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Explaining the "Up-to-God" response to desired family size question*

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Abstract:

Respondents in developing countries frequently give a nonnumeric (Up-to-God) response to the desired family size question asked in fertility surveys. In literature nonnumeric respondents are viewed as fatalists or as those who consider family size to be beyond the realm of conscious choice and are usually excluded from analysis. This paper proposes and investigates an economic explanation for this response based on demand - supply model of fertility. Nonnumeric response is modeled as a discrete choice problem. The hypothesis is that respondents give nonnumeric response if their desired demand for children exceeds their potential supply of children. Data on husbands and wives from Bangladesh Demographic and Health Survey (1993-94) are used to assess the validity of the supply-constrained hypothesis. Reduced form probit model is set up to estimate the net effect of demand side and supply side variables on the likelihood of a spouse giving a nonnumeric response. Two purely supply related variables used in the analysis are marital duration and wife's infecundity status. Joint husband-wife likelihood of giving nonnumeric response is estimated using bivariate probit which allows for within-couple correlation of unobserved variables. Results obtained from probit and bivariate probit models are consistent with expected effects. They show support for the supply-constrained view of nonnumeric response. Infecundity of wife significantly raises her own likelihood of giving nonnumeric response and marital duration significantly reduces husband's likelihood of giving nonnumeric response. Husbands are more likely to give nonnumeric response than wives are. Also, some variables show systematic differences in the way they affect each spouse's likelihood of giving nonnumeric response.

1. Introduction

Fertility surveys routinely include questions that are intended to gauge respondents' preferred[1] number of children. One such question is the desired family size question[2] that asks respondents to provide the number that they would like to have if they could start their reproductive life all over again. Respondents in developing countries frequently give a nonnumeric response ("Up to God" or "Whatever God give us"). The percentage of respondents giving this response varies between countries and across surveys[3]. Nonnumeric response to this question is puzzling since respondents are being asked about a number but they provide a qualitative answer instead.

In demography literature, where this response has received most attention, the explanations that are proposed relate to respondent's perception of family size as an issue of personal choice. Nonnumeric respondents are seen as those who either perceive fertility to be beyond the calculus of choice or as those who do not have a preference for family size (Van de Walle, 1992; McCarthy and Oni 1987). Nonnumeric response is also seen as indicating a preference for a very large number of children (Fapohunda and Todaro, 1989) or as reflecting a "pre-modern" understanding of fertility issues (McCarthy and Oni, 1987).

This paper explores an alternative explanation for this response based on the concepts of demand for and supply of children[4]. When family size is modeled as the outcome of the interaction between couples' demand for and supply of children (Easterlin

[1] The word commonly used is "preferences" for number of children. There is debate about whether these questions capture preferences or tastes for family size (Westoff, 1991) or whether they capture respondents' demand for children (McClelland, 1983; Easterlin, 1978).
[2] In Demographic and Health Surveys (DHS) (Macro International), respondents with living children were asked: "If you could go back to the time you did not have children and could choose exactly the number of children to have in your whole life, how many would that be?" Respondents with no living children were asked: "If you could choose exactly the number of children to have in your whole life, how many would that be?"
[3] It varies from less than 10% of the sample (Thailand; Knodel and Prachuabmoh, 1973) to almost 80% of the sample (Pakistan DHS, 1990-91).
[4] Supply refers to the number of children a couple could have if they did not regulate their fertility.

1978; Easterlin, Pollak and Wales, 1980; Boulier and Rosenzweig, 1978; Rosenzweig and Schultz, 1985), then in equilibrium, couples can be supply-constrained (demand exceeds supply) or have excess supply (supply exceeds demand). Easterlin's synthesis model, combines the concepts of demand for children, potential supply of children and cost of fertility regulation to analyze the fertility behavior of couples in a static framework. In equilibrium, couples' demand for children can exceed or fall short of the potential supply. Motivation to use contraceptives only arises in an excess supply situation.

The hypothesis explored in this paper is that nonnumeric respondents are those who are supply-constrained. Two factors that indicate that this might be a valid hypothesis. First relates to the expressions used to convey their desired family size which are, "Whatever God gives us", and, "Up to God". These phrases convey a notion of accepting whatever nature provides them, which can be equated to their 'supply' of children. Second, nonnumeric respondents are observed to be less likely to have ever used contraceptives. If they are supply-constrained then this behavior would be a rational response. If the respondent is not supply-constrained, then he or she is able to report a number that is equal to the number that is demanded (i.e., gives a numeric response).

If the supply-constrained explanation is valid then dropping nonnumeric respondents from the sample will be equivalent to dropping those who are supply-constrained. The estimates of demand equation from such a sample will, therefore, be subject to selection bias[5]. Jensen (1985) recognizes that nonnumeric response may be given based on some "selection rule". However, his explanation for nonnumeric response is

[5] Selection bias refers to the bias in Ordinary Least Squares (OLS) estimates due to the sample being a non-random sample. OLS estimates in this case are inconsistent estimates of the true parameters. This is equivalent to the problem of estimating wage equation for women where wages are observed only for those women who participate in the labor force. Women non-randomly select into participating and not participating in the labor force based on their individual characteristics. Estimates of the wage equation based only on participating women will be subject to selection bias.

similar to that often proposed in literature. He chooses "modernity" variables to explain selection into giving nonnumeric (or numeric) response, based on the assumption that "strong family size preferences are linked to modernity".

Data are from 1993-94 Bangladesh Demographic and Health Survey (BDHS) in which 3,284 currently married husbands and wives were surveyed. This data is combined with the Services Availability data that provide information on village characteristics and availability of health and family planning services. About a quarter of the 3,284 couples surveyed gave a nonnumeric response to the desired family size question and more husbands than wives gave a nonnumeric response[6].

The likelihood of husbands and wives giving a nonnumeric response is estimated as univariate probit models. The paper also estimates a bivariate probit model which allows for within-couple correlation of unobserved variables that influence husbands' and wives' likelihood of giving nonnumeric response.

Section 2 discusses the treatment of nonnumeric response in literature and presents the theoretical model. Section 3 presents the empirical model. Section 4 describes the data and the variables used in the analysis. Section 5 discusses the results. Section 6 concludes.

2. Theoretical framework

The notion that at any point in time there may be couples that are supply-constrained or are in excess-supply equilibrium is equivalent to the notion of countries being in different stages of fertility transition. Bangladesh was well in to the start of fertility decline during the late 1980s and the early 1990s (Mitra et al, 1994). Figure 1 presents (hypothetical)

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[6] In surveys where husbands are not asked the desired family size question, the percentage of nonnumeric response may be underestimated.

trends in fertility demand and supply and actual achieved fertility that can exist in a society at a point in time. This is based on Easterlin's (1978) illustration of possible trends in demand and supply of children over time associated with economic development. The trends across couples are modeled against wife's years of education showing that demand for children falls as wife's education increases. Supply of children is shown to increase with women's education, which could be due to reduced breastfeeding practices or due to improved nutrition and health.

In region A are those couples for whom demand for children exceeds the potential supply. In region B are those couples who are in excess supply equilibrium but attain a higher achieved fertility due to high costs of contraception. In region C are those couples who are in excess supply equilibrium and who do not find cost of fertility regulation to be prohibitively high. These are couples who are able to attain a family size that is closer to their demand for children.

The hypothesis investigated in this paper is that nonnumeric respondents are those who are in region A of Figure 1. In demography literature, nonnumeric response has been modeled as arising out of an individual's perceived of lack of control over fertility decision-making (van de Walle 1992; McCarthy and Oni, 1987)[7]. Another explanation proposed in literature is that nonnumeric respondents prefer large number of children (McCarthy and Oni, 1987; Jensen, 1985; Olaleye, 1995). Characteristics such as fatalistic attitude and religious/ cultural attitudes have also been used to explain the likelihood of couples giving this response. Riley, Hermalin and Rosero-Bixby (1993) in a comprehensive analysis of possible explanations also include survey design and data collection procedures (such as the extent of probing). They compare average reported desired family size and percentage of

[7] Reproductive decisions are not within calculus of choice.

nonnumeric respondents across various surveys and they find that there is a general trend of higher average desired family size associated with higher percentage of nonnumeric respondents.

McCarthy and Oni (1987) come closest to the hypothesis tested in this paper when they assert that nonnumeric respondents may be "pre-modern" or "pre-transition" – that is they belong to region A of Figure 1. At the same time they also stress that for these couples fertility regulation is not within the realm of conscious choice and that they are fatalistic as well as lack a modern understanding of fertility issues. However, it is asserted here that couples for whom demand for children exceeds supply may be aware of contraception techniques (traditional or modern) and yet choose not to use contraception since they can attain their desired family size without regulating their fertility. This is what Olaleye (1994) refers to as the "rational" response explanation of nonnumeric response.

Let U represent the lifetime static utility that parents maximize. It depends on number of children, C, who survive to the adulthood, the quality, Q, of their children (such as education and health), leisure hours of husband and wife, L_h and L_w, their use of fertility regulation methods, R, and other goods, X. Parent's utility function is also a function of preference parameters, T_w and T_h, of each parent and of the expected survival probability of children, S[8].

(1) $U=U(C, Q, L_h, L_w, R, X; S, T_w, T_h)$

(2) $p_xX + p_cC + p_qQ + p_rR = I + W_h + W_w$

where, p_j, j = x, c, q, r, refer to market prices, I is the household non-labor income and W_h and W_w are market wage rates of husband and wife respectively. Parents maximize their

[8] Survival probability is assumed to be exogenous.

lifetime utility U, subject to the budget constraint represented by equation 2. The reduced form demand function for children obtained from this model is,

(3) $C_d = f(p_x, p_c, p_q, p_r, I, W_h, W_w; S, T_w, T_h)$

(4) $R_d = r(p_x, p_c, p_q, p_r, I, W_h, W_w; S, T_w, T_h)$

Equation 4 represents the demand function for use of fertility regulation methods. Couples set R_d equal to zero if their demand for children exceeds the supply of children.

In Easterlin's synthesis model, "desired" demand for children is the demand when fertility regulation is costless both in terms of disutility from use of contraceptives as well as in terms of monetary costs. That is, the effect of p_r (monetary cost of fertility regulation) and the effect of psychic costs of fertility regulation (associated with R in the utility function) on C_d are equal to zero so that desired demand for children, C^*_d, is a function of costs and benefits of children alone and not of fertility regulation costs.

(5) $C^*_d = f(p_x, p_c, p_q, I, W_h, W_w; S, T_w, T_h)$

The utility function (1) is a unitary utility function with the underlying assumption that the husband and wife have the same preferences over the number and quality of children. This might be a valid assumption because marriage entails daily interaction and exchange of information as well as affection and mutual assistance all of which work to bring spousal agreement over goals and thus confound individual preferences.

It is possible, however, for each spouse to have different preferences for children since the costs borne and benefits of children enjoyed by husbands and wives can differ for couples. In societies of South Asia, for example, these costs and benefits may differ between husbands and wives due to strong patriarchal systems and low rates of widow re-marriage (Mason and Taj, 1987). Mott and Mott (1985) compared husbands' and wives' fertility intentions, reported achieved fertility and family planning for a sample of Yoruba couples in

Nigeria. Their findings indicated that women's fertility intentions were individual intentions and not necessarily related to those of their husbands'.

Fried and Udry (1979) using data on young urban American couples show that husband's and wife's costs and benefits of another birth are significant predictors of the likelihood of pregnancy. They conclude that neither spouse completely incorporates the other's cost-benefit payoff from having children. Thomson (1983) uses data from the U.S. Value of Children Survey to show that husbands and wives do not share economic and emotional "utility" of children and that individual utilities are important for couple's expectation of another birth.

