alimony payments, then the positive association between divorce and non-labor income would arise from reverse causation.

[14] "... the massive adoption of family planning politics applied in the country in the 60's and 70's, allowed to delay the first union without restricting early sexual activity." (Zamudio and Rubiano (1991))

5. The model of child quality

This section studies the association between family structure and fertility with the welfare of children. The sample of children includes those living in the households with their mothers.[15] I consider children 7 to 15 years old because their school attendance is more likely to be a parental decision than for older children. Home leaving causes a growing selection problem at later ages and the school attendance of a child older than 15 may depend also on market opportunities for children. Because children 7 to 15 are expected to be attending school, it is not possible to estimate their complete education. Instead, a dummy indicator of "schooling" was constructed, based on the years of formal education completed by a child given his/her age. For each woman the measure of child quality averages the "schooling" of all her children ages 7 to 15. The "schooling" measure and the child quality indicator are described in Appendix 1.

5.1. Estimation of reduced form model of child quality

In the equation:

$$q_f = \beta_1 + \beta_2 a_f + \beta_3 l_f + \beta_4 e_f + \mu_f, \tag{5.1}$$

the average "schooling" of all the children ages 7 to 15 for woman f given by q_f is assumed to be a function of her individual characteristics a_f (age, migration, geographic location), non-labor income l_f and her education e_f. The error term μ_f is assumed to be zero mean and uncorrelated with the observables.

The mother's age may determine children schooling in a nonlinear manner. The mother's non-labor income, used as a proxy for the lifetime family income, may have an effect on the family's capacity to invest in child education. Distances from urban centers may indicate reduced access to schools in rural areas.[16]

[15] It would be desirable to correct for the selection bias that occurs by considering only children living in the household. However, since the characteristics of children outisde the household are not provided, this correction cannot be implemented (Holmes, 1999).

[16] Although endowments such as the sex and age of the children may be related with their schooling, the model only takes into account mother variables. If mother's age and child's age are considered in the same equation, the timing of births decision is implicit. However this decision may also be endogenous. The assumption that boys and girls are treated equally with respect to schooling is not too strong in Colombia, where children education levels are similar by gender.

The mother's education is included for a number of reasons. More educated women are more efficient investors children quality (Becker (1975)). More educated women are richer and can invest more in child schooling (income effect). More educated mothers are more able to help the children with homework and reduce the cost of schooling (Schultz (1998), Rosenzweig et al (1999)). More educated mothers may possess a higher school ability that may be inherited by the child.

The results of the estimation, included in Table 5, columns 1 and 2, confirm the behavioral hypotheses advanced in previous studies (Becker (1975), Schultz (1998), Rosenzweig et al (1999), Holmes (1998)). Child quality increases with age until mother's are 33, then it begins to decrease. Women with higher education have higher child quality. An urban resident woman with 10 years of education has a q_f 0.47 higher than one with zero years of education. This means that if both women had one child age 7 to 15, the child of the more educated woman has 47% higher probability of attending school at the proper level than the child of the woman without education. Being born in rural areas and living in rural areas far from the capital of the departamento are negatively related to child quality.

5.2. Child quality with correction for selection bias

The nature of the child quality indicator implies that the model is estimated only for women who have a child age 7 to 15. This sample restriction might be generating biased results in my estimations. In this subsection the selection bias introduced when considering only women with at least one child in that age range is corrected with the Heckman procedure (Heckman (1979)). The instruments for the selection equation are the labor market indicators, the sex ratio and the family planning programs listed in Section 2. The results, reported in Appendix Table A5, show that the parameter "lambda" that identifies the selection is not significant either in the urban or in the rural models. In this case, the OLS parameters obtained in Table 5 are "preferable" (or less biased) than the corrected ones shown in Table A5 (Bound et al (1995)). For this reason, the following models are estimated without selection bias correction.

5.3. Child quality with IV for fertility

Becker (1991) introduced the notion of a trade-off between number of children and their quality. "The interaction between quantity and quality of children explains

why education per child tends to be lower in families having more children."[17] This section takes into account how quantity may affect child quality, and that neither of these variables is independent of parental preferences. The link between fertility and child quality is analyzed by estimating the following model:

$$q_f = \delta_1 + \delta_2 a_f + \delta_3 l_f + \delta_4 e_f + \delta_5 n_f + \psi_f; \tag{5.2}$$

where q_f (the child quality indicator) is a function of the woman's characteristics (age, migration, geographic location) a_f, non-labor income l_f, and her education e_f. The variable n_f is the number of children ever born to woman f. Under the OLS assumption, the error term ψ_f is zero mean and uncorrelated with the observables. However, the model presented in Section 3 suggested that fertility is not exogenous to child quality. This implies that the error term in equation (3.1) is correlated with the error term in equation (5.2), imparting bias to the estimated coefficients of equation (5.2).

In order to correct this bias, the variable n_f can be replaced by its instrumental variables predicted value. The instruments used to explain the number of children are the labor demand characteristics y_f, the sex ratio r_f and the family planning programs p_f.[18]

The results, reported in columns 5 and 6 of Table 5, show that mothers with higher fertility have lower child quality than the average. The coefficient of "number of children" increases up to 4.5 times in the urban model when the variable is instrumented, compared with the OLS coefficient that assumed fertility was exogenous (reported in columns 3 and 4 of Table 5). In the rural model the coefficient of fertility increases 3.5 times, when compared with the OLS coefficient. This implies that the negative effect of child quantity on child quality would be underestimated if the endogeneity of fertility was not taken into account. A possible interpretation for the change in the coefficients of fertility between the OLS and IV models could be that the error term in the OLS equation is collecting some unobservable variables that relate having more children positively with child quality.[19] If this

[17] Chapter 5, Becker (1991).

[18] The first stage of the IV model is estimated for the restricted sample of mothers with a child aged 7 to 15.

