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Parental bargaining, health inputs and child mortality in India

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Abstract

The primary objective of this paper is to examine the relationship between the status of women in the household, the use of health care (demand for prenatal care and hospital delivery) and child mortality in India. Parents care about the health of their children but cannot directly affect child health by their actions. Instead they can, through their actions, control the use of health inputs. I jointly estimate the decision to use prenatal care, the decision to deliver the baby in hospital and child mortality. The estimation methodology allows us to account for unobserved heterogeneity and self-selection in the use of health inputs. The estimation results show that: (1) a woman's education has a stronger effect on health care usage relative to that of her husband; (2) a woman's control over household resources (ability to keep money aside) has a significant effect on health care usage; (3) both prenatal care and hospital delivery significantly reduces the hazard of child mortality; and (4) not accounting for unobserved heterogeneity and self-selection in the use of health inputs results in under-estimation of the effect of health inputs on child mortality.

JEL classification: D13; I12; C35; C41

Keywords: Prenatal care; Hospital delivery; Child mortality; Bargaining; India

1. Introduction

The primary objective of this paper is to examine the relationship between the status of women in the household, the use of health care and child mortality in India.[1] In doing so it combines two important lines of research: (1) the relationship between the status of women within the household and the use of health care; and (2) the relationship between the use of health care and child mortality.

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[1] The terms status, power and control are all used to refer to the position of the woman within the household and the society (more broadly). In this paper, I will use the terms inter-changeably.

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Analysis of household behaviour has, traditionally, been based on the idea that family members maximise a single utility function—the unitary household or common preference model. The assumption of common preference ordering among family members, underlying such analysis, can be traced back to Becker (1981). While this approach has proved useful for its elegance and analytical tractability, the underlying hypothesis of a single utility function encompassing all family members has been increasingly challenged in recent years. Such challenges have included attempts at modelling individual utility to incorporate divergent and conflicting preference of different family members. See, for example, Manser and Brown (1980), McElroy and Horney (1981), Chiappori (1988, 1992) and Browning and Chiappori (1998). Crucial to the notion of non-unitary models of the household is the notion of power (Pollak (1994)).[2] Much of the empirical work using bargaining models has tested the resource pooling implication of the unitary model. Failure to accept the hypothesis of resource pooling generally leads to the conclusion that there exists some sort of bargaining process within the household.

This literature in recent years has been extended to examine the fertility effects of spousal differences. In the demography literature it has long been argued that males and females differ in their desires regarding fertility and family planning (see Mason and Taj, 1987; Pritchett, 1994). Empirically, it has been observed that male and female preferences both significantly affect fertility and family planning (see Freedman et al., 1980; Bankole, 1995; Thomson et al., 1990; Thomson, 1997; Dodoo, 1998). This paper extends the literature to examine whether relative power within the household has implications for health care usage. The literature on this issue is surprisingly scarce. To the best of my knowledge the only other paper that exhibits the relationship between relative power within the household and health care usage is Beegle et al. (2001).

The second broad area of research that this paper examines is the relationship between the use of health care and health outcomes. The specific health outcome that I consider is child mortality.[3] In estimating the effect of health inputs on child mortality, it is important to take into account the issue of self-selection in the use of health inputs. Essentially, women who demand health care (choose to have prenatal care or choose to deliver the child in a hospital) might not necessarily be a random subset of all mothers. It is likely that these women are those who anticipate complications at birth or other factors that might lead to an increased risk of child mortality and hence are more like to seek health care (remember that health is private information to the woman and unobserved to the researcher). This could be termed as adverse self-selection. Ignoring this adverse self-selection could lead to an under estimate of the effect of prenatal care on birth outcomes. On the other hand, women who choose to have prenatal care could be low risk women, with a strong preference for healthy children. This could be termed as favourable self-selection.[4] Ignoring favourable self-selection actually causes the effects of health inputs on birth outcomes to be overstated. What all this implies is that health inputs is endogenous in the health outcome (child mortality) regression. To

[2] See Schultz (1990), Thomas (1990), Kanbur and Haddad (1994), Lundberg and Pollak (1994), Hoddinott and Haddad (1995), Lundberg et al. (1997), Frankenberg and Thomas (1998), Phipps and Burton (1998), Quisumbing and Maluccio (2000), Maitra and Ray (2002) for interesting applications using data sets from different countries.