Bargaining models of intrahousehold resource allocation, such as divorce threat models (McElroy and Horney, 1981) and separate spheres model (Lundberg and Pollak, 1993), allow household members to have different preferences. Empirical tests of these models are based on estimating the impact of non-labor income owned by each spouse on household demands. If preferences are the same then impact of non-labor income should be the same regardless of ownership. Schultz (1990) found that for a sample of Thai couples, non-labor income owned by wives had a significantly larger (positive) impact on couples' fertility than non-labor income owned by husbands. This contributes to the evidence that spouses can differ in their preferences for family size.

In this paper, each spouse is allowed to have separate preferences over child number and quality. Assume that each spouse maximizes his/her utility subject to the household budget constraint. Allowing the resulting demand functions to differ between spouses gives rise to two desired demand functions, one for each spouse. The desired demand function for each spouse is given below.

(6) Wife: $C^{*}_{dw} = f_w(p_x, p_c, p_q, I, W_h, W_w; S, T_w, T_h)$

(7) Husband: $C^*_{dh} = f_h(p_x, p_c, p_q, I, W_h, W_w; S, T_w, T_h)$

The potential supply of children to a couple, C_s, is a function of their natural fertility, NF, and the exogenous probability of survival of children, S. It captures the number of children that they can expect to have (surviving to adulthood) if they did not regulate their fertility. Supply differs from the biological maximum due to cultural practices such as postpartum abstinence and breastfeeding.

(8) $C_s = S \times NF$

Given their individual desired demands for children, the process by which husbands and wives arrive at a joint "couple demand", C^*, for children is not known apriori. Since we are looking at dyads, there are only two decision-makers and the majority rule cannot apply. One example of the decision rule that might apply is the one considered in bargaining models of household behavior. In bargaining models it is assumed that the preferences of the spouse with the higher bargaining power will be reflected in household demands.

We do not observe the "couple" desired demand, C^*, but we do observe individual desired demands when wives and husbands are asked the desired family size question in fertility surveys. Comparing individual desired demands, C^*_{dw} and C^*_{dh}, with the couple supply of children gives rise to four possible outcomes. Table 1a summarizes these possible outcomes. Column 1 in Table 1a shows the cases that can arise given the characteristics of the individual and those of the spouse: one spouse is supply constrained and the other is not; both spouses are supply constrained; neither spouse is supply constrained.

When a spouse is not supply constrained, he or she reports C^*_{di}, i = w,h, when asked the desired family size question, i.e., gives a numeric response. Let J_i be a dummy variable that takes value of 1 if an individual gives nonnumeric response and takes value 0 if the individual gives numeric response. Then by the hypothesis of this paper, if a spouse is supply constrained ($C^*_{di} \geq C_s$, i = w, h), he or she will give a nonnumeric response. This is shown in Column 2 of Table 1a.

Couple desired demand for children, C^*, for couples where only one spouse is supply-constrained will depend upon the decision-rule which husbands and wives use to arrive at a joint goal. Depending upon which spouse's desired demand prevails the joint demand, C^*, will accordingly be greater than or less than couple supply. Couples where both spouses are supply-constrained or both have excess demand, the joint couple demand, C^*, will correspondingly be larger than or smaller than the couple supply. Column 5 of Table 1a shows that in equilibrium, the actual fertility of couples, C, can follow two regimes. Actual fertility will follow the supply function if couple demand is supply-constrained. It will follow the desired demand function, C^*, if couple desired demand is less than supply.

This paper does not go beyond Column 2 of Table 1a to analyze couples' actual fertility and their nonnumeric response. Instead, it analyzes whether the relationship asserted between Columns 1 and 2 of Table 1a are validated by the data. The next section describes the empirical model set up to examine this hypothesis regarding nonnumeric response.

3. Empirical model

In this section, the empirical models estimated in the paper are derived. The section also describes the three specifications of empirical models that are estimated. Each of these specifications is estimated to test the validity of the supply-demand related explanation for giving nonnumeric or numeric response and specifically to examine the effect of supply side variables on the likelihood of giving nonnumeric response.

First, a probit model is set up and likelihood of giving nonnumeric response is estimated for wives and husbands separately. Then, wives' and husbands' likelihood of giving this response is estimated jointly by allowing within-couple correlation of unobserved variables and a bivariate probit model is specified to estimate this. Finally, the paper also specifies a probit model that estimates a "pooled" model. In this specification, data on wives and husbands are combined and a dummy for sex is used to directly estimate the effect of gender on likelihood of giving nonnumeric response.

Consider a dummy variable, J_i, which takes value 1 if a respondent gives nonnumeric response and takes value 0 if the respondent gives a numeric response. Then, giving nonnumeric response is a discrete choice problem. Respondents choose to give nonnumeric or numeric response by comparing their desired demand with their couple supply. Individual i is assumed to give nonnumeric response if $C^*_{di} \geq C_s$. This discrete choice can be written as a probit model in terms of an unobserved variable, J_i^*, such that if $J_i^* > 0$ then respondent i gives nonnumeric response, otherwise i gives a numeric response.

(9) $J_i^* = \delta_0 + \delta_1(C^*_{di} - C_s) + \varepsilon_i^*$, $i = w, h$, ; $J_i = 1$ if $J_i^* > 0$, $J_i = 0$ otherwise

where, ε_i follows a standard normal distribution. The explanatory variable in equation 9 is the difference between the respondent's desired demand for and supply of children. A test of the hypothesis of this paper rests on the significance of the regression parameter δ_1.

In order to estimate the probit model associated with equation 9, we would have to estimate individual desired demand equations, C^*_{di}, and couples' supply of children, C_s, then use their predicted values to estimate likelihood of nonnumeric response. This would be a "structural" equations approach similar to the one estimated by Lee (1978) to study the effect of union membership on wage rates.

The empirical form of the desired demand and supply equations are as follows:

(10) $C^*_{di} = \alpha_d + \beta_d X_{di} + \gamma_d Z_i + \varepsilon_{di}$

(11) $C_{si} = \alpha_s + \beta_s X_{si} + \gamma_s Z_i + \varepsilon_{si}$

X_d contains variables that capture prices, incomes and child survival probabilities, while X_s contains biological supply variables and probability of child survival as well as other variables from the demand side that may influence natural fertility (such as wife's education). Z_i contains village level characteristics.

One problem with estimating the "structural" form of the probit model is that we do not observe desired demand for those respondents who give a nonnumeric response so we can not estimate equation 10 for them. The other problem is that estimating supply equation given by equation 11 for each couple is difficult. The concept of supply of children is intuitively clear yet it is difficult to capture this for individual couples (Hermalin, 1983). Ways used in literature to capture potential supply include using the actual number of children (Montgomery, 1987), using Coale and Trussell's (1974) natural fertility schedule (Boulier and Mankiw, 1986) and using variables such as length of second birth intervals, age at first birth and so on (Easterlin and Crimmins, 1985). The problem with these approaches is that either the variables are endogenous to the couple's demand for children or that they do not vary by individual characteristics of couples.

To go around these problems, a "reduced form" model is estimated that makes it unnecessary to estimate the potential supply schedule for each couple. Substituting equations 10 and 11 into 9, yields:

(12) $J_i^* = \delta_0 + \delta_1(\alpha_d + \beta_d X_{di} + \gamma_d Z_i + \varepsilon_d - \alpha_s - \beta_s X_s - \gamma_s Z_i - \varepsilon_s) + \varepsilon_i^*$,

Or,

(13) $J_i^* = \eta_0 + \eta_1 X_{di} - \eta_2 X_s + \eta_3 Z_i + \varepsilon_i$, i = 1…N

where, N is the number of couples, $\varepsilon_i = \varepsilon_i^* + \delta_1(\varepsilon_d - \varepsilon_s)$. Since this is a linear combination of normally distributed errors with mean zero, ε_i is also normally distributed as $N(0, \sigma^2_\varepsilon)$.

Equation 13 represents a probit model that estimates the net effect of demand side and supply side variables on the likelihood of an individual giving nonnumeric response. Variables that raise a spouse's demand for children or lower the couples' supply of children will raise the likelihood of that spouse giving a nonnumeric response. The advantage of this framework is that a number of socioeconomic variables (such as spousal education) can be allowed to influence supply of children as well as demand for children. Choice of variables that purely influence supply side is problematic. In this paper, marital duration and reported infecundity status of wives are used.

Equation 13 is estimated for wives and husbands separately using maximum likelihood estimation. The standard errors are corrected for within cluster correlation (within communities) of error terms as well as for arbitrary heteroscedasticity.

Wife's and husband's desired demand for children are simultaneously determined given the household budget constraint and the couple shares the supply schedule for children, thus, the likelihood of husbands and wives giving a nonnumeric response will be correlated. Estimation of equation 13 for wives and husbands ignores this within-couple correlation of unobserved variables. Moreover, it can be expected that this correlation is positive. As discussed earlier, a husband and wife share the family building process together and there would be unobserved factors related to this process which influence both spouses' likelihood of giving nonnumeric response in the same direction. The immediate household environment and the extended family environment in which husbands and wives live will also affect both spouses' likelihood of giving nonnumeric response in the same way.

Allowing for this correlation of unobserved variables, a bivariate probit model can be set up (Greene, 1997) consisting of two equations – one for each spouse – where the error terms are correlated and follow a bivariate standard normal distribution with zero mean, unit variance and correlation ρ.

(14) $J_{wi}^{*} = \eta_{0w} + \eta_{1w}X_{di} - \eta_{2w}X_{si} + \eta_{3w}Z_i + \varepsilon_{wi}$

$J_{hi}^{*} = \eta_{0h} + \eta_{1h}X_{di} - \eta_{2h}X_{si} + \eta_{3h}Z_i + \varepsilon_{hi}$

$J_{wi} = 1$ if $J_{wi}^{*} > 0$, 0 otherwise

$J_{hi} = 1$ if $J_{hi}^{*} > 0$, 0 otherwise

$E(\varepsilon_{wi}) = E(\varepsilon_{hi}) = 0$

$Var(\varepsilon_{wi}) = Var(\varepsilon_{hi}) = 1$

$Corr(\varepsilon_{wi}, \varepsilon_{hi}) = \rho \neq 0, i = 1,\ldots, N$

Each regression equation in (14) contains characteristics of both spouses as well as household and village level variables. Tests of equality between the coefficients obtained from wife and husband equations are also carried out. These tests indicate whether any of these characteristics affect one spouse differently than the other. If so then something can be said about gender differences in the impact of these characteristics on the likelihood of nonnumeric response. Bivariate probit model is estimated using maximum likelihood technique. The likelihood function for this model is shown in Appendix A. Standard errors are adjusted for within-cluster correlation of error terms and arbitrary heteroscedasticity. The estimate of ρ obtained and its statistical significance indicates the direction and importance of this correlation. A Lagrange multiplier test is performed to test whether ρ is significantly different form zero or not.

The paper also estimates a third specification of the probit model. In this specification, husbands' and wives' data are pooled together. This specification again models individual likelihood of nonnumeric response like equation 13, however, the difference here is that husbands' and wives' data are combined so that there are 2N observations (where N is the number of couples). A dummy for sex is included in the regression.