[19] Some of these variables could be a positive effect for a child of having older siblings (a child may become more alert or receive more help with homework) or the economies of scale for a mother of having more children (an older child may help with taking care of the youngest children, giving her time to help other children with their homework).

is the case, the coefficient of fertility under the OLS assumption is being biased towards zero because these unobservables may be balancing the overall negative effect of fertility on child quality. With the IV procedure the model takes into account the predictable part of fertility based on observable data. The fertility variable is "cleaned" from that "noise" and the negative effect of fertility on child quality is revealed to be larger.

5.4. Child quality with IV for family structure

The family structure in which a child grows up may be related to child quality. In order to quantify this relationship, the family structure indicator is included in the model of child quality as an additional explanatory variable. The estimated model is:

$$q_f = \alpha_1 + \alpha_2 a_f + \alpha_3 l_f + \alpha_4 e_f + \alpha_5 c_f + \alpha_6 MS_f + \eta_f; \tag{5.3}$$

where q_f (the child quality indicator) is assumed to depend on the woman's characteristics a_f (age, migration, geographic location), non-labor income l_f and education e_f. The variable MS_f is the marital status indicator corresponding to the dummy variables m_{fj}, u_{fj}, d_{fj}, w_{fj} and s_{fj} defined in section 4 (equal to one when a given woman f in region j is respectively married, in a free union, divorced/separated, widow or single). Initially the error term η_f is assumed to be zero mean and uncorrelated with the observables. Under this assumption the indicators of family structure show a significant association with child quality, as reported in Table 6, except for the dummy variable s_{fj}.[20]

The model of Section 4 hypothesizes that the marital status indicator is associated with factors that in turn may be associated with child quality. Therefore, the error term in equation (4.1) may be correlated with the error term in equation (5.3), biasing the estimated coefficients of equation (5.3). To obtain unbiased estimates, MS_f is recognized as endogenous and the family structure indicator is replaced by its instrumental variables predicted value.[21] I use the same instruments of the model as in Subsection 5.3. The results are included in Table 7. They show that mothers in a free union tend to have lower child quality than the average, and married mothers tend to have higher child quality than the average

[20] The sample has only 12 observations of single mothers with children between 7 -15.

[21] The first stage of the IV model is estimated for the restricted sample of mothers with a child aged 7 to 15, based on the models from Table 4.

in urban areas.[22] In rural areas mothers who are separated or divorced show a negative association with child quality.

The different sign of the free union and married coefficients in urban areas may indicate that it is not only the presence of a couple of parents what matters for the child to achieve better schooling goals, but the fact that the parents are legally married.[23] A legal marriage may represent more commitment to the union, giving more stability to the household.[24] On the other hand, the fact that the free union is more common for second or further unions, may imply that the children in these households are living more frequently with one step parent than with an intact couple of parents.[25]

Comparing the estimations shown in Table 6 (assuming that marital status is exogenous) and Table 7 (assuming that marital status is endogenous) it is found that when the marital status dummies are instrumented, their coefficients increase in size (when they are significantly different from zero). In urban regions, the positive effect of having a mother who is married appears to be 4.6 times larger on child quality than the one obtained assuming that marital status is exogenous and the negative effect of having a mother who is in a free union appears to be 6.2 times larger on child quality than the one observed under the assumption that marital status is exogenous. The negative effect of having a separated or divorced mother becomes significant when its possible endogeneity is recognized in the rural regions. In this case, as in the case of fertility, there is a change in the magnitude of the coefficients of marital status between Table 6 and Table 7.

The instrumental variables methodology provides a measure of predictable marital status that is free from noises, such as measurement errors or some omitted variables that may influence both the marital status decision and the child quality but that are unobservable with the available data.[26] These unobservables

[22]The coefficient of the variable d_{fj} may not be significant using the standard errors corrected for the prediction bias.

[23]Murphy (1999) presents evidence that in the U.S. the difference in child outcomes between children whose parents are married and those whose parents are not has increased.

[24]According to Zamudio and Rubiano (1991), in Colombia the mean duration of a catholic marriage is 10.5 years, 6.6 years for a civil marriage and 6.3 years for the free union.

[25]Case et al (2000) show that living with a step mother is associated with less expenditures on food in the household.

[26]Some of these unobservable variables could be certain characteristics of the children's father that are not taken into account in these models that may affect both the mother's marital status choice and the child quality. For example there could be a positive association between

or measurement errors can bias (towards zero) the marital status variables coefficients in the model from Table 6. The model from Table 7 shows a more accurate measure of the association between the mother's marital status choice ("cleaned" from unobservables) and child quality.

6. Conclusions

This paper analyzed the relationships between family structure, fertility and child schooling in Colombia. Although it is not possible to establish confidently causal connections between these outcomes, the reduced form models estimated here offer some policy implications. In particular the paper quantifies the relationship between family planning programs extended in the country in the 70's and fertility, and its effects over child quality.

I have developed an empirical model where marital status and fertility are determined by socioeconomic characteristics of the woman and also by factors exogenous to her, such as social programs of family planning and the balance between adult males and females in the regions where she lives. The reduced form analysis of the marital status choice made by urban resident women depicted a negative relationship between non-labor income and the probabilities of being in a free union or married relative to being single, and a positive relationship with the probabilities of being separated or divorced or widow, relative to being single. In urban and rural areas, the probabilities of being married, in a free union, divorced/separated or widow are positively related to age, relative to being single, whereas increases in education are related to increases in the probability of being single relative to any of the other marital statuses. The results confirm the intuition that marital status is related to the balance between males and females, showing that in regions where there are more men relative to women, it is less likely that a woman stays single, relative to the other marital statuses.