[3] While this is a somewhat negative measure of child health, the available data on child anthropometric status (a more positive measure of child health) is not particularly reliable.

[4] This definition of favourable self-selection is due to Gortmaker (1979). See also Panis and Lillard (1994).

account for this potential endogeneity, following Panis and Lillard (1994), I use a model where child health outcomes are jointly estimated with a behavioural model where the health inputs are themselves choices. I focus on two particular health inputs—the decision to have prenatal care and the decision to deliver the baby in a hospital.

One important objective of this paper is to examine the effect of "power" on the use of health care, using data from India. The last few decades has seen massive improvements in the availability and access to reproductive and maternal health care in India. For example, during the late 1990s 42% of the births were delivered by a doctor or a health professional, up from 34% in the late 1980s. Infant (0–1) and young children (0–4) mortality rates have also dropped significantly over the past two decades.[5] However the position of women in the traditional Indian household continues to be poor. Most women continue to have very little authority within the household and few opportunities outside the household. Women in India are often prevented from working outside the home and prevented from travelling outside the home unless accompanied by an elder relative, both of which have severe implications for their access to health care. Social norms (particularly in North India) result in a reluctance to have women and girls examined by an outsider, particularly a male doctor. Efforts to deliver prenatal services to pregnant women are frequently hindered by the prevailing attitudes towards pregnancy (pregnancy is not regarded as condition that requires special care) and because of the lack of information pregnant women are often unaware of the need for routine care (during pregnancy and up to 6 weeks after delivery) and that maternity care is available from female health workers at sub-centres. The program that provides iron and folic acid tablets to women (a key component of prenatal care) has been unsuccessful because of delivery bottlenecks. Only 25% of all deliveries take place in health facilities. In rural areas deliveries are often at home in the presence of female family members and traditional birth attendants (*dais*), in unhygienic conditions, increasing the chance of infection in both the mother and the child. It is therefore clear that anything that increases the power of women within the household is likely to directly increase the use of health inputs and indirectly reduce child mortality.

Before proceeding further, let me briefly summarise the results. First, a woman's education has a stronger effect on health care usage relative to that of her husband; second, a woman's control over household resources has a significant effect on health care usage; third, both prenatal care and hospital delivery significantly reduces the hazard of child mortality; and finally not accounting for unobserved heterogeneity and self-selection in the use of health inputs results in under-estimation of the effect of health inputs on child mortality.

2. Methodology

Assume that parents make decisions regarding the quality (health attainment or educational attainment) of their children and parental utility is derived from market consumption

[5] For example, the infant mortality rates have fallen from 133 deaths per 1000 births in 1972–1974 to 80 in 1990–1992 and the mortality rates of young children have declined from 53 to 26 deaths per 1000 over the same period (World Bank (1996)).

goods that are purchased from the market (X), leisure (h) and child quality (Q). Child quality is produced according to the following production function

$$Q = Q(X, C; \Omega) \tag{1}$$

where C denotes health inputs and Ω denotes the household's production efficiency parameter. The utility of the mother (m) and the father (f) are denoted by U^m and U^f and the utility of an individual may be written as