(15) $J^*_k = \eta_{0k} + \eta_{1k}X_{dk} - \eta_{2k}X_{sk} + \eta_{3k}Z_k + \eta_{3k}Sex_k + \varepsilon_k$, k = 1,…, 2N

where, k refers to the individual (husband or wife). Sex is equal to 1 if female. The significance of coefficient η_{3k} indicates whether spouses of one gender are more likely to give a nonnumeric response.

4. Data description and Variables

A. Bangladesh Demographic and Health Survey

Bangladesh Demographic and Health Survey (1993-94) was conducted between November 1993 and March 1994 and covered all five divisions of Bangladesh – Dhaka, Khulna, Rajshahi, Barishal and Chittagong[9]. The survey was conducted under the authority of National Institute of Population Research and Training (NIPORT) in collaboration with Macro International (U.S.A.). The survey collected data on fertility, marriage, births, maternal and child health and family planning. In this survey, 9,640 ever-married women aged 10-49 were interviewed and of these, 3,284 currently married women and their husbands were also interviewed. The analysis of this paper is based on this couples sub-sample. It considers all couples including polygamous couples and those where one spouse is sterilized and those where the wife was pregnant at the time of the survey. About 15% of the couples live in urban areas. The economy is predominantly agrarian and more than half the couples (57%) own agricultural land. The sample covers 301 villages and urban blocks spread across Bangladesh.

[9] The Chittagong cyclone of 1991 devastated more than one-thirds of this region. It is likely that the effect of this natural disaster persisted at the time of the DHS survey in 1993.

A useful feature of this DHS survey is the availability of fertility and family planning use data on wives and husbands. The analysis of this paper does not have to rely on wife's report of her husband's characteristics. Another useful feature is the availability of data on community characteristics from the Services Availability survey that was also fielded at the same time as the main survey. This survey collected information on primary sampling units (p.s.u.) or villages and urban blocks and their access to general services such as schools (primary, secondary and higher) and public and private institutions (post office, markets and cinema). It also collected data on presence of Grameen Bank (a group based lending program), income generating Non Governmental Organizations (NGOs) and Cottage Industries cooperatives in the village. Finally, the survey collected data on access to family welfare clinics and hospitals.

The main shortcoming of this survey is that data on wages, household incomes and prices were not collected. Another shortcoming is that data on background characteristics of the respondents were not collected, thus, we do not have information on respondents' siblings and parents.

B. Nonnumeric Response in BDHS 1993-94

BDHS posed the desired family size question[10] to both wives and husbands. Those who gave an "Up-to-God" response to this question were classified as nonnumeric respondents in this analysis. The wording of the desired family size question emphasized that each individual's family size desires were being asked. No further questions were asked to distinguish whether the respondent was reporting own family size desires or those of the spouse. The question was worded differently for those who had living children and those

[10]Respondents with living children were asked: "If you could go back to the time you did not have children and could choose exactly the number of children to have in your whole life, how many would that be?"

who did not in order to get meaningful response from younger wives and husbands who may not have children at the time of the survey.

However, the question did not distinguish between respondents who had been married before or who were in polygamous marriages and those who were in their first, monogamous unions. It is not unambiguously clear whether respondents take earlier marriages (or other current marriages in case of polygamous couples) into account or not when responding to the desired family size question. This is important for the current analysis because respondents may take reproductive experience from past marriage into account when answering this question. Reproductive experience from past marriages will affect the respondent's supply of children. This is especially important for men in Bangladesh where widowers and those who are divorced can easily re-marry but for re-marriage for women is not socially acceptable. Table 4B shows that 648 husbands (20%) and 215 wives (6.5%) report having been married before.

The percentage of women giving nonnumeric response in Bangladesh has declined over the years. In Bangladesh Fertility Survey (BFS) conducted in 1975, 29% of the women gave a nonnumeric response, while in the 1989 BFS, only 8% of the women respondents gave a nonnumeric response (Larson and Mitra, 1992). Compared to these two surveys, in BDHS (1993-94), approximately 8% of women respondents gave a nonnumeric response.

No information is available for percentage of men giving nonnumeric response in previous Bangladeshi surveys. In BDHS (1993-94), about 17% of the husbands gave a nonnumeric response. There were 796 couples (24% of the couples) where one or both the spouses gave a nonnumeric response. Table 1B shows the number of couples where either one spouse gave nonnumeric response, both gave nonnumeric response or both gave

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Respondents with no living children were asked: "If you could choose exactly the number of children to have numeric response. In about 15% of couples, only the husbands gave nonnumeric response while in about 7% of the couples, only the wife gave nonnumeric response. In a smaller proportion of the couples, approximately 3%, both husbands and wives gave nonnumeric response.

C. Variables and Expected Effects

Table 2 presents an overview of the explanatory variables used to estimate equations 13, 14 and 15. It also summarizes the expected effects of these variables on wives' and husbands' likelihood of giving nonnumeric response. Table 3 presents means and standard deviations of these variables.

The analysis in this paper is based on respondents' comparison of demand for and supply of children. This comparison can be expected to vary between couples who have completed their family size and those who have not. Also this comparison would vary between different age cohorts of women and men who would have faced different fertility – child mortality environments at the start of their reproductive life. Finally, this assessment of demand and supply would also vary because respondents in different age groups are at different stages in their life cycle. To capture this, age of husband and wife (and the square of their ages) are included as continuous variables in the estimation of likelihood of giving nonnumeric response. Also, results are reported for 2 age cohorts of wives one where the wife is 34 or less and the other where the wife is 35 – 49. Stratification by narrower age groups of wives would have been desirable but such stratification results in smaller number of observations per category which lowers the precision of the estimates (Boulier and Rosenzweig, 1978).

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in your whole life, how many would that be?"

Expected probability of children surviving to adulthood, S, will affect wives' and husbands' desired demand for children through its impact on the number of children surviving to adulthood (Ben-Porath, 1980). If survival probabilities are expected to decline, then in order to have a certain number of children alive at the end of their reproductive years, husbands and wives will raise their desired demand for children. Declining survival probability also lowers couples' potential supply of children. In terms of expected child mortality rate, if this increases, then each spouse's desired demand for children can be expected to rise. Rising child mortality rate will also lower couple's supply of children. Thus, the net effect of increasing child mortality would be to raise wives' and husbands' likelihood of giving nonnumeric response.

Since data on village level child mortality of children is not available, I use own reported child mortality rate experienced by parents. Own experienced child mortality may be potentially endogenous. Village-level child mortality rates and not individual level child mortality, would be relevant indicators of parents' expectations regarding survival probability of children. While individual experienced child mortality rates could be aggregated to obtain village level rates, in most villages only 5 to 10 households were surveyed. Aggregating child mortality rates based on few observations would, therefore, not provide an accurate measure of village-level child mortality rates.

In BDHS, a substantial proportion of husbands and wives reported different numbers of children ever born and those that had died. Consequently, on average, child mortality rate experienced by husbands differs from those experienced by wives. Husbands report a higher average rate of child mortality than wives (Table 3). A tabulation of the differences in reported children ever born and possible reasons for these differences are shown in Tables 4A - 4C. 22% of the husbands and wives reported different number of children ever born. Of these, 13% of the couples were those who had been in more than one union. For the remaining 8% of the couples, the source of the discrepancy in reported children ever born could not be "accounted for" and these could be genuine cases of reporting error. Thus, it is possible that those who report child mortality rate different from that of their spouse are including experiences from previous marital unions. In the estimation of equations 13 and 14, each spouse's own reported child mortality was used.

Data on incomes and prices are not available in BDHS. Proxies such as husband's and wife's years of education, ownership of household assets and village level characteristics such as distance to nearest school (primary, secondary and higher) and market and presence of Grameen Bank and income generating NGOs and cottage industries cooperatives are used instead.

Wife's education raises the value of her market time. Because the value of her market time is high, she may want to "substitute" away from more to less number of children because time spent on childbearing is more costly for her (substitution effect). But, a higher value of her market time also enables her to "afford" larger families (income effect). Empirical findings consistently show that higher female education is associated with lower fertility (Schultz, 1997, Strauss and Thomas, 1995) which implies that the substitution effect of female education dominates the income effect. So, we can expect that wife's education will lower her own desired demand for children. The effect of her education on husband's desired demand is not clear *apriori*. If more educated women marry men who have taste for smaller family size (Basu, 1999), then effect of wife's education on husband's desired demand would also be negative. Wife's education can also be expected to influence a couple's supply of children. Easterlin (1978) highlights the effect of increase in formal education on raising natural fertility of couples. This effect could come about through breaking down of cultural norms regarding duration of breastfeeding. Also, empirical evidence shows wife's education to be positively correlated with child survival probabilities (Strauss and Thomas, 1995). The net effect of these demand side and supply side effects should be that increasing wife's education lowers wives' and husbands' likelihood of giving nonnumeric response.

Since children are less intensive in husband's time, the income effect of an increase in husband's education (a proxy for his market wages) is likely to overwhelm the substitution effect (Schultz, 1997). Thus, husband's education can be expected to raise his own desired demand for children as well as raise his wife's desired demand for children. Husbands' education is also expected to be beneficial for child health[11] and can be expected to raise supply of children through better child survival probabilities. Overall, husbands' education can be expected to raise the likelihood of both spouses giving nonnumeric response if the demand increasing effect of his education outweighs the supply improving effect.

Four dummy variables that reflect spouse's non-market time use are included in this analysis. These are, whether wife watches television or reads the newspaper and whether husband watches television or listens to the radio[12]. Thomas, Strauss and Henriques (1990) estimate the effect of these variables on child health (height) and test whether mothers' education primarily affects child health through these "information" seeking activities where she is exposed to relevant information regarding inputs into child health. Their findings for Brazilian data suggest that this is one of the main ways in which mother's education has a beneficial impact on child health. Thus, if wife listens to radio, reads newspaper and if

[11] Empirical evidence shows the magnitude of the effect of paternal education on child mortality to be smaller than that of maternal education (Strauss and Thomas, 1995).

[12] Thomas, Strauss and Henriques (1990) point out that these variables would be simultaneously determined with other time allocation decisions of the respondent such as time spent in child care, market work and other leisure activities and so they should be treated as endogenous to desired demand for children. However, in this paper they are treated as exogenous.

husband watches television or listens to radio, then couple supply of children can be expected to be higher due to the beneficial impact of these activities on child health and therefore child survival probabilities. Also, each spouse's desired demand can be expected to be lower due to better child survival probabilities. The net effect of these variables would be to lower each spouse's likelihood of giving nonnumeric response.

Two variables that capture wife's mobility are also included in the analysis. These are, whether she frequently visits other places and localities and whether she is allowed to visit a health center or a hospital unaccompanied by her husband. Given the cultural practice of female seclusion (*purdah*), these two indicators of wife's mobility come close to capturing how "empowered" she is. As Kabeer (1999) argues, measures of woman's activity which require her to step out of her routine behavior[13] are a more accurate indicator of her how empowered she is. While her empowerment may raise her ability to enforce her preferences in joint couple decision-making, it is not clear how it affects hers or her husband's desired demand for children. However, such mobility of the wife may have a beneficial impact on child health and child survival probabilities. Such mobility enables her to use inputs into child health more effectively since she is able to access health facilities without the presence of her husband. Thus, wife's mobility can be expected to have a positive impact on couple's supply of children. Working through the improved child survival probabilities, these mobility variables can be expected to lower both spouses' desired demand for children. Their net effect, therefore, would be to lower the likelihood of either spouse giving a nonnumeric response.

[13] Including those activities that are socially sanctioned as being in the female "sphere" of household activities such as child-care.