Both women's education and the family planning programs show a negative relationship with fertility. According to the estimates, an increase of one year of schooling in the female population is associated with a decrease in the fertility rate of approximately 0.13 in urban areas and 0.14 in rural areas, keeping the

the father's unemployment and the mother's choice of a free union. The negative effect of the mother's free union on child quality can be compensated by the positive aspect that the unemployed father is more time at home and can take care of the children and help them with their homework.

other variables constant at their means. Simulations of the model suggest that doubling the budget for the rural community program of pills and condoms could have been associated with a reduction in the mean rural fertility rate from 2.71 to 2.64, keeping all the other variables evaluated at their means. A positive interaction between education and the family planning program was found in the urban model, which indicates that the programs may be more effective for women with less education. According to the model simulations, if the fixed expenditures for family planning clinics in urban municipalities in 1970 had been doubled, a differential effect by education groups would have been observed. If all the other variables are evaluated at their means and education varies, this exercise would be associated with reductions in the urban fertility rate of 0.17 for women with zero years of schooling, 0.11 for women with two years of schooling and 0.03 for women with five years of schooling.

The goal of the paper was to uncover the relationships between the outcomes analyzed above and child quality. I constructed an indicator of child quality based on child's schooling and age that is averaged over all of a woman's children aged 7 to 15. A reduced form model that links this indicator to female characteristics confirms the expected positive relationship between mother's schooling and child's schooling. An additional year of education of the mother is associated with a child being 4.7 percent more likely to attend school at a level that is adequate to his (her) age in urban areas. In rural areas the effect of an additional year of education of the mother is even larger (the child is 5.6 percent more likely to attend school at the adequate level).

The child quality model was structurally extended with the addition of fertility and five dummy variables for each possible marital status. The OLS results confirm the intuition that families with more children tend to sacrifice child quality. Child quantity seems to be more detrimental to child quality in urban than rural regions. On the other hand, living with a married mother is related with better child quality outcomes in urban and rural areas. In urban areas the mother's free union shows a negative association with child quality.[27] These results may be interpreted as a sign that what matters for a child to achieve better schooling goals is not necessarily the presence of a couple of parents but the legal marriage between them, probably because a legal marriage may represent a more stable

[27] A significant association between single motherhood and child quality was not found, probably because there were too few single mothers with children in school ages in the sample.

household.[28]

The instrumental variable methodology provided estimates that go in the same direction but are larger than the estimated coefficients using OLS.[29] When the marriage market characteristics and the family planning programs are used as instruments to explain fertility, the coefficient of "number of children" increased 4.5 times with the instrumental variable methodology in the urban model, and 3.5 times in the rural model. When the same set of instruments are used to explain marital status, the estimated coefficients in the model of child quality increase in size. The dummy of separated or divorced that was not significant under the assumption of exogeneity of marital status in rural areas, becomes significant and negative, evidence of the negative impact of divorce on children welfare. In urban regions, the positive effect of having a mother who is married appears to be 4.6 times larger on child quality than the one obtained assuming that marital status is exogenous and the negative effect of having a mother who is in a free union appears to be 6.2 times larger on child quality than the one observed under the assumption that marital status is exogenous. These results indicate that if the endogeneity of family structure and fertility is ignored, the relationships between these variables and child quality could be substantially underestimated.

[28]Given that the free union is a more common agreement for second or later marital unions (Zamudio and Rubiano (1991)), the children in these households may more frequently end up living with one step-parent.

[29]Given that the two estimates differ substantially, the OLS model is seriously misspecified. (Hausman (1978))

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Table 1 Cross tabulations main variables

a. Fertility by ages and area

Ages	Urban	Rural	All
15-20	0.131	0.276	0.174
	(0.43)	(0.71)	(0.53)
21-25	0.958	1.795	1.199
	(1.21)	(1.71)	(1.42)
26-30	1.923	3.362	2.390
	(1.77)	(2.45)	(2.12)
31-35	3.174	5.274	3.843
	(2.40)	(2.99)	(2.78)
35-40	4.318	6.665	5.093
	(3.24)	(3.68)	(3.57)
All (15-40)	1.524	2.712	1.888
	(2.26)	(3.21)	(2.64)

b. Fertility by marital status and area

Marital status	Urban	Rural	All
Free union	3.188	3.992	3.550
	(2.58)	(2.97)	(2.79)
Married	2.981	4.610	3.531
	(2.35)	(3.23)	(2.79)
Widow	4.233	5.520	4.484
	(3.28)	(3.57)	(3.36)
Separated/ divorced	2.524	3.305	2.728
	(2.05)	(2.69)	(2.26)
Single	0.048	0.155	0.076
	(0.29)	(0.61)	(0.40)
All	1.524	2.712	1.888
	(2.26)	(3.21)	(2.64)

c. Child quality by marital status and area

Marital status	Urban	Rural	All
Free union	0.443	0.134	0.299
	(0.42)	(0.29)	(0.39)
Married	0.686	0.276	0.537
	(0.39)	(0.36)	(0.43)
Widow	0.466	0.091	0.395
	(0.39)	(0.20)	(0.39)
Separated/ divorced	0.458	0.169	0.392
	(0.44)	(0.31)	(0.43)
Single	0.688	0.000	0.458
	(0.46)	(0.00)	(0.50)
All	0.619	0.232	0.475
	(0.41)	(0.34)	(0.43)

d. Child quality by fertility and area

Number of children	Urban	Rural	All
1	0.672	0.125	0.609
	(0.47)	(0.35)	(0.49)
2	0.761	0.390	0.712
	(0.40)	(0.48)	(0.43)
3	0.729	0.294	0.644
	(0.39)	(0.40)	(0.43)
4	0.665	0.341	0.577
	(0.41)	(0.43)	(0.44)
5	0.585	0.236	0.438
	(0.40)	(0.35)	(0.42)
>5	0.437	0.192	0.300
	(0.37)	(0.29)	(0.35)
All	0.619	0.232	0.475
	(0.41)	(0.34)	(0.43)

Source: ENH 74
Samples include women aged 15-40 in 1978.