$$U^i = U^i(X, Q, h_i); \quad i = m, f$$

Their reservation utility levels are $\bar{U}^m$ and $\bar{U}^f$. The reservation utility or the threat point defines the outside option available to each member of the household (or the utility that an individual would receive outside the household). Reservation utility typically depends on prices and characteristics that affect an individuals' ability to his/her preferences in the bargaining process within the household. They could include re-marriage market opportunities, social and family support as well as resources that an individual might take away from the household should the household dissolve. For the purposes of this paper, it is assumed that the reservation utility level of i ($i = m, f$) depends on the vector of prices p, unearned or asset incomes A_i and a set of extra-household environmental parameters α_i (see McElroy, 1990), so that

$$\bar{U}^i = \bar{U}^i(p, A_i; \alpha_i); \quad i = m, f \tag{2}$$

The two parents (m and f) then choose X, $h_i (i = m, f)$ and Q to maximise

$$V = [U^m(X, Q, h_m) - \bar{U}^m(p, A_m; \alpha_m)] \times [U^f(X, Q, h_f) - \bar{U}^f(p, A_f; \alpha_f)] \tag{3}$$

subject to the full income constraint

$$pX = w_m(T_m - h_m) + w_f(T_f - h_f) + A_m + A_f \tag{4}$$

and the household production function given by Eq. (1). Here, w_i is the wage rate, T_i is the time endowment of individual i, $i = m, f$.

As a solution to this problem one obtains a reduced form demand function for child quality (Q), which depends on prices (p), individual unearned income (A), the household production efficiency parameter (Ω), health inputs (C) and variables that reflect the bargaining power of each member within the household, so that

$$Q = Q(p, C, A_m, A_f; \alpha_m, \alpha_f, \Omega) \tag{5}$$

An empirical version of Eq. (5) is

$$Q = Q(p, C, \phi; \Omega) \tag{6}$$

where ϕ is the set of variables reflecting each member's relative authority and power within the household that affects the demand for goods. The set of variables in ϕ will include unearned income of the different members (A_i) and the extra environmental parameters (α_i). From an empirical point of view, any variable that reflects relative authority or bargaining power within the household is a candidate for ϕ.

In analysing child health I make the assumption that bargaining between parents does not directly affect child health. What this bargaining does affect is health inputs, which in turn affects child health. So, rather than determining child health (Q) directly, parental bargaining (maximising (3) subject to the budget constraint in (4) and the child health production function (Eq. (1)) determines the amount of health care C, so that instead of estimating Eq. (6) I estimate

$$C = C(p, \phi; \Omega) \tag{7}$$

In addition health care usage is assumed to depend on a number of individual (child level) characteristics (I), household and parental characteristics (H) and health infrastructure variables (S).[6] So, the estimated equation is:

$$C = C(I, H, S, \phi; \Omega) \tag{8}$$

Health care usage (C) in turn affects child health (see Eq. (6)). In addition child health is also assumed to depend on a set of child specific characteristics (I), a set of parental and household characteristics (H) and a set of community level variables (V). The child health production function can be written as

$$Q = Q(I, H, C, V; \Omega) \tag{9}$$

Child health production function (Eq. (9)) is estimated taking into account the potential endogeneity of health inputs (Eq. (7)). The estimation methodology used follows Panis and Lillard (1994). The estimation methodology allows me to account for mother specific unobserved heterogeneity. These are common to all children born to the same mother and are essentially mother specific health endowments, like genetic traits or biological characteristics that might make some women more susceptible to infection and thereby increase the risk to all children born to this woman. These endowments are known to the woman but are unobserved to the researcher. Not accounting for unobserved heterogeneity introduces potential bias in the estimates.

2.1. Prenatal care and hospital delivery

The decision on health care usage is estimated by two probits: choice of prenatal care and hospital delivery. Define two binary variables PRENATAL and HOSPDEL as follows:

$$\text{PRENATAL} = \begin{cases} 1 & \text{if the woman chooses to have prenatal care} \\ 0 & \text{otherwise} \end{cases}$$

$$\text{HOSPDEL} = \begin{cases} 1 & \text{if the child is born in a hospital} \\ 0 & \text{otherwise} \end{cases}$$

[6] The data set is cross sectional in nature and hence we can ignore prices. However, we can use the health infrastructure availability variables to measure the price of obtaining health care. All other price variation is assumed to be captured by the state dummies that we include in the set of explanatory variables.