Ownership of assets such as agricultural land and household consumer durables such as television, radio and cupboard are observed to be associated with higher demand for children in low income agricultural societies (Schultz, 1997). The effect of these variables on each spouse's desired demand is expected to be positive. These variables do not affect supply of children. Thus, the net effect of ownership of assets on each spouse's likelihood of giving a nonnumeric response is expected to be positive.

Two variables included in the analysis mainly affect couples' supply of children. These are marital duration and wife's (in)fecundity status. It is difficult to capture couples' natural fertility or supply of children using household and individual level variables. Proximate determinants of natural fertility (Bongaarts, 1978) include a) duration of exposure to intercourse, b) fecundability and frequency of intercourse, c) duration of postpartum infecundability, d) spontaneous intrauterine mortality, e) sterility. Easterlin and Crimmins (1985) used variables that were close approximations of these proximate determinants for couples. The variables used by them include marital duration, first and second birth interval, months of breastfeeding in last closed interval, proportion of pregnancy wastage, and whether the woman was secondarily sterile. As Schultz (1986) points out, all of these variables are endogenous to couples' fertility decision-making. Montgomery (1987) when estimating a switching model of demand and supply of births, uses only marital duration as determinant of couple's supply of births. Boulier and Mankiw (1986) use Coale and Trussell's natural fertility schedule in their investigation of Easterlin's synthesis model using Philippines and U.S. data. This natural fertility schedule, however, does not vary by individual characteristics of women.

In this paper, marital duration is included as one variable that influences couples' supply. This variable controls for the variation in supply that arises in the sample simply due to the fact that some couples have been married longer than others. Marital duration in BDHS was based on a question that asked respondents the years since their first marriage. As noted earlier, a significant proportion of husbands in this survey had been married before and their report of marital duration does not match with their (current) wife's report. On an average, husbands report marital duration of 16.3 years while wives report 14.9 years (see Table 3). To go around this problem, husbands' reported marital duration is used to explain his own likelihood of nonnumeric response and wives' marital duration is likewise used to explain her own likelihood of nonnumeric response. Since couples who have been married longer are expected to have "higher" supply of children, the effect of marital duration on likelihood of nonnumeric response can be expected to be negative.

The other purely supply side variable used in the analysis is whether wife is infecund at the time of survey. This is a dummy variable that takes value 1 if a woman is physiologically unable to have children, or considers herself physiologically unable to have children, at the time of the survey. Menarche (roughly 12 years of age) signals the onset of the physiological ability to have children (fecundity) and menopause (roughly age 48-50 years) marks the end (Frank, 1993). In this paper, women are coded as infecund based on the definition used by DHS. DHS codes women as infecund if, a) they report themselves to be infecund, b) report being menopausal, c) have not had their period in last six months or more, d) have had no births in the 5 years preceding the survey and never used contraception (Stover, 1997). A woman is also coded as infecund if her husband reports her to be so – this is important because this reflects husband's perception of the couple's ability to have children.

Infecundity can be age related for those women who are in the age group 45-49 or it can set in prematurely. Women who reach infecundity prematurely can be expected to have a lower supply of children than fecund women. A distribution of infecund women by age group is shown in Table 5. About 15% of the women in the sample are infecund. Graph 1 shows the mean children ever born to women by their fecundity status. At each age group of women, except 45-49, infecund women have fewer children ever born to them than fecund women. This difference between fecund and infecund women is largest for women in the 30-34 age group. Children ever born are the net outcome of interactions of demand and supply factors and use of contraceptive methods. However, this difference in the average number born to women in the two groups indicates that lower supply may have played an important role in reducing the number ever born to infecund women. Thus, infecund women and their husbands can be expected to perceive a lower supply than fecund couples. The net effect of this variable would, therefore, be to raise both spouses' likelihood of giving a nonnumeric response.

Village level variables are included in the analysis as proxies for price of children's education (distance to nearest religious, primary, secondary and high school), prices of goods (distance to weekly and daily markets), income earning opportunities (presence of Grameen Bank, NGOs and cooperative societies) and price of health and family planning services (distance to nearest Family Welfare Center or hospital). There is a timing issue associated with these variables. The availability of these facilities is measured at the time of the survey so the quality and availability of these services at past times are unknown to us. This is problematic since respondents' fertility decisions are made in the past and would, therefore, be affected by status of facilities in past periods.

In Bangladesh, group based lending programs such as Grameen Bank, and income generating NGOs are involved not only involved in income-generation through self employment schemes but also have a strong social development component. For example, Grameen Bank has a family planning awareness program that encourages members to have small families (Pitt, Khandker, Mckernan and Latif, 1999). Also these programs target poor women. Several studies have analyzed the impact of group based lending programs on fertility (Pitt and Khandker, 1996) and contraceptive use (Pitt and Khandker, 1996, Schuler, Hashemi and Riley, 1997).

The availability of cheap credit and social development programs can influence spouses' fertility-related decisions since they increase the shadow price of children. Shadow price of children increases because value of market time increases, especially for women. This not only increases income but also increases the cost of time spent in bearing and raising children that may dominate potential income increases. Moreover, social development programs encourage families to send their children to school that also contributes to raising the shadow price of children. Social development programs also provide information regarding nutrition and health and contraceptives that can alter individuals' attitudes towards fertility[14]. It can be expected that these effects combine to lower spouses' desired demand for children. Thus, the presence of Grameen Bank and income generating NGOs and cooperatives can be expected to lower the likelihood of spouses giving nonnumeric response.

Distance to school nearest to the village reflects the time cost involved in sending children to school – especially girls. In this sense, distance to schools captures the price of schooling. Farther away the facility, the higher the price of schooling would be for villagers. Empirical studies find that availability of schooling infrastructure in a community raises enrollments and completed years of schooling (Strauss and Thomas, 1995). Thus, higher

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[14] The potential empowering effects of women's participation in such programs raising women's bargaining power in the household has also received much attention in literature (Schuler et al, 1997, Pitt et al 1999).

price of investing in child "quality" can be expected to be associated with higher demand for child "quantity" (Birdsall, 1988). Distance to schools can therefore be expected to raise the likelihood of giving nonnumeric response.

Distance to commercial centers such as daily or weekly markets can reflect the general price level in the village. If the village is far away from such commercial trading centers, then the prices of goods, especially those goods that go into production of child quality (height, weight), can be expected to be higher. There is some empirical evidence that higher food prices have a negative impact on child height and weight for height (Strauss and Thomas, 1995). So, higher prices of goods can be associated with higher demand for child quantity. Given this effect, it can be expected that distance to daily or weekly markets raises both spouses' the likelihood of giving nonnumeric response.

Price of health and family planning facilities are captured by how far these facilities are from the village. The farther away the facilities are the higher the time cost of using these facilities for the residents of the village. Strauss and Thomas (1995) report a study from Philippines that shows that distance to health facilities has negative impact on child height and weight for height. The availability of health services will also affect supply of children through the effect on child survival probabilities as well as on maternal health. It can be expected that the higher the distance to such facilities, the higher the spousal demand for children as and lower the supply of children. Given these effects on desired demands and couple supply of children, it can be expected that distance to health and family planning facilities raises the likelihood of giving nonnumeric response.

Two other village level characteristics are also included – distance to nearest district and sub-district (*Thana*) headquarters and presence of community television in village. The presence of a community television in the village will facilitate the flow of information regarding health and family planning services and hence have a beneficial effect on child and maternal survival probabilities. This can be expected to have a positive effect on couples' supply of children and negative effect on desired demands for children. Thus, the presence of community television in the village can be expected to lower the likelihood of respondents giving nonnumeric response.

Saha (1999) observes that in rural Bangladesh, the sub-district headquarters is the center of not only administrative activities but also where families shop for food and other commodities and sell their produce. Administrative headquarters also provide opportunities for non-farm employment for men. Thus, proximity to the administrative headquarters can be associated with higher income opportunities for the villagers. Once again, higher income earning opportunities can have both substitution and income effects. If the substitution effect dominates then proximity to the administrative headquarters will be associated with lower demand for children. Moreover, as health facilities are also typically located in these towns, maternal and child survival probabilities can also be expected to higher for those living close by. Thus, it can be expected that the further the individual lives from the district/sub-district headquarters, the higher the likelihood of giving nonnumeric response.

Urban residence is known to be associated with higher cost of child rearing (Schultz, 1997), thus, respondents living in urban areas are expected to have lower desired demand for children than those who live in rural areas. Health facilities are also likely to be more easily accessible in urban areas so supply of children is also expected to be higher for urban residents than for rural residents. Urban residence is, therefore, expected to lower both spouses' likelihood of giving nonnumeric response.

Some geographical regions of Bangladesh are routinely subject to natural disasters such as floods and cyclones. Chittagong region in the south east of Bangladesh is routinely subject to such natural disasters. In April 1991, this region witnessed one of the worst cyclone disasters of the 20th century when atleast 138,000 people were killed (National Oceanic and Atmospheric Administrations (NOAA), USA). Pitt and Khandker (1996) note that more than one-third of Chittagong region was destroyed by this cyclone. Moreover, the spread of diseases following floods and cyclones take further toll on human life. Given this, it can be expected that respondents residing in this region have a higher desired demand for children due to the expectations of low child survival probabilities. Correspondingly, the effect of residence in Chittagong region would be to raise the likelihood of giving nonnumeric response.

From the preceding discussion of effects of variables on likelihood of nonnumeric response, there is no *apriori* basis for expecting any of the effects to vary significantly by gender of the spouse. This is reflected in the last two columns of Table 2. However, given that some variables (such as wife's education, mobility) can be expected to have a stronger impact on one spouse's desired demand for children than that of the other, we can expect some differences by gender in the significance of these variables in explaining likelihood of giving nonnumeric response.

5. Results

A. Comparing contraceptive knowledge, use and fertility intentions

As discussed earlier, in literature, nonnumeric response is frequently linked to respondent's recognition of fertility regulation being within his or her control. Table 6 presents a comparison between couples where both spouses give nonnumeric response and couples where one or both the spouses give a nonnumeric response. The variables considered here are those that relate to fertility regulation by the respondents. There is almost universal awareness of modern techniques of contraception (such as pills, injection) for all categories of couples. In spite of this universal awareness of contraception techniques, a higher percentage of wives and husbands in couples where one or both the spouses gives nonnumeric response, report never having used contraceptives and also not using contraceptives at the time of the survey.

Table 6 also compares the fertility intentions of wives and husbands. Not only are there differences in fertility intentions between numeric couples and nonnumeric couples (where one or both spouses give nonnumeric response) but there are also significant differences within different categories of nonnumeric couples. 46% of wives in couples where only wives give nonnumeric response report wanting another child. This is substantially higher than the percentage of wives reporting intentions for another child for both numeric couples (32%) and couples where only the husband gives a nonnumeric response (34%). Again, only 39% of wives in couples where wife gives nonnumeric response report wanting to stop while 53% of wives in numeric couples and 51% of wives in couples where only husbands give nonnumeric response report wanting to stop. The pattern is repeated for percentage of husbands wanting to have another child or stop having children.

These comparisons suggest that nonnumeric respondents are aware of fertility regulation methods and yet they are less likely to use these techniques. The comparisons also show that nonnumeric respondents have definite fertility intentions for the future and that there are important differences in these intentions between couples where only wife is nonnumeric and couples where only husband is nonnumeric. There is also evidence that nonnumeric respondents are more likely to want additional children than numeric couples – this is consistent with the supply-constrained hypothesis. If nonnumeric respondents feel that they have not attained their desired family size then they would be more likely to report wanting additional children. Thus, there is some support for the hypothesis of this paper.