Table continues in next page…

Table 1 Cross tabulations main variables continuation…

e. Fertility by ages, marital status and area

	Urban					Rural				
Ages	15-20	21-25	26-30	31-35	35-40	15-20	21-25	26-30	31-35	35-40
Marital status										
Free union	0.882	2.151	3.017	4.176	5.878	1.119	2.945	3.994	5.828	6.981
	(0.86)	(1.26)	(1.73)	(2.45)	(3.41)	(1.03)	(1.52)	(2.12)	(2.85)	(3.29)
Married	0.881	1.634	2.550	3.647	4.915	1.129	2.458	4.003	5.873	7.237
	(0.78)	(1.12)	(1.56)	(2.03)	(2.94)	(1.19)	(1.58)	(2.34)	(2.62)	(3.48)
Widow	--	1.300	3.000	3.929	5.408	1.000	2.667	3.250	5.750	7.667
	--	(0.67)	(2.07)	(3.25)	(3.43)	(0.00)	(1.15)	(1.89)	(3.59)	(3.20)
Separated/	1.017	1.606	2.189	3.307	3.824	1.333	2.017	2.902	4.194	6.216
divorced	(0.63)	(1.09)	(1.36)	(2.24)	(2.55)	(1.05)	(1.17)	(2.05)	(2.58)	(3.21)
Single	0.017	0.070	0.095	0.130	0.294	0.030	0.297	0.530	0.538	1.000
	(0.14)	(0.31)	(0.36)	(0.46)	(0.89)	(0.19)	(0.77)	(0.96)	(1.10)	(1.81)

f. Marital status by area

Marital status	Urban	Rural	All
Free union	9.68%	18.03%	12.23%
Married	31.97%	36.93%	33.49%
Widow	1.33%	0.73%	1.14%
Separated/ divorced	7.20%	5.76%	6.76%
Single	49.82%	38.56%	46.37%

g. Age distribution by area

Ages	Urban	Rural	All
15-20	36.24%	34.30%	35.64%
21-25	21.89%	20.10%	21.34%
26-30	16.60%	18.08%	17.05%
31-35	12.58%	13.32%	12.81%
35-40	12.69%	14.20%	13.15%

Source: ENH 74
Samples include women aged 15-40 in 1978.

Table 2

Descriptive statistics of variables by area — Sample of all women aged 15 - 40 in ENH74

Variables	Urban		Rural		All	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent variables:						
Dummy Married =1	0.320		0.369		0.335	
Dummy Free Union =1	0.097		0.180		0.122	
Dummy Widow =1	0.013		0.007		0.011	
Dummy Separated or divorced =1	0.072		0.058		0.068	
Dummy Single = 1	0.498		0.386		0.464	
Number of children ever born	1.524	2.257	2.712	3.212	1.888	2.644
Child quality indicator *(see text for definition)*	0.619	0.415	0.232	0.342	0.475	0.432
Number of observations for child quality indicator	1,724		1,026		2,750	
Individual characteristics						
Non labor income /1.000 in pesos of 1978	0.046	0.632	0.003	0.070	0.033	0.528
Age	24.94	7.45	25.43	7.62	25.09	7.51
Age squared	677	400	705	412	686	404
Years of schooling	6.205	3.452	2.795	2.439	5.161	3.544
Dummy Born in rural area=1	0.191	0.393	0.000	0.000	0.132	0.339
Distance from capital of departamento in km.	28.493	51.578	94.391	67.429	48.664	64.497
Labor market indicators						
Female occupation rate in municipality	0.311	0.074	0.157	0.088	0.264	0.106
Proportion of occupied in industry in municipality	0.227	0.112	0.087	0.084	0.184	0.123
Marriage market indicator						
Sex ratio from Census in departamento	0.922	0.053	0.960	0.042	0.934	0.053
Family planning programs per 1000 relevant population						
Expenditures in family planning clinics (in US 1970$)	61.798	59.608	--		--	
Costs of community program of pills & condomns (in US 1977$)	--		166.35	208.77	--	
Expenditures in family planning clinics * years of schooling/1000	0.410	0.504	--		--	
Number of observations	7,760		3,423		11,183	

Source: ENH74

Table 3
Ordinary least squares regressions for children ever born to women aged 15-40.

		Number of children ever born				
		Urban (1)			Rural (2)	
		Coef.	t -stat.		Coef.	t -stat.	
	Individual characteristics						
(1)	Non labor income/1000	-0.042	(1.44)		0.274	(0.52)	
(2)	Age	0.069	(3.42)	*	0.195	(5.03)	*
(3)	Age squared/100	0.224	(5.95)	*	0.188	(2.62)	*
(4)	Years of schooling	-0.153	(18.37)	*	-0.130	(6.66)	*
(5)	Born in rural area=1	0.072	(1.45)				
(6)	Distance from capital of departamento/1000				1.879	(3.08)	*
	Labor market indicators						
(7)	Female occupation rate in municipality	-0.771	(2.36)	*	-1.006	(2.20)	*
(8)	Proportion of occupied in industry in municipality	-0.794	(4.41)	*	0.503	(1.05)	
	Marriage market indicator						
(9)	Sex ratio from Census in departamento	1.619	(3.33)	*	3.725	(4.06)	*
	Family planning programs per 1000 relevant population						
(10)	Expenditures in family planning clinics/1000	-2.729	(3.87)	*			
(11)	Expenditures in family planning clinics/1000 * years of schooling	0.440	(4.81)	*			
(12)	Costs of community program of pills & condomns/1000				-0.212	(0.76)	
(13)	Costs of community program of pills & condomns/1000 * years of schooling **(1)**				-0.072	(0.97)	
(14)	Intercept	-1.86			-6.78		
	Number of observations	7,760			3,423		
	F - Test	700			416		
	Adj R-squared	0.474			0.548		
	Test of joint significance variables (7) to (13)	22.11			7.48		

(1) When this interaction term is not included, the coefficient of the Cost of community program of pills and condomns /1000 is significant with value -0.411 (t=2.20).