Both the decision to have prenatal care and the decision to deliver the baby in a hospital depends on a set individual/child level characteristics (I), parental and household characteristics (H), a set of variables measuring the relative power or the husband and the wife (ϕ), a set of supply side variables (S) and a term that captures unobserved heterogeneity (η), that is assumed to apply to all children born to the same mother. This mother specific error term (mother-specific unobserved heterogeneity) may be correlated with all other heterogeneity terms. Denote $\tilde{Z}_i = (I_i, H_i, \phi_i, S_i);\ i = p, h$ as the relevant vector of explanatory variables in the equations characterising demand for prenatal care ($i = 1$) and the decision to have the baby in a hospital ($i = 2$).[7] The heterogeneity components are assumed to be uncorrelated with the other covariates. So, the estimated equations are as follows:

$$\text{PRENATAL} = \alpha_0 + \alpha_1 \tilde{Z}_p + \eta_p + \varepsilon_p \tag{10}$$

$$\text{HOSPDEL} = \beta_0 + \beta_1 \tilde{Z}_h + \eta_h + \varepsilon_h \tag{11}$$

All other residual variation is captured by ε with $\varepsilon_i \sim \text{IIDN}(0, 1);\ i = p, h$. The likelihood functions in the two cases are given by

$$L^p(\eta_p) = \begin{cases} \Phi(\alpha_0+\alpha_1\tilde{Z}_p+\eta_p) & \text{if the woman chooses to have prenatal care} \\ 1-\Phi(\alpha_0+\alpha_1\tilde{Z}_p+\eta_p) & \text{otherwise} \end{cases} \tag{12}$$

$$L^h(\eta_h) = \begin{cases} \Phi(\beta_0 + \beta_1\tilde{Z}_h + \eta_h) & \text{if child was born in a hospital} \\ 1 - \Phi(\beta_0 + \beta_1\tilde{Z}_h + \eta_h) & \text{otherwise} \end{cases} \tag{13}$$

2.2. Child mortality

Child mortality is modelled as a failure time process represented by a log hazard of duration equation. The model is one of proportional hazard with covariates and unobserved heterogeneity shifting the baseline hazard. The log hazard of mortality for a child at time t is given by

$$\ln h(t) = \gamma_0 + \gamma_1 T(t) + \gamma_2 \tilde{Z}_m + \eta_m + \varepsilon_m \tag{14}$$

Here, $\tilde{Z}_m$ denotes a set of individual (I), parental and household characteristics (H) and a set of health inputs (C, which include PRENATAL and HOSPDEL) that affect the hazard of child mortality and a set of community level variables (V). $T(t)$ is a spline in time beginning with the time the child enters the risk of dying (in this case, the moment the child is born). Denote the time at which the child enters the risk of dying by t_0 and subdivide the duration $t - t_0$ into K discrete periods. Then the baseline log hazard function is defined as a spline or a piecewise linear function and the log hazard of the event will have different slopes over the duration. The baseline hazard function can be written as

$$\gamma_0 + \gamma_1 T(t) = \gamma_0 + \sum_{k=1}^{K} \gamma_{1k} T_k(t) \tag{15}$$

[7] Note that the set of explanatory variables are equation specific. I will come back to the issue of identification later.

The baseline hazard function is therefore the sum of the effects of the various sources of time dependence within the period of risk for an individual and the resulting log hazard equation is piecewise linear in time since the individual enters the risk of the event. η_m captures unobserved heterogeneity, assumed to be uncorrelated with the set of explanatory variables. All other residual variation is captured by ε_m with $\varepsilon_m \sim \text{IIDN}(0, 1)$. The conditional likelihood of child mortality is therefore given by

$$L^m(\eta_m) = \begin{cases} S^c = \Gamma(t, Z(t^c), \eta_m) & \text{if censored} \\ S^u = \Gamma(t, Z(t^u), \eta_m) & \text{if uncensored} \end{cases} \tag{16}$$

Remember that the sample is censored if the child is alive at the time of the survey and is uncensored if the child is dead at the time of the survey.