B. Probit model estimates

Probit model estimates of each spouse's likelihood of giving nonnumeric response are reported in Tables 7, 8 and 9. These tables report coefficients (rather than marginal effects) for a selection of variables. The coefficients indicate the direction of the effect of each variable on the dependent variable. Standard errors are based on Huber/White estimate of the variance-covariance matrix that provides robust variance–covariance estimates corrected for arbitrary heteroscedasticity and clustering of data.

Table 7 reports estimates of the individual's likelihood of giving nonnumeric response when data on husbands and wives are combined. The estimates are based on Equation 15. As anticipated, education has a negative impact on the likelihood of giving nonnumeric response while own experienced child mortality significantly raises this likelihood. The two purely supply side variables also have the anticipated effects. Infecundity raises the likelihood of giving nonnumeric response. Those who have been married longer are less likely to give this response. Presence of Grameen Bank in the village significantly lowers respondents' likelihood of giving nonnumeric response. Also, the further away the nearest high school is the higher is the likelihood of giving nonnumeric response. Of the regional effects, only Chittagong has a significant effect. Residence in this division is associated with significantly higher likelihood of giving nonnumeric response.

In almost all studies of nonnumeric response, only wives' likelihood of giving nonnumeric response has been estimated (Jensen, 1985; McCarthy and Oni, 1987; Olaleye, 1995). In this paper, we investigate both spouses' likelihood of giving nonnumeric response and estimate whether spouse of one gender is more likely to give this response than the other is. The specification in Equation 15 allows us to estimate this. As table 7 shows, wives are significantly less likely to give a nonnumeric response than husbands controlling for all other individual, household and village level characteristics. If the hypothesis of this paper is valid, then this indicates that in this Bangladeshi sample, all else being equal, husbands are more likely to perceive a supply constraint than wives are.

Next, each spouse's likelihood of giving nonnumeric response is estimated based on Equation 13. Tables 8 and 9 report probit model estimates of wives' and husbands' likelihood of giving nonnumeric response respectively. Results are reported for the entire sample, the sub-sample where the wife is 34 or younger and the sub-sample where wife is 35 or older.

Looking first at wives (Table 8), her education has a significant impact only for the older sub-sample of couples where it is associated with lower likelihood of nonnumeric response. This is consistent with anticipated effect of this variable. If this result was only the outcome of more literate (and numerate) women being able to give a numeric response, then this effect should have been observed for the entire sample and the younger sub-sample as well. So, it would appear that her education does pick up some of the effects set out in the previous section. Husband's education also has a significant impact only on older women's likelihood of nonnumeric response. It raises the likelihood of giving nonnumeric response and this is consistent with anticipated effect of this variable.

Since almost 20% of husbands and 6.5% of wives have been married before, child mortality experience from past marriages can be expected to have a significant effect on their demand for children as well their perception of supply of children. Accordingly, each spouse's own child mortality rate was calculated using the number of children ever born and number of child deaths reported by him or her. This own reported child mortality rate was used to explain own likelihood of giving nonnumeric response.

Child mortality rate experienced by the wife does not have any statistically significant impact on likelihood of giving nonnumeric response for all, younger or older women. Wife's age shows significant effects for the sub-sample of younger wives. Her age is associated with decreasing likelihood of giving nonnumeric response and the quadratic effect of her age is significant as well. Husband's age does not significantly affect her likelihood of giving nonnumeric response. Mobility variables that indicate whether wife is able to visit other localities and health centers unaccompanied by her husband show a significant negative effect on the her likelihood of giving nonnumeric response.

Of the purely supply side related variables, wife's years since first marriage (marital duration) has no significant effect on likelihood on giving nonnumeric response. However, infecundity status of wife has a significant impact on likelihood of nonnumeric response for the entire sample and for the sub-sample of older wives. It shows that women who are infecund (or are reported to be so by their husbands) are significantly more likely to give a nonnumeric response than fecund women. This effect is consistent with the view that women in the reproductive age group who report being infecund, experience a lower supply of children than fecund women.

Presence of Grameen Bank in the village significantly lowers wife's likelihood of giving nonnumeric response for the sub-sample of older wives only. Distance to nearest high school raises her likelihood of giving nonnumeric response for the sub-sample of younger wives as well for the entire sample. Of the regional effects, as compared to those living in Barishal division, wives living in Chittagong area are significantly more likely to give a nonnumeric response. This is true for the entire sample as well as for the younger and older wives.

Looking next at husbands' likelihood of giving nonnumeric response (Table 9), wife's education has a significant negative impact on husbands of older wives only. This parallels the effect of wife's education on her own likelihood of nonnumeric response. Husband's education has no statistically significant impact on his own likelihood of giving nonnumeric response.

Child mortality rate experienced by husband does not significantly affect his likelihood of giving nonnumeric response in this probit model specification. His age has a significantly negative effect for the sub-sample of couples where wives are 34 or younger. The square of his age has a significant and positive effect for this same sub-sample. Wife's age has no significant impact on husbands' likelihood of nonnumeric response. Only one wife's mobility variable has a significant effect on husbands' likelihood of giving nonnumeric response. If his wife can visit health center unaccompanied by him, then he is less likely to give a nonnumeric response. This effect holds for the sub-sample of couples with young wives as well for the entire sample.

Of the purely supply-side variables, infecundity status of wife does not significantly affect husbands' likelihood of giving nonnumeric response. However, husband's years since first marriage (marital duration) has a significantly negative effect on his likelihood of giving nonnumeric response, as was the anticipated effect of this variable.

Of the village level variables, presence of Grameen Bank and distance to nearest weekly market have significant effects on the likelihood of husbands giving nonnumeric response. Presence of Grameen Bank in the village significantly lowers the likelihood of husbands giving nonnumeric response. Just as for wives, this effect is significant for the older sub-sample of couples and for the entire sample. Distance to nearest weekly market has a negative effect on the likelihood of husbands giving nonnumeric response. This is contrary to what was the anticipated effect of this variable.

There are some significant regional effects as well. As compared to those living in Barishal division, husbands living in Chittagong division are more likely to give a nonnumeric response. Those living in Dhaka, Khulna and Rajshahi are less likely to give a nonnumeric response.

C. Bivariate Probit model estimates

Allowing for within couple correlation of unobserved variables, a bivariate probit model of wives' and husbands' likelihood of giving nonnumeric response was estimated. Table 10 reports the coefficient estimates for a selection of variables. Robust standard errors are reported which are based on Huber/White estimate of the variance-covariance matrix. Estimates are reported for the entire sample, for the sub-sample of couples where the wife is 34 or younger and the sub-sample of couples where wife is 35 or older.

Estimates of the correlation of residuals are significant for the entire sample as well as the sub-samples of younger and older couples. The correlations are positive indicating that unobserved variables influence both spouses' likelihood of giving nonnumeric response in the same way. The magnitude of the correlation for the sub-sample of older couples (0.30) is larger than that for the sub-sample of younger couples (0.12).

Individual level estimates of wives' and husbands' likelihood of nonnumeric response given in Tables 8 and 9 ignore the correlation between wives' and husbands' likelihood of giving nonnumeric response. Thus, they are less efficient than the bivariate probit estimates because they do not incorporate the information contained in the spousal correlation of unobservables.

The coefficient estimates from the bivariate probit model show pattern of effects that are similar to those obtained from individual probit estimates. However, an important difference is the effect of child mortality variable. Child mortality rate experienced by husbands now has a significant positive effect on his own likelihood of giving nonnumeric response. This effect holds for the entire sub-sample as well as for the sub-sample of younger couples where the wife is 34 or younger. Wife's experienced child mortality rate has no significant effect on her own likelihood of nonnumeric response.

Bivariate probit estimates show that variables have similar effects on each spouse's likelihood of giving nonnumeric response. There are some differences. While infecundity status of wives only affects wives' likelihood of nonnumeric response, it has no effect on husband's likelihood of giving this response. Marital duration affects only husbands' likelihood of nonnumeric response. Child mortality experienced by husband affects his own likelihood of giving nonnumeric response while wife's child mortality experience has no significant impact on her own likelihood of giving nonnumeric response. Distance to nearest high school significantly affects wives' but not husbands' likelihood of giving nonnumeric response. On the other hand, distance to weekly market significantly affects husbands' and not wives' likelihood of giving nonnumeric response.

Are these differences in effects between husbands and wives statistically significantly different? If so then something can be said about gender differences in variables that influence the likelihood of giving nonnumeric response.Tests of equality were carried out for all the variables (except child mortality and marital duration since own experienced values were used for each spouse) in the bivariate probit model. A selection of the results is presented here. Tests of equality of coefficients for wife's mobility, infecundity status, distance to nearest high school, distance to nearest weekly market and dummy for Chittagong division are reported in Table 10.

The effect of wife's mobility when she is able to visit other places unaccompanied by her husband is significantly different for all couples and for the sub-sample of couples where wife is younger. Wife's mobility when she is able to visit health centers unaccompanied by her husband has a significantly different effect on wife and husband's likelihood of giving a nonnumeric response for the sub-sample of older couples only. Among the village level variables, the effect of distance to nearest high school has a significantly different effect on husbands and wives only for the entire sample of couples. The effect of distance to nearest weekly market is significantly different for the all couples and for the sub-sample of younger couples. There is also significant difference in the effect of residing in Chittagong region. This difference is significant for all the couples as well as for the sub-sample of older couples.

The difference between the effect of wife's infecundity status on wife's and husband's likelihood of nonnumeric response is significant for the entire sample and for the sub-sample of older couples. Effect of the other supply related variable, marital duration, shows that husband's marital duration has a significant negative effect on his likelihood of giving nonnumeric response but wife's marital duration does not have any significant impact on her own likelihood of nonnumeric response. One explanation for these effects of marital duration and wife's infecundity could be that for husbands, current wife's infecundity status need not be a constraint for him since it is possible for him to re-marry and in this way meet his demand for children. In the Bangladeshi context, re-marriage is very difficult for women.

While theoretical analysis of effects of variables on the likelihood of giving nonnumeric response did not indicate that some variables affect wives and husbands differently, empirical analysis showed that such differences did exist in the data. These differences by gender that were observed can be explained by the social context in which fertility decisions are being made. In Bangladesh, it is socially acceptable for men to re-marry and often the second marriage involves marrying a much younger woman. About 20% of the husbands in BDHS report having been in more than one union. The mean age difference between husband's and wife's age jumps from 8.5 years to 14.7 years for couples where husband reports having being married more than once. Experiences from past marriage give rise to differences in husbands' and wives' response to certain variables, most notably expectations of child survival.

6. Conclusions

A significant proportion of respondents give a nonnumeric response to the desired family size question in fertility surveys in developing countries. Concerns about child supply remain an important factor in influencing fertility levels in developing countries. This paper explored the hypothesis that respondents give nonnumeric response if their desired demand for children exceeds their potential supply of children. Until recently, most fertility surveys posed the desired family size question to women only so that men's likelihood of giving nonnumeric response has mostly gone unexamined. This paper analyzed both wives' and husbands' likelihood of giving nonnumeric response.

Results obtained from probit and bivariate probit models are generally consistent with expected effects. They show that there is some support for the supply-constrained view of nonnumeric response. Especially, infecundity of wife significantly raises her own likelihood of giving nonnumeric response and marital duration significantly reduces husband's likelihood of giving nonnumeric response. Own experienced child mortality rate reported by husbands is associated with higher likelihood of husbands giving a nonnumeric response. Husbands are more likely to give nonnumeric response than wives are. Also, some variables show systematic differences in the way they affect each spouse's likelihood of giving nonnumeric response. Effects of variables show important differences across age cohorts of couples.