Source: ENH74

Table 4

Multinomial Logit estimates of marital status by area for women aged 15 to 40 - Urban

		Probability of being in free union				Probability of being married			
	Individual characteristics	Coef.	RRR	z - stat.		Coef.	RRR	z - stat.	
(1)	Non labor income/1.000	-0.424	0.654	(2.02)	*	-0.458	0.633	(3.56)	*
(2)	Age	0.190	1.209	(25.82)	*	0.228	1.256	(37.32)	*
(3)	Years of schooling	-0.284	0.753	(19.45)	*	-0.057	0.945	(6.01)	*
(4)	Born in rural area=1	-0.077	0.926	(0.71)		-0.103	0.903	(1.21)	
	Labor market indicators in municipality								
(5)	Female occupation rate	-3.310	0.037	(4.83)	*	-0.110	0.896	(0.20)	
(6)	Proportion of occupied in industry	-2.157	0.116	(5.51)	*	-0.714	0.490	(2.36)	*
	Marriage market indicator								
(7)	Sex ratio from Census (departamento)	5.294	199	(4.99)	*	3.047	21	(3.88)	*
	Family planning programs per 1.000.000 relevant population								
(8)	Expenditures family planning clinics	4.727	1.005	(5.17)	*	2.057	1.002	(2.72)	*
	Intercept	-8.32				-8.35			

		Probability of being separ./divorced				Probability of being widow			
	Individual characteristics	Coef.	RRR	z - stat.		Coef.	RRR	z - stat.	
(1)	Non labor income/1.000	0.134	1.144	(1.82)	*	0.077	1.081	(1.37)	
(2)	Age	0.338	1.402	(17.02)	*	0.214	1.239	(26.48)	*
(3)	Years of schooling	-0.169	0.844	(4.36)	*	-0.181	0.834	(10.79)	*
(4)	Born in rural area=1	-0.425	0.654	(1.60)		-0.126	0.881	(1.01)	
	Labor market indicators in municipality								
(5)	Female occupation rate	-0.891	0.410	(0.50)		-1.461	0.232	(1.90)	*
(6)	Proportion of occupied in industry	-0.794	0.452	(0.79)		-1.035	0.355	(2.26)	*
	Marriage market indicator								
(7)	Sex ratio from Census (departamento)	3.059	21	(1.06)		4.936	139	(4.21)	*
	Family planning programs per 1.000.000 relevant population								
(8)	Expenditures family planning clinics	-0.443	1.000	(0.16)		4.294	1.004	(3.99)	*
	Intercept	-14.03				-10.18			

Number of observations	7760
Wald chi2	1967
Pseudo R2	0.213
Log likelihood = -7233.3024	
Test of joint significance variables (5) to (8)	144

Reference category: Probability of being single
RRR= relative risk ratio

Source: ENH74

table continues in next page …

Table 4 continuation

Multinomial Logit estimates of marital status by area for women aged 15 to 40 - Rural

		Probability of being in free union				Probability of being married			
	Individual characteristics	Coef.	RRR	z - stat.		Coef.	RRR	z - stat.	
(1)	Non labor income/1.000	-5.847	0.003	(1.66)		-7.264	0.001	(2.68)	*
(2)	Age	0.203	1.225	(17.87)	*	0.258	1.294	(24.17)	*
(3)	Years of schooling	-0.311	0.733	(10.73)	*	-0.063	0.939	(3.26)	*
(4)	Distance Km. from cap. departamento/1.000	0.493	1.000	(0.56)		1.724	1.002	(2.12)	*
	Labor market indicators in municipality								
(5)	Female occupation rate	-0.981	0.375	(1.23)		-3.173	0.042	(5.31)	*
(6)	Proportion of occupied in industry	2.033	7.637	(2.84)	*	1.730	5.641	(3.06)	*
	Marriage market indicator								
(7)	Sex ratio from Census (departamento)	11.427	91794.3	(8.86)	*	0.782	2.187	(0.64)	
	Family planning programs per 1.000.000 relevant population								
(8)	Community program of pills & condomns	-1.714	0.998	(5.37)	*	-0.695	0.999	(2.83)	*
	Intercept	-15.458				-6.486			

		Probability of being separ./divorced				Probability of being widow			
	Individual characteristics	Coef.	RRR	z - stat.		Coef.	RRR	z - stat.	
(1)	Non labor income/1.000	-23437.9	(dropped)			2.400	11.023	(2.10)	*
(2)	Age	0.329	1.390	(8.13)	*	0.223	1.250	(16.11)	*
(3)	Years of schooling	-0.095	0.909	(0.98)		-0.118	0.889	(2.87)	*
(4)	Distance Km. from cap. departamento/1.000	6.895	1.007	(2.50)	*	0.980	1.001	(0.70)	
	Labor market indicators in municipality								
(5)	Female occupation rate	0.855	2.351	(0.37)		0.292	1.340	(0.29)	
(6)	Proportion of occupied in industry	2.822	16.817	(1.43)		1.532	4.627	(1.41)	
	Marriage market indicator								
(7)	Sex ratio from Census (departamento)	-1.477	0.228	(0.22)		3.080	21.749	(1.44)	
	Family planning programs per 1.000.000 relevant population								
(8)	Community program of pills & condomns	-1.999	0.998	(1.50)		-1.516	0.998	(3.56)	*
	Intercept	-11.486				-9.762			

Number of observations 3423
Wald chi2(31) 894.35
Pseudo R2 0.2158
Log likelihood = -3340.4595

Test of joint significance variables (5) to (8) 202

Reference category: Probability of being single

Source: ENH74

Table 5

Ordinary least squares regressions for child quality indicator for women aged 15 to 40