2.3. Joint estimation

When both inputs are treated as endogenous, the joint marginal likelihood can be written as

$$\int_{\eta_p} \int_{\eta_h} \int_{\eta_m} \left[\prod L^p(\eta_p) \prod L^h(\eta_h) \prod L^m(\eta_m) \right] f(\eta_p, \eta_h, \eta_m)\, \mathrm{d}\eta_p\, \mathrm{d}\eta_h\, \mathrm{d}\eta_m \tag{17}$$

where $f(\eta_p, \eta_h, \eta_m)$ denotes the joint distribution of the unobserved heterogeneity components. Here, $f(\eta_p, \eta_h, \eta_m)$ is assumed to be a three dimensional normal distribution characterised as follows:

$$\begin{pmatrix} \eta_p \\ \eta_h \\ \eta_m \end{pmatrix} \sim N \left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_p^2 & & \\ \rho_{ph}\sigma_p\sigma_h & \sigma_h^2 & \\ \rho_{hm}\sigma_p\sigma_m & \rho_{hm}\sigma_h\sigma_m & \sigma_m^2 \end{bmatrix} \right) \tag{18}$$

The full specification model is estimated jointly using Full Information Maximum Likelihood (FIML) method.

As already argued, the primary reason for joint estimation is self-selection. This essentially implies that the correlation between the heterogeneity terms in the demand for health care equations (equations characterising demand for prenatal care and hospital delivery) and the child mortality equations could be non-zero, i.e. $\text{Cov}(\eta_p, \eta_h) \not\equiv 0$; $\text{Cov}(\eta_p, \eta_m) \not\equiv 0$; $\text{Cov}(\eta_h, \eta_m) \not\equiv 0$. However, conditional on all the heterogeneity terms, the equations are independent and the conditional joint likelihood can be obtained simply by multiplying the individual conditional likelihoods (Eq. (17)).

3. Data, descriptive statistics and explanatory variables

The analysis is based on the National Family and Health Survey 1999 (NFHS2) data from India. Because of reasons specified later, I restrict the analysis to the sample of women residing in rural areas. The survey collected information on prenatal care and place of delivery for children born in the three years preceding the survey and this leaves me with a sample of 18614 children born to 13284 women.

The women were asked whether they went for antenatal check up during pregnancy. I use the response to this question to examine the demand for prenatal care. In 48.77% of cases, the woman went for prenatal care. Respondents were also asked about the place of delivery. The majority of children (77.07%) were born at home—either at the respondent's home, or in their parents' home or in someone else's home. 22.72% of the children were born in hospital/health centre/dispensary. The remaining were born elsewhere. 92.76% of the children are alive at the time of the survey and the average age at death (for children that have died) is 3.29 months. Table 1 presents descriptive statistics for the variables of interest. Note that the sample used is not national: I use data from 15 states—Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, West Bengal and Uttar Pradesh.

3.1. Explanatory variables used

Both the decision to have prenatal care and the decision to deliver the baby in a hospital depends on a set individual characteristics (I), a set of parental and household characteristics (H), a set of variables measuring the relative power or the husband and the wife (ϕ), a set of supply side variables (S). The individual characteristic included are: the birth order of the child and the age of the woman and her husband at the time of birth. In the hospital delivery regressions, I include one other birth specific variable: whether there were any danger signs during pregnancy. It is likely that women choose to deliver their child in a hospital if they have some particular (private) information about the health of the unborn child. For this purpose I include a dummy variable "whether there were any danger signs in pregnancy". It is expected that if the woman did observe any danger signs during pregnancy, she would choose to deliver the child in a hospital, where the level of care is likely to be higher.