Ideally, better data on supply related variables are needed for empirical analysis of the supply-constrained view of nonnumeric response. However, as discussed in Section 4, it is difficult to obtain couple level measures of child supply. Health and nutrition status of husbands and wives would have proved useful since these can influence supply of children through their effect on fecundity and frequency of intercourse (Behrman and Deolalikar, 1988). Unfortunately, BDHS (1993) did not collect data on maternal height and weight or male height and weight.

The results suggest that at least part of the explanation for nonnumeric response may lie in respondents' demand-supply considerations. Nonnumeric response cannot be considered to be a random occurrence in the sample and dropping nonnumeric respondents from the sample will bias any estimates of fertility based on it. Moreover, there are important differences in the way variables affect husbands' and wives' likelihood of giving nonnumeric response and in this sample, husbands are found to be more likely to give a nonnumeric response than wives are. Ignoring husbands' fertility behavior could also induce potential bias in the analysis of fertility of couples.

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FIGURE 1: Couples at different stages of fertility transition

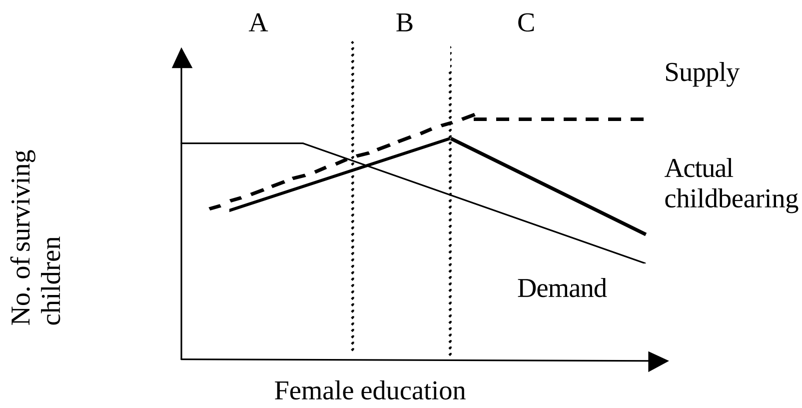

Table 1A: Possible combinations of husband's and wife's desired demands and Nonnumeric response

(1)	(2)	(3)	(4)	(5)
	J_i = 1 if nonnumeric response, 0 otherwise		Joint Couple Desired Demand, C^*	Couple's Actual Fertility, C: $C = C_s$ if $C^* \geq C_s$ $C = C^* + R_d(C_s - C^*)$ if $C^* < C_s$
$C^*_{dw} \geq C_s$ $C^*_{dh} < C_s$	1 0	W is supply constrained, H is not	Depends on decision rule	Depends on decision rule
$C^*_{dw} < C_s$ $C^*_{dh} \geq C_s$	0 1	H is supply constrained, W is not	Depends on decision rule	Depends on decision rule
$C^*_{dw} \geq C_s$ $C^*_{dh} \geq C_s$	1 1	Both are supply constrained	$C^* \geq C_s$ (Supply constrained)	Given by supply function, C_s
$C^*_{dw} < C_s$ $C^*_{dw} < C_s$	0 0	Neither is supply constrained	$C^* < C_s$ (Excess supply)	Given by demand function, C^*

Table 1B:

HUSBAND

	N=3284	J=1	J=0
WIFE	J=1	96 (2.92%)	216 (6.58%)
WIFE	J=0	484 (14.74%)	2488 (75.76%)

Table 2: List of Variables and Expected Effects (in parentheses)

●Demand side variable

♦Supply side variable

	Variable	Wife's demand for children	Husband's demand for children	Couple's Supply	Wife gives Nonnumeric response (J_{wi} = 1)	Husband gives Nonnumeric response (J_{hi} = 1)
Individual level variables	Her Education	●(-)	●(-)	♦(+)	(-)	(-)
	His Education	●(+)	●(+)	♦(+)	(+)	(+)
	Wife reads newspaper, watches tv (1 if yes)	●(-)	●(-)	♦(+)	(-)	(-)
	Husband watches tv, listens to radio	●(-)	●(-)	♦(+)	(-)	(-)
	Wife's Mobility (1): Visits other places (1 if yes)	●(-)	●(-)	♦(+)	(-)	(-)
	Wife's Mobility (2): Visits Health Center (1 if yes)	●(-)	●(-)	♦(+)	(-)	(-)
	Child Mortality Rate – Reported by wife or husband (Children dead / Children Ever Born)	●(+)	●(+)	♦(-)	(+)	(+)
	Marital Duration reported by wife or husband			♦(+)	(-)	(-)
	Wife Infecundity status (1 if infecund)			♦(-)	(+)	(+)
Household level variables	Ownership of assets (tv, radio, bike, cot, cupboard)	●(+)	●(+)		(+)	(+)
	Own agricultural land (1 if yes)	●(+)	●(+)		(+)	(+)
	Electricity in household (1 if yes)	●(+)	●(+)		(+)	(+)

	Variable	Wife's demand for children	Husband's demand for children	Couple's Supply	Wife gives Nonnumeric response ($J_{wi} = 1$)	Husband gives Nonnumeric response ($J_{hi} = 1$)
Village level variables	Grameen Bank in Village (1 if yes)	●(-)	●(-)		(-)	(-)
	Presence of Mothers Club in village (1 if yes)	●(-)	●(-)		(-)	(-)
	Income generating NGOs, Cooperative society & Cottage Industries (1 if yes)	●(-)	●(-)		(-)	(-)
	Distance to nearest religious school (*Madrasha*); Primary School; High School (miles)	●(+)	●(+)		(+)	(+)
	Distance to weekly market; daily market (miles)	●(+)	●(+)		(+)	(+)
	Distance to nearest Cinema; Post Office;	●(+)	●(+)		(+)	(+)
	Distance to district and sub-district (*Thana*) headquarters (miles)	●(+)	●(+)	♦(-)	(+)	(+)
	Distance. To Health Center and Family Welfare Center (miles)	●(+)	●(+)	♦(-)	(+)	(+)
	Community tv in village (1 if yes)	●(-)	●(-)	♦(+)	(-)	(-)
Regional level variables	Region dummies: Chittagong	●(+)	●(+)		(+)	(+)
	Urban (1 if yes)	●(-)	●(-)	♦(+)	(-)	(-)

Table 3: Means and Standard deviations of selected variables: Bangladesh DHS 1993-94, Couples sample

Variable	Obs	Mean	Std. Dev.
Her Education (Years)	3284	2.20	3.22
His Education (Years)	3283	3.60	4.29
Child Mortality Rate (Wife)	3055	0.14	0.21
Child Mortality Rate (Husband)	3091	0.16	0.21
Children Ever Born (Wife)	3284	3.71	2.62
Children Ever Born (Husband)	3284	4.14	2.96
Children Dead (Wife)	3284	0.68	1.13
Children Dead (Husband)	3284	0.84	1.31
Her Age (Years)	3284	29.48	8.96
His Age (Years)	3284	39.22	11.16
Household Owns Agricultural Land (1 if Yes)	3283	0.57	0.50
Household Owns Cupboard (1 if Yes)	3283	0.24	0.43
Household Owns Bed (1 if Yes)	3283	0.75	0.43
Household has electricity (1 if Yes)	3283	0.19	0.40
Household owns radio (1 if Yes)	3283	0.28	0.45
Household owns television (1 if Yes)	3283	0.09	0.28
Household owns Bike (1 if Yes)	3283	0.20	0.40
Wife reads newspaper (1 if Yes)	3284	0.07	0.26
Wife watches television (1 if Yes)	3284	0.17	0.38
Wife’s Mobility (1): Visits other places (1 if yes)	3282	0.63	0.48
Wife’s Mobility (2): Visits Health Center (1 if yes)	3282	0.79	0.41
Distance to Sub-District Headquarters (Miles)	3275	5.27	4.41
Distance to District Headquarters (Miles)	3284	16.14	11.99
Mothers Club in village (1 if Yes)	3276	0.55	0.50
Grameen Bank in village (1 if Yes)	3284	0.46	0.50
BSIC cottage industries in village (1 if Yes)	3284	0.08	0.27
Cooperative Society in village (1 if Yes)	3275	0.62	0.49
Income generating NGOs in village (1 if Yes)	3284	0.60	0.49
Community television in village (1 if Yes)	3270	0.79	0.41
Distance to Religious school (*Madrasha*) (Miles)	3267	0.62	2.37
Distance to Primary School (miles)	3267	0.11	0.44
Distance to High School (miles)	3267	0.93	1.13
Distance to Post office (miles)	3267	1.14	1.78
Distance to Daily market (miles)	3267	1.37	1.94
Distance to Weekly market (miles)	3284	0.91	1.32
Distance to Cinema (miles)	3284	5.34	6.44
Distance to nearest Family Welfare Center	3259	1.74	1.95
Distance to nearest hospital/ Health Center	3024	4.96	3.46
Husband watches television (1 if Yes)	3284	0.39	0.49

Variable	Obs	Mean	Std. Dev.
Husband Listens to radio (1 if Yes)	3284	0.65	0.48
Urban	3284	0.15	0.36
Chittagong	3284	0.18	0.38
Dhaka	3284	0.29	0.45
Khulna	3284	0.14	0.35
Rajshahi	3284	0.29	0.45
Her Years since first marriage (marital duration)	3284	14.93	9.65
His Years since first marriage (marital duration)	3284	16.32	10.88
Wife is Infecund (1 if Yes)	3284	0.15	0.36

Table 4A: Distribution of differences in Children ever born reported by husbands and wives, Bangladesh DHS 1993-94

(HIS – HERS)

	Frequency	Percent
-7	2	0.06
-4	2	0.06
-3	10	0.3
-2	24	0.73
-1	116	3.53
0	2564	78.08
1	248	7.55
2	92	2.8
3	56	1.71
4	46	1.4
5	37	1.13
6	32	0.97
7	25	0.76
8	12	0.37
9	4	0.12
10	3	0.09
11	3	0.09
12	1	0.03
13	3	0.09
16	2	0.06
19	1	0.03
20	1	0.03
TOTAL	3284	100

Table 4B: Number of unions reported by husbands and wives

		HUSBAND		
		ONCE	MORE THAN ONCE	Total
WIFE	ONCE	2563	500	3063
	MORE THAN ONCE	67	148	215
	Total	2630	648	3278

Table 4C: Sources of differences in reported children ever born

	Frequency	Percent
SAME REPORTED CHILDREN EVER BORN	2564	78.08
MORE THAN ONE UNION	437	13.31
UNACCOUNTED FOR	283	8.62
Total	3284	100.00

Table 5: Distribution of Infecund and Fecund women by age, Bangladesh DHS 1993-94

	Infecund		
Age	No	Yes	Total
10 -14	43	2	45
	(95.6%)	(4.4%)	(100)
15-19	389	13	402
	(96.8%)	(3.2%)	(100)
20-24	651	35	686
	(94.9%)	(5.1%)	(100)
25-29	638	40	678
	(94.1%)	(5.9%)	(100)
30-34	461	46	507
	(90.9%)	(9.1%)	(100)
35-39	333	74	407
	(81.8%)	(18.2%)	(100)
40-44	219	109	328
	(66.8%)	(33.2%)	(100)
45-49	73	158	231
	(31.6%)	(68.4%)	(100)
Total	2807	477	3284
	(85.5%)	(14.5%)	(100)