Dependent variable: child quality	Baseline specification				Fertility assumed exogenous and estimated by OLS				Fertility assumed endogenous and estimated by instrumental variables[a]			
	Urban (1)		Rural (2)		Urban (3)		Rural (4)		Urban (5)		Rural (6)	
	Coef.	t -stat.	Coef.	t -stat.	Coef.	t -stat.	Coef.	t -stat.	Coef.	t -stat.	Coef.	t -stat.
Explanatory variables:												
Individual characteristics												
Non labor income/1000	0.007	(0.44)	-0.405	(0.69)	0.003	(0.17)	-0.188	(0.32)	-0.014	(0.66)	0.373	(0.40)
Age	0.116	(4.08) *	0.044	(1.58)	0.112	(4.04) *	0.044	(1.59)	0.099	(2.77) *	0.044	(1.50)
Age squared/100	-0.177	(4.06) *	-0.066	(1.52)	-0.159	(3.73) *	-0.059	(1.37)	-0.095	(1.69) *	-0.042	(0.84)
Years of schooling	0.047	(15.99) *	0.057	(10.95) *	0.039	(13.04) *	0.055	(10.57) *	0.011	(1.47)	0.050	(5.85) *
Born in rural area=1	-0.112	(5.17) *			-0.097	(4.60) *			-0.045	(1.56)		
Distance Km. from capital of departamento/1.000			-0.517	(3.54) *			-0.447	(3.06) *			-0.268	(0.99)
Fertility												
Number of children ever born					-0.039	(9.23) *	-0.016	(3.75) *	-0.177	(6.01) * [a]	-0.056	(1.12) [a]
Intercept	-1.453		-0.561		-1.321		-0.533		-0.847		-0.458	
Number of observations	1,724		1,026		1,724		1,026		1,724		1,026	
F - Test	76.6		28.5		81.1		26.4		46.8		22.2	
Adj R-squared	0.1799		0.1181		0.2182		0.1293		--		--	

[a] Predicted fertility on the basis of model presented in columns (1) and (2) from Table 3 identified by labor market indicators, sex ratio and family planning programs.

Source: ENH74

Table 6

Regressions for child quality indicator for women aged 15-40 - Marital status assumed exogenous and estimated by OLS - Urban

	(1)		(2)		(3)		(4)		(5)	
Individual characteristics										
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Non labor income/1.000	0.0044	(0.27)	0.0222	(1.37)	0.0140	(0.85)	0.0146	(0.89)	0.0057	(0.35)
Age/100	0.0041	(0.02)	0.0833	(0.41)	0.1283	(0.62)	0.1078	(0.53)	0.0718	(0.35)
Years of schooling	0.0450	(14.92) *	0.0423	(14.00) *	0.0478	(16.15) *	0.0472	(15.91) *	0.0484	(16.31) *
Born in rural area=1	-0.1125	(5.23) *	-0.1150	(5.39) *	-0.1155	(5.33) *	-0.1132	(5.24) *	-0.1129	(5.21) *
Marital status variables										
Dummy free union	-0.1221	(5.04) *								
Dummy married			0.1538	(7.45) *						
Dummy widow					-0.1534	(2.70) *				
Dummy separated/divorced							-0.1281	(3.71) *		
Dummy single									0.1563	(1.17)
Intercept	0.444		0.299		0.371		0.386		0.382	
Number of observations	1724		1724		1724		1724		1724	
F- test	78.73		86.04		74.33		75.91		72.91	
Adj R-squared	0.184		0.198		0.176		0.179		0.1726	

Source: ENH74

table continues in next page …

Table 6 continuation

Regressions for child quality indicator for women aged 15-40 - Marital status assumed exogenous and estimated by OLS - Rural

	(6)		(7)		(8)		(9)		(10)	
Individual characteristics										
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Non labor income/1.000	-0.452	(0.77)	-0.305	(0.52)	-0.462	(0.78)	-0.367	(0.62)	-0.460	(0.78)
Age	0.065	(0.30)	0.106	(0.50)	0.218	(1.02)	0.209	(0.98)	0.187	(0.88)
Years of schooling	0.053	(10.19) *	0.053	(10.06) *	0.057	(11.04) *	0.057	(11.01) *	0.057	(11.01) *
Distance Km. from capital of departamento/1.000	-0.001	(3.64) *	-0.001	(3.72) *	-0.001	(3.50) *	-0.001	(3.60) *	-0.001	(3.58) *
Marital status variables										
Dummy free union	-0.090	(3.88) *								
Dummy married			0.101	(4.61) *						
Dummy widow					-0.127	(1.30)				
Dummy separated/divorced							-0.059	(1.11)		
Dummy single									-0.203	(1.26)
Intercept	0.180		0.076		0.099		0.104		0.110	
Number of obs	1026		1026		1026		1026		1026	
F- test	31.36		32.76		28.32		28.22		28.3	
Adj R-squared	0.129		0.134		0.118		0.117		0.118	

Source: ENH74

Table 7

Regressions for child quality indicator for women aged 15-40 - Marital status assumed endogenous and estimated by instrumental variables [a,b] - Urban

	(1)		(2)		(3)		(4)		(5)	
Individual characteristics										
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Non labor income/1.000	-0.0052	(0.32)	0.0807	(3.80) *	0.0427	(1.17)	-0.0559	(1.84) *	-0.0023	(0.13)
Age/100	-0.3577	(1.66)	0.1175	(0.58)	0.3283	(1.07)	-0.1789	(0.78)	0.0390	(0.19)
Years of schooling	0.0280	(6.21) *	0.0207	(3.52) *	0.0464	(13.56) *	0.0560	(12.87) *	0.0506	(13.93) *
Born in rural area=1	-0.1093	(5.09) *	-0.1218	(5.65) *	-0.1240	(5.22) *	-0.1127	(5.20) *	-0.1090	(4.95) *
Marital status variables										
Dummy free union	-0.7549	(5.89) *								
Dummy married			0.7160	(5.41) *						
Dummy widow					-0.7184	(1.12)				
Dummy separated/divorced							0.9560	(2.43) *		
Dummy single									2.5076	(1.13)
Intercept	0.762		-0.009		0.327		0.360		0.371	
Number of observations	1724		1724		1724		1724		1724	
F- test	80.98		79.66		72.88		74		72.89	
Adj R-squared	0.184		0.186		0.173		0.175		0.173	

[a] Predicted marital status on the basis of model presented in Table 4 identified by labor market indicators, sex ratio and family planning programs.

[b] Standard errors are not corrected for bias using predicted instrumental variables.