Graph 1: Mean Children Ever Born to women by their fecundity status, Bangladesh DHS 1993-94

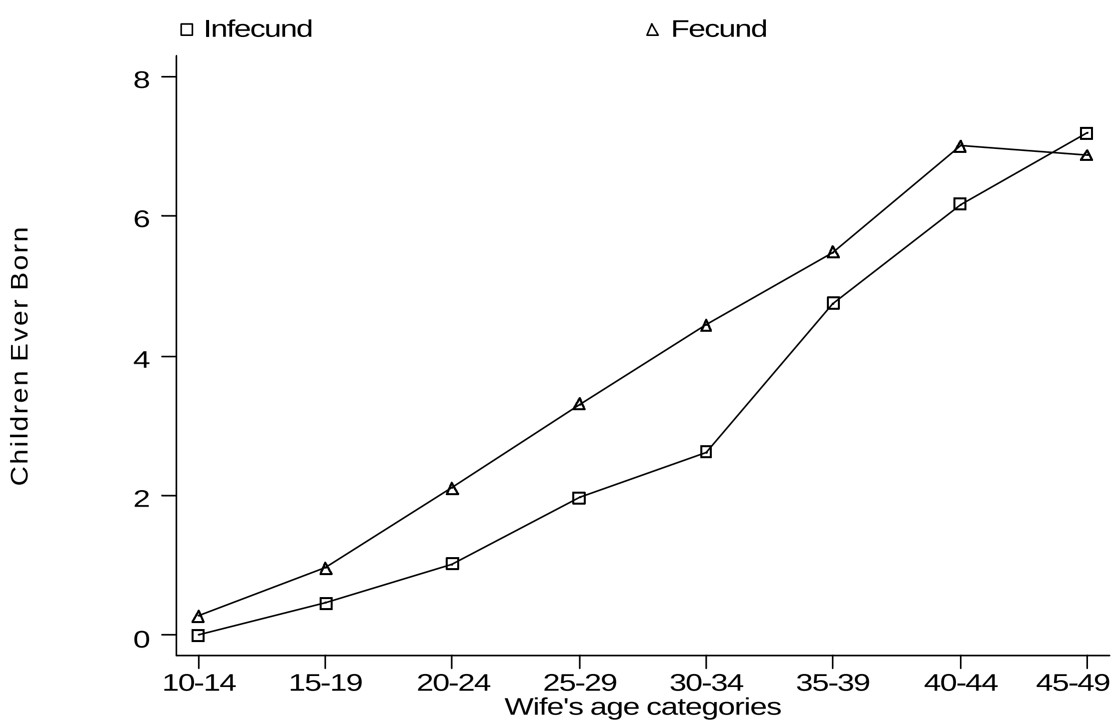

TABLE 6: Comparing characteristics of couples when one or both spouses give nonnumeric response, Bangladesh DHS 1993-94

	Both Numeric	Wife Nonnumeric	Husband nonnumeric	Both Nonnumeric
Wife knows modern method of contraception	2488 (100%)	215 (99.54%)	484 (100%)	94 (97.92%)
Husband knows modern method of contraception	2487 (99.96%)	216 (100%)	480 (99.17%)	91 (94.79%)
Wife never used contraceptives	574 (23.07%)	120 (55.56%)	169 (34.92%)	66 (68.75%)
Husband never used contraceptives	385 (15.47%)	74 (34.26%)	161 (33.26%)	56 (58.33%)
Wife: Have another child	788 (31.7%)	100 (46.3%)	165 (34.09%)	36 (37.5%)
Wife: No more children	1315 (52.9%)	85 (39.35%)	248 (51.24%)	37 (38.54%)
Husband: Have another child	788 (31.68%)	89 (41.4%)	169 (34.92%)	31 (32.29%)
Husband: No more children	1305 (52.47%)	100 (46.51%)	218 (45.04%)	43 (44.79%)
Wife: Not currently using contraceptives	1113 (44.73%)	159 (73.61%)	278 (57.44%)	80 (83.33%)
Husband: Not currently using contraceptives	955 (38.38%)	126 (58.33%)	264 (54.55%)	73 (76.04%)
Total Number of Couples	2488	216	484	96

Table 7: PROBIT MODEL FOR HUSBANDS AND WIVES, POOLED DATA
Dependent Variable = 1 if individual gives Nonnumeric Response

	Coefficients (standard error)
Education (yrs)	-0.018* (0.008)
Child mortality rate	0.254* (0.108)
Age (yrs)	-0.005 (0.013)
Grameen Bank In Village	-0.163* (0.073)
Distance to nearest High School	0.055+ (0.030)
Distance to Weekly Market	-0.027 (0.027)
Infecund (1 if Yes)	0.230** (0.070)
Sex (1 if Female)	-0.302** (0.072)
Marital duration	-0.014* (0.006)
Chittagong	0.366** (0.109)
Dhaka	-0.031 (0.107)
Khulna	-0.103 (0.111)
Rajshahi	-0.091 (0.103)
Constant	-1.042** (0.314)
Observations	5425
Wald Chi-square statistic[1]	343.38*

Robust standard errors, adjusted for clustering and arbitrary heteroscedasticity
[1]Wald test for coefficients of model = 0.

Other Variables: Distance. To Health Center and Family Welfare Center; Distance to District and Thana Head quarters; Presence of Mothers Club, Income generating NGOs, Cooperative society & Cottage Industries; Community tv in village; Distance to Madrasha , Primary school, daily market, Cinema; Ownership of assets by household (agricultural land; radio, t.v., bed, cupboard), Electricity in household, Urban, watches tv; reads newspaper; $(age)^2$.
* significant at 5%; ** significant at 1%; + significant at 10%

Table 8:PROBIT MODEL FOR WIVES
Dependent Variable = 1 if Wife gives Nonnumeric Response

	ALL COUPLES	**WIFE <=34**	**WIFE>=35**
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Her Education (yrs)	-0.004 (0.018)	0.014 (0.023)	-0.079* (0.040)
His Education (yrs)	0.004 (0.011)	-0.011 (0.014)	0.041+ (0.024)
Child Mortality Rate – (reported by Wife)	0.200 (0.169)	0.294 (0.219)	0.038 (0.318)
Her Age (yrs)	-0.050 (0.038)	-0.189* (0.086)	0.149 (0.319)
$(\text{Her Age})^2$	0.001+ (0.001)	0.004* (0.002)	-0.002 (0.004)
His Age (yrs)	-0.035 (0.030)	-0.027 (0.037)	0.094 (0.082)
$(\text{His Age})^2$	0.000 (0.000)	0.000 (0.000)	-0.001 (0.001)
Wife's Mobility (1): Visits other places (1 if yes)	-0.159* (0.078)	-0.127 (0.091)	-0.281+ (0.144)
Wife's Mobility (2): Visits Health Center (1 if yes)	-0.349** (0.086)	-0.223* (0.110)	-0.692** (0.148)
Grameen Bank in Village (1 if yes)	-0.146 (0.101)	-0.079 (0.114)	-0.286+ (0.157)
Distance to nearest High School (Miles)	0.103* (0.040)	0.120** (0.045)	0.065 (0.065)
Distance to Weekly Market (Miles)	-0.002 (0.030)	-0.028 (0.034)	0.061 (0.044)
Marital duration (yrs) (reported by wife)	-0.011 (0.015)	-0.016 (0.020)	-0.018 (0.021)
Infecund (1 if yes)	0.297** (0.107)	0.067 (0.215)	0.370** (0.130)
Chittagong	0.538** (0.140)	0.492** (0.159)	0.725** (0.247)
Dhaka	0.106 (0.154)	0.152 (0.164)	0.127 (0.273)
Khulna	-0.113 (0.171)	-0.178 (0.204)	-0.013 (0.274)
Rajshahi	0.129 (0.142)	0.112 (0.150)	0.220 (0.259)
Constant	0.243 (0.662)	1.634 (1.119)	-6.611 (6.560)
Observations	2746	1881	865
Wald Chi-square statistic[1]	201.17*	104.31*	125.15*

	ALL COUPLES	**WIFE <=34**	**WIFE>=35**
Robust standard errors, adjusted for clustering and arbitrary heteroscedasticity [1]Wald test for coefficients of model = 0.			
Other Variables: Distance To Health Center and Family Welfare Center; Distance to District and Thana Head quarters; Presence of Mothers Club, Income generating NGOs, Cooperative society & Cottage Industries; Community tv in village; Distance to Madrasha , Primary school, daily market, Cinema; Ownership of assets by household (agricultural land; radio, t.v., bed, cupboard), Electricity in household, Urban, Wife watches tv; wife reads newspaper; husband watches tv; husband listens to radio. * significant at 5%; ** significant at 1%; + significant at 10%			

Table 9:PROBIT MODEL FOR HUSBANDS
Dependent variable = 1 if Husband gives Nonnumeric Response

	ALL COUPLES	**WIFE <=34**	**WIFE>=35**
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Her Education (yrs)	-0.023 (0.016)	-0.011 (0.018)	-0.069* (0.030)
His Education (yrs)	-0.001 (0.011)	-0.010 (0.013)	0.016 (0.019)
Child Mortality Rate – (reported by husband)	0.231 (0.144)	0.254 (0.174)	0.247 (0.249)
Her Age (yrs)	-0.010 (0.031)	0.007 (0.077)	-0.076 (0.254)
$(\text{Her Age})^2$	0.000 (0.000)	0.000 (0.001)	0.001 (0.003)
His Age (yrs)	-0.023 (0.021)	-0.058* (0.028)	-0.058 (0.061)
$(\text{His Age})^2$	0.001* (0.000)	0.001** (0.000)	0.001 (0.001)
Wife's Mobility (1): Visits other places (1 if yes)	0.058 (0.068)	0.139 (0.089)	-0.053 (0.110)
Wife's Mobility (2): Visits Health Center (1 if yes)	-0.272** (0.068)	-0.294** (0.088)	-0.188 (0.141)
Grameen Bank in Village (1 if yes)	-0.149+ (0.080)	-0.063 (0.104)	-0.303* (0.124)
Distance to nearest High School (Miles)	0.025 (0.033)	0.063 (0.046)	-0.032 (0.048)
Distance to Weekly Market (Miles)	-0.060+ (0.031)	-0.111** (0.043)	0.007 (0.041)
Marital duration (yrs) (reported by Husband)	-0.022** (0.007)	-0.028** (0.010)	-0.020* (0.010)
Infecund (1 if yes)	0.032 (0.092)	-0.170 (0.174)	0.112 (0.122)
Chittagong	0.235+ (0.129)	0.261+ (0.155)	0.165 (0.209)
Dhaka	-0.137 (0.122)	-0.044 (0.142)	-0.370+ (0.221)
Khulna	-0.112 (0.134)	0.093 (0.163)	-0.472* (0.212)
Rajshahi	-0.234+ (0.131)	-0.230 (0.154)	-0.364+ (0.209)
Constant	-0.106 (0.500)	0.140 (1.030)	3.017 (5.166)
Observations	2777	1907	870
Wald Chi-square statistic[1]	213.20*	159.00*	136.85*

	ALL COUPLES	WIFE <=34	WIFE>=35
Robust standard errors, adjusted for clustering and arbitrary heteroscedasticity [1]Wald test for coefficients of model = 0			
Other Variables: Distance To Health Center and Family Welfare Center; Distance to District and Thana Head quarters; Presence of Mothers Club, Income generating NGOs, Cooperative society & Cottage Industries; Community tv in village; Distance to Madrasha , Primary school, daily market, Cinema; Ownership of assets by household (agricultural land; radio, t.v., bed, cupboard), Electricity in household, Urban, Wife watches tv; wife reads newspaper; husband watches tv; husband listens to radio. * significant at 5%; ** significant at 1%; + significant at 10%			