Source: ENH74

table continues in next page …

Table 7 continuation

Regressions for child quality indicator for women aged 15-40 - Marital status assumed endogenous and estimated by instrumental variables [a,b] - Rural

	(6)		(7)		(8)		(9)		(10)	
Individual characteristics										
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Non labor income/1.000	-0.452	(0.77)	-0.236	(0.39)	-0.452	(0.77)	2.538	(2.80) *	-0.447	(0.76)
Age/100	0.065	(0.27)	0.068	(0.31)	0.164	(0.54)	0.865	(3.29) *	0.197	(0.91)
Years of schooling	0.053	(8.45) *	0.051	(7.89) *	0.057	(11.03) *	0.052	(9.97) *	0.058	(10.25) *
Distance Km. from capital of departamento/1.000	-0.001	(3.61) *	-0.001	(3.72) *	-0.001	(3.38) *	-0.001	(4.87) *	-0.001	(3.23) *
Marital status variables										
Dummy free union	-0.091	(1.06)								
Dummy married			0.147	(1.78)						
Dummy widow					0.112	(0.11)				
Dummy separated/divorced							-1.989	(4.32) *		
Dummy single									0.593	(0.22)
Intercept	0.180		0.062		0.115		-0.012		0.100	
Number of obs	1026		1026		1026		1026		1026	
F- test	28.19		28.66		27.94		32.19		27.95	
Adj R-squared	0.117		0.119		0.116		0.132		0.116	

[a] Predicted marital status on the basis of model presented in Table 4 identified by labor market indicators, sex ratio and family planning programs.

[b] Standard errors are not corrected for bias using predicted instrumental variables.

Source: ENH74

Appendix 1

Construction of the child quality measure

This Appendix explains how the indicator of "schooling" was constructed. Each child has a "quality" measure q* that is an unobservable latent variable with a dichotomous proxy q, such that:

$q=1$ if $q^* \geq q_r$,
$q=0$ if $q^* < q_r$,

where q_r (reservation level of quality) is a subjectively defined threshold level. The dichotomous character of this measure implies that two children with different levels of q* are considered equal as long as both are at the same side of q_r.

The threshold level q_r was defined based on the grades completed by the child given his or her age, depending on the grades completed by the majority of children in each age in the region (urban or rural). Table A1 shows the grades completed by the majority of children in each age by areas.

Table A1. Grade completed by majority of children in age

Age of child	Urban	Rural
7	1	1
8	1	1
9	2	1
10	3	2
11	3	2
12	4	3
13	5	3
14	5	4
15	5	2

In urban areas, most of the 10 year old children have completed 3rd grade, whereas in rural areas the same birth cohort of children have completed 2nd grade. For older children, the difference in attainment at same age between rural and urban areas increases. A 13 year old in urban areas would have completed on average 5th grade, but in rural areas only 3rd. The attainment levels do not increase monotonically with age, since the level of attainment of the majority of children aged 10 and 11 is the same. (A linear indicator such as grade over age would not take into account these non-linearities.)

Table A2 shows the proportions of children in each age that have completed a given grade.

Table A2. Proportions of children in age that have completed grades

Age of child	Grade	Urban	Rural
7	1	47%	8%
8	1	68%	30%
9	1	55%	45%
10	2	45%	41%
11	3	41%	28%
12	4	61%	17%
13	5	57%	8%
14	6	42%	6%
15	7	39%	5%

Taking into account these percentages, the schooling indicator is defined using the scheme above as follows:

$$\text{schooling (i)} = \begin{cases} 1 \text{ if } 7 \le age_i \le 9 & \text{and} \quad grade_i \ge 1, \\ 1 \text{ if } age_i = 10 & \text{and} \quad grade_i \ge 2, \\ 1 \text{ if } age_i = 11 & \text{and} \quad grade_i \ge 3, \\ 1 \text{ if } age_i = 12 & \text{and} \quad grade_i \ge 4, \\ 1 \text{ if } age_i = 13 & \text{and} \quad grade_i \ge 5, \\ 1 \text{ if } age_i = 14 & \text{and} \quad grade_i \ge 6, \\ 1 \text{ if } age_i = 15 & \text{and} \quad grade_i \ge 7, \\ 0 & \text{otherwise.} \end{cases}$$

If the child i's schooling is "appropriate" for his age, then schooling (i) = 1. If the child i does not attend school, or is lagged behind the majority of children of his age, then schooling (i) = 0.

For each mother with children between 7-15, the following number is calculated:

$$q_f = [\Sigma_i \text{ schooling(i)}\ ] / n.$$

where n is the number of children between 7-15 and i=1,…,n. The measure q_f considers the average schooling of all the children 7-15 for woman f and constitutes the child quality indicator for that woman.

This indicator captures late entry to school, grade repetition or sporadic school attendance of the woman's children. If a child is left behind the majority of children of his age, he has schooling=0, even though the survey does not inform directly about these events. However, the schooling indicator (and therefore the woman's child quality indicator) does not capture how far is a child from the "adequate" level of schooling, because it clusters all cases in a dummy variable.

Table A3

	Budget Clinics (2)			Other programs	
	Human Costs divided by 1000 relevant population (3)	Other expenditures clinic divided by 1000 relevant population	Total (1) divided by 1000 relevant population	Total costs radio programs / (1000 relevant population) (4)	
Municipalities				**Departamentos**	
Armenia	232.00	131.52	363.52	Antioquia	18.19
Barranquilla	198.71	45.05	243.76	Bogota	41.50
Bogota	308.08	139.17	447.26	Bolivar	44.97
Bucaramanga	293.44	131.48	424.92	Boyaca	13.19
Buenaventura	319.85	146.30	466.14	Caldas	28.21
Cali	70.69	40.78	111.47	Cauca	9.02
Cartagena	67.51	24.41	91.92	Cesar	11.40
Cucuta	233.10	99.47	332.57	Cordoba	22.14
Ibague	170.00	67.98	237.98	Cundinamarca	8.68
Manizales	224.36	86.42	310.78	Huila	23.33
Medellin	129.74	53.83	183.57	Magdalena	26.44
Monteria	296.45	71.63	368.08	Meta	33.72
Palmira	308.91	117.68	426.58	Nariño	20.70
Pasto	379.54	132.66	512.20	Norte de Santander	34.62
Pereira	222.06	101.36	323.43	Quindio	70.76
Tulua	440.33	167.74	608.07	Risaralda	51.96
				Santander	22.89
				Sucre	7.96
				Tolima	18.84
				Valle	30.40

(1) Includes doctors, nurses, rent, equipment and all.
(2) Costs in dollars of 1970.
(3) Relevant population is urban female population of municipality in ages 15-39 in 1970.
(4) Relevant population is total females 15-39 in 1970 in departamento obtained from DANE.