Table 10: BIVARIATE PROBIT MODEL FOR COUPLES
Dependent variable 1=1 if Wife gives nonnumeric response
Dependent variable 2=1 if Husband gives nonnumeric response

	ALL COUPLES		**WOMEN <=34**		**WOMEN >=35**	
	Coefficient (standard error)		Coefficient (standard error)		Coefficient (standard error)	
	WIFE	HUSB	WIFE	HUSB	WIFE	HUSB
Her Education (yrs)	-0.004 (0.019)	-0.022 (0.015)	0.014 (0.021)	-0.010 (0.018)	-0.080+ (0.041)	-0.067* (0.031)
His Education (yrs)	0.003 (0.012)	-0.002 (0.011)	-0.012 (0.014)	-0.010 (0.013)	0.043+ (0.022)	0.016 (0.019)
Child Mortality Rate (reported by Wife)	0.210 (0.169)		0.301 (0.210)		0.048 (0.294)	
Child Mortality Rate (reported by Husb)		0.242+ (0.144)		0.294+ (0.173)		0.179 (0.261)
Her Age (yrs)	-0.047 (0.037)	-0.018 (0.030)	-0.192* (0.083)	-0.003 (0.074)	0.157 (0.323)	-0.095 (0.251)
$(\text{Her Age})^2$	0.001+ (0.001)	0.000 (0.000)	0.004* (0.002)	0.000 (0.001)	-0.002 (0.004)	0.001 (0.003)
His Age (yrs)	-0.037 (0.027)	-0.021 (0.022)	-0.029 (0.035)	-0.054* (0.027)	0.093 (0.083)	-0.069 (0.060)
$(\text{His Age})^2$	0.000+ (0.000)	0.000* (0.000)	0.000 (0.000)	0.001** (0.000)	-0.001 (0.001)	0.001 (0.001)
Wife's Mobility (1): Visits other places (1 if Yes)	-0.161* (0.073)	0.053 (0.064)	-0.127 (0.093)	0.140+ (0.082)	-0.298* (0.130)	-0.072 (0.108)
Wife's Mobility (2): Visits Health Center (1 if Yes)	-0.347** (0.086)	-0.266** (0.075)	-0.222* (0.107)	-0.301** (0.090)	-0.679** (0.153)	-0.145 (0.147)
Grameen Bank in Village (1 if Yes)	-0.143+ (0.085)	-0.148* (0.071)	-0.074 (0.111)	-0.066 (0.089)	-0.295* (0.143)	-0.300* (0.122)
Distance to nearest High School (Miles)	0.102** (0.036)	0.025 (0.032)	0.116** (0.045)	0.064 (0.042)	0.070 (0.062)	-0.028 (0.053)
Distance to Weekly Market (Miles)	-0.005 (0.029)	-0.060* (0.028)	-0.028 (0.036)	-0.111** (0.037)	0.057 (0.049)	0.003 (0.043)
Marital duration (yrs) (Wife)	-0.011 (0.014)		-0.015 (0.019)		-0.021 (0.022)	
Marital Duration (yrs) (Husband)		-0.021** (0.007)		-0.027** (0.010)		-0.020+ (0.011)
Infecund (1 if yes)	0.308** (0.106)	0.058 (0.094)	0.085 (0.211)	-0.052 (0.178)	0.394** (0.137)	0.101 (0.114)
Chittagong	0.537** (0.146)	0.241* (0.114)	0.491** (0.183)	0.266+ (0.145)	0.745** (0.254)	0.166 (0.202)
Dhaka	0.113 (0.148)	-0.113 (0.114)	0.160 (0.184)	-0.020 (0.143)	0.133 (0.269)	-0.356+ (0.204)

	ALL COUPLES		WOMEN <=34		WOMEN >=35	
	Coefficient (standard error)		Coefficient (standard error)		Coefficient (standard error)	
	WIFE	HUSB	WIFE	HUSB	WIFE	HUSB
Khulna	-0.101 (0.167)	-0.093 (0.130)	-0.171 (0.225)	0.115 (0.164)	-0.007 (0.276)	-0.477* (0.227)
Rajshahi	0.137 (0.149)	-0.216+ (0.115)	0.116 (0.181)	-0.204 (0.147)	0.223 (0.270)	-0.378+ (0.200)
Constant	0.253 (0.593)	-0.027 (0.492)	1.702 (1.062)	0.204 (0.958)	-6.694 (6.505)	3.701 (5.177)
Correlation of. Residuals	0.18* (0.047)		0.12+ (0.064)		0.30* (0.074)	
Observations	2740		1877		863	
Model Wald Chi-square statistic[1]	349.97*		228.76*		215.81*	
Chi-square statistic for equality of coefficients						
Infecundity	3.37+		0.26		3.02+	
Wife's mobility 1	5.08*		4.83*		2.04	
Wife's mobility 2	0.53		0.32		6.99**	
Distance to nearest High School	3.06+		0.83		1.82	
Distance to nearest weekly market	2.88+		2.97+		1.15	
Chittagong	2.83+		1.04		3.65+	

Robust standard errors, adjusted for clustering and arbitrary heteroscedasticity
[1]Wald test for coefficients of model = 0

Other Variables: Distance To Health Center and Family Welfare Center; Distance to District and Thana Head quarters; Presence of Mothers Club, Income generating NGOs, Cooperative society & Cottage Industries; Community tv in village; Distance to Madrasha , Primary school, daily market, Cinema; Ownership of assets by household (agricultural land; radio, t.v., bed, cupboard), Electricity in household, Urban, Wife watches tv; wife reads newspaper; husband watches tv; husband listens to radio.
* significant at 5%; ** significant at 1%; + significant at 10%

Appendix A: Likelihood function for a Bivariate Probit model

J_{wi} = 1 or 0

J_{hi} = 1 or 0

The underlying regression can be expressed as follows:

(A) $J_{wi}^* = \eta_w X_{wi} + \varepsilon_{wi}$

(B) $J_{hi}^* = \eta_h X_{hi} + \varepsilon_{hi}$

Where, ε_w and ε_h follow are bivariate normal distribution with $E(\varepsilon_w) = E(\varepsilon_h) = 0$, $Var(\varepsilon_w) = Var(\varepsilon_h) = 1$, $Corr(\varepsilon_w , \varepsilon_h) = \rho \neq 0$.

J_{wi}^* and J_{hi}^* are not observed, but if $J_{wi}^* \geq 0$ then $J_{wi} = 1$ and if $J_{hi}^* \geq$ then $J_{hi} = 1$. Four possible cases can arise:

1) $J_{wi} = 0$ and $J_{hi} = 0$
2) $J_{wi} = 1$ and $J_{hi} = 0$
3) $J_{wi} = 0$ and $J_{hi} = 1$
4) $J_{wi} = 1$ and $J_{hi} = 1$

Suppose for N1 couples Case 1 is observed; for N2 couples Case 2 is observed; for N3 couples Case 3 is observed; for N4 couples Case 4 is observed. Total number of couples

N = N1 + N2 + N3 + N4.

Likelihood function (L) is given by,

$$L = \prod_{i=1}^{N1} \Pr(J_{wi} = 0, J_{hi} = 0) \prod_{i=N1+1}^{N2} \Pr(J_{wi} = 1, J_{hi} = 0) \prod_{i=N2+1}^{N3} \Pr(J_{wi} = 0, J_{hi} = 1) \prod_{i=N3+1}^{N4} \Pr(J_{wi} = 1, J_{hi} = 1)$$

Or,

$$L =$$
$$\prod_{i=1}^{N}[\Pr(J_{wi}=0, J_{hi}=0)]^{(1-J_{wi})(1-J_{hi})} \times [\Pr(J_{wi}=1, J_{hi}=0)]^{J_{wi}(1-J_{hi})}$$
$$\times [\Pr(J_{wi}=0, J_{hi}=1)]^{(1-J_{wi})J_{hi}} \times [\Pr(J_{wi}=1, J_{hi}=1)]^{J_{wi}J_{hi}}$$

From regression equations A and B above

$J_w = 0 \Rightarrow$, $J_w^* < 0$, OR, $\varepsilon_w < -\eta_w X_w$; $J_w = 1 \Rightarrow$, $J_w^* \geq 0$, OR, $\varepsilon_w \geq -\eta_w X_w$

$J_h = 0 \Rightarrow$, $J_h^* < 0$, OR, $\varepsilon_h < -\eta_h X_h$; $J_h = 1 \Rightarrow$, $J_h^* \geq 0$, OR, $\varepsilon_h \geq -\eta_h X_h$

Let $f_1(x)$ represent standard normal probability density function (pdf) and F(a) represent the cumulative distribution function (cdf) associated with it such that $F(a)=Prob(x<a)$

Let $f_2(x,y,\rho)$ represent the bivariate normal pdf with correlation ρ and $F_2(a,b, \rho)$ represent the cdf such that $F_2(a,b, \rho) = Prob(x<a, y<b)$

Then, $\Pr(J_{wi} = 0, J_{hi} = 0) = \Pr(\varepsilon_w < -\eta_w X_w, \varepsilon_h < -\eta_h X_h) = 1 - F_1(\eta_h X_h) - F_1(\eta_w X_w) + F_2(\eta_w X_w ,\eta_h X_h, \rho)$

$\Pr(J_{wi} = 1, J_{hi} = 0) = \Pr(\varepsilon_w \geq -\eta_w X_w, \varepsilon_h < -\eta_h X_h) = F_1(\eta_w X_w) - F_2(\eta_w X_w ,\eta_h X_h, \rho)$

$\Pr(J_{wi} = 0, J_{hi} = 1) = \Pr(\varepsilon_w < -\eta_w X_w, \varepsilon_h \geq -\eta_h X_h) = F_1(\eta_h X_h) - F_2(\eta_w X_w ,\eta_h X_h, \rho)$

$\Pr(J_{wi} = 1, J_{hi} = 1) = \Pr(\varepsilon_w \geq -\eta_w X_w, \varepsilon_h \geq -\eta_h X_h) = F_2(\eta_w X_w ,\eta_h X_h, \rho)$

Substituting these in the Likelihood function and taking logs,

$$\ln L(\boldsymbol{h}_w, \boldsymbol{h}_h, \boldsymbol{r}) =$$
$$\sum_{i=1}^{N}[(1-J_{wi})(1-J_{hi})\ln\{1 - F_1(\boldsymbol{h}_h X_h) - F_1(\boldsymbol{h}_w X_w) + F_2(\boldsymbol{h}_w X_w, \boldsymbol{h}_h X_h, \boldsymbol{r})\}$$
$$+ J_{wi}(1-J_{hi})\ln\{F_1(\boldsymbol{h}_w X_w) - F_2(\boldsymbol{h}_w X_w, \boldsymbol{h}_h X_h, \boldsymbol{r})\} + (1-J_{wi})J_{hi}\ln\{F_1(\boldsymbol{h}_h X_h) - F_2(\boldsymbol{h}_w X_w, \boldsymbol{h}_h X_h, \boldsymbol{r})\}$$
$$+ J_{wi}J_{hi}\ln\{F_2(\boldsymbol{h}_w X_w, \boldsymbol{h}_h X_h, \boldsymbol{r})\}$$

Differentiating this log likelihood with respect to each of the 3 parameters and simultaneously setting the derivatives equal to zero provides the maximum likelihood estimates of the parameters.