Source: 1970 Budget: Source and Application Funds/ January 1 - December 31 -1970

Aggregation made by the author following these criteria:
1. Data from different hospitals in same city are added by city.
2. "Atlantico" clinic costs were added to Barranquilla's.
3. New and old clinics were combined.
4. Radio program expenditures were added to supplementary radio expenditures
5. Radio programs produced in one city are assumed to be heard by all the departamento where that city is Therefore radio program expenditures are added at the departamento level.
6. Table shows only information for municipios and departamentos included in the survey ENH74.

Table A4

COSTS OF FAMILY PLANNING PROGRAM - COLOMBIA 1977 divided by 1000 of relevant population (2)				
	CLINIC PROGRAMS (IUD, pills, others) (1)	FEMALE STERILIZATION	MALE STERILIZATION	COMMUNITY PROGRAM PILLS / CONDOMNS
Municipalities				
Armenia	688.06	126.43	1.76	74.80
Barranquilla	287.88	340.73	0.27	60.21
Bogota	332.31	231.12	3.32	91.69
Buenaventura	498.92	369.52	2.52	192.18
Bucaramanga	695.06	374.84	15.07	108.56
Caldas (Antioquia)	1682.45	0.00	0.00	343.71
Cali	298.97	207.63	10.06	39.74
Cartagena	239.78	715.29	0.00	76.77
Cucuta	441.06	0.00	0.00	100.61
Ibague	443.75	139.78	9.79	53.54
Manizales	569.83	283.38	7.04	137.98
Medellin	565.56	270.08	5.12	38.97
Monteria	730.64	2853.05	0.00	242.08
Palmira	606.27	102.97	12.93	217.54
Pasto	620.37	78.53	4.29	96.38
Pereira	728.37	395.03	2.95	126.11
Quibdo	493.22	152.88	0.00	0.00
Tulua	860.97	139.91	0.50	267.77
Rural areas of departamentos (3)				
Antioquia	--	129.99	--	302.32
Cundinamarca	--	881.26	--	474.56
Quindio	--	175.86	--	891.74
Risaralda	--	258.18	--	940.74
Tolima	--	61.87	--	713.49
Valle	--	222.50	--	263.40
Nariño	--	263.58	--	443.28
Santander del Sur	--	42.51	--	314.95

(1) Costs are in dollars of 1977.
(2) Relevant population is urban female population of that municipality in ages 15-40 in 1977.
(3) Relevant population is rural female population of departamento in ages 15-40 in 1977.

Sources: Trias y Ojeda (1978) and DANE-DNP (1999)

Aggregation made by the author following these criteria:
1. Data from different hospitals in same city are added by city.
2. "Unidades moviles" in cities are added to the rural program of that departamento.
3. Rural program given in few rural areas is aggregated at the departamento level.
4. Only total costs of program are taken into account.
5. Table shows only information from municipios included in the survey ENH74.

Table A5
Selection bias correction in regressions of child quality - Women 15 to 40 years old.

Child quality model: Dependent variable: Child quality indicator

	Urban			Rural		
	Coefficient	z -stat.		Coefficient	z -stat.	
Individual characteristics						
Non labor income/1.000	0.0071	(0.44)		-0.4119	(0.70)	
Age	0.1464	(2.69)	*	0.0501	(1.00)	
Age squared/100	-0.2196	(2.81)	*	-0.0737	(1.02)	
Years of schooling	0.0456	(11.52)	*	0.0566	(10.19)	*
Born in rural area=1	-0.1132	(5.21)	*			
Distance Km. from capital of departamento/1.000				-0.0005	(3.41)	*
Intercept	-2.0089			-0.6699		

Selection model: Dependent variable: Having a child aged 7 to 15

	Urban			Rural		
	Coefficient	z -stat.		Coefficient	z -stat.	
Individual characteristics						
Non labor income/1.000	0.0011	(0.04)		-1.1843	(0.87)	
Age	0.9440	(18.33)	*	0.8464	(13.34)	*
Age squared/100	-0.0132	(16.09)	*	-0.0116	(11.35)	*
Years of schooling	-0.0595	(9.29)	*	-0.0605	(4.42)	*
Born in rural area=1	-0.0710	(1.37)				
Distance Km. from capital of departamento/1.000				0.3058	(0.64)	
Labor market indicators						
Female occupation rate in municipality	0.2648	(0.70)		-1.5792	(4.10)	*
Proportion of occupied in industry in municipality	-0.7032	(3.39)	*			
Marriage market indicator						
Sex ratio from Census in departamento	0.4632	(0.85)		1.4607	(1.95)	*
Family planning programs per 1000 relevant population						
Expenditures in family planning clinics /1.000.000	0.0115	(0.02)				
Costs of community program of pills & condomns /1.000.000				-0.1797	(1.12)	
Intercept	-16.5338			-15.7407		
Selection model statistics		Std. Errors			Std. Errors	
rho	0.1196	*(0.1806)*		0.0309	*(0.2210)*	
sigma	0.3764	*(0.0081)*		0.3206	*(0.0072)*	
lambda	0.0450	*(0.0686)*		0.0099	*(0.0709)*	
Number of observations	7,760			3,423		
Censored observations	1,724			1,026		
Uncensored observations	6,036			2,397		
Wald chi2(5)	374.4			142.2		
Log likelihood	-3077			-1425		

Source: ENH74

Please see Table 2 for units of variables