The parental and household characteristics included are: the highest level of education attained by the mother and the father, primary occupation of the father, state of residence, religion and ethnicity and variables that are indicative of information availability for the mother (whether the woman reads newspaper and watches television at least once a week). The set of variables measuring the relative power of the husband and wife are specified in Section 3.2. I use the availability of services variables to identify the prenatal care and the hospital delivery equations. Prenatal care is identified by the presence of a sub-centre in the village, the presence of a Primary Health Centre in the Village, the presence of a Community Health Centre in the Village, the presence of a Government Dispensary in the village and finally the presence of a private clinic in the village. Hospital delivery is identified by the presence of a Government Hospital in the village and the presence of a Private Hospital in the village. The presence of a Primary Health Centre in the village is included in both the prenatal care and hospital delivery regressions. Since the availability of services information is available only for the rural sample, the analysis is restricted to the rural sample.

The individual characteristics included in the child mortality regressions include the gender of the child, the birth order of the child, the age of the mother at the time of the birth and other variables that could potentially affect the hazard of child mortality: the size of the child at birth (birth weight), whether a health worker visited the woman when she was pregnant, whether the woman chose to have prenatal care, whether the child was born in a hospital, whether there were any danger signs during pregnancy, whether the woman was

Table 1
Selected descriptive statistics

	Sample size	Mean	S.D.
Mother level variables			
Residence: Andhra Pradesh	13284	0.0445	0.2062
Residence: Bihar	13284	0.1452	0.3523
Residence: Gujarat	13284	0.0447	0.2066
Residence: Haryana	13284	0.0439	0.2049
Residence: Karnataka	13284	0.0010	0.0319
Residence: Kerala	13284	0.0283	0.1659
Residence: Madhya Pradesh	13284	0.1207	0.3257
Residence: Maharashtra	13284	0.0412	0.1986
Residence: Orissa	13284	0.0660	0.2482
Residence: Punjab	13284	0.0345	0.1826
Residence: Rajasthan	13284	0.1321	0.3386
Residence: Sikkim	13284	0.0219	0.1462
Residence: Tamil Nadu	13284	0.0400	0.1960
Residence: West Bengal	13284	0.0421	0.2007
Residence: Andhra Pradesh	13284	0.1941	0.3955
Source of drinking water: piped into residence	13284	0.0972	0.2962
Source of drinking water: public tap	13284	0.1043	0.3056
Source of drinking water: private hand pump	13284	0.2134	0.4097
Source of drinking water: public hand pump	13284	0.2922	0.4548
Source of drinking water: private open well	13284	0.0704	0.2559
Source of drinking water: public open well	13284	0.1538	0.3608
Toilet: own flush toilet	13284	0.0672	0.2503
Toilet: own pit toilet/latrine	13284	0.0663	0.2488
No toilet facilities at home	13284	0.8480	0.3590
Woman reads newspaper at least once a week	13284	0.1138	0.3176
Woman watches television at least once a week	13284	0.2808	0.4494
Has electricity	13284	0.4681	0.4990
Religion: Hindu	13284	0.8410	0.3657
Religion: Muslim	13284	0.1070	0.3091
Religion: Christian	13284	0.0141	0.1180
Religion: Sikh	13284	0.0252	0.1567
Religion: Buddhist	13284	0.0095	0.0968
Scheduled caste/schedules tribe	13284	0.3357	0.4722
Other backward caste	13284	0.3386	0.4733
Woman or jointly with husband decides what to cook	13284	0.6990	0.4587
Woman or jointly with husband decides on health care	13284	0.3483	0.4765
Woman or jointly with husband decides on jewellery purchase	13284	0.3044	0.4602
Woman or jointly with husband decides about respondent staying with family	13284	0.2806	0.4493
Permission needed to go to market	13284	0.7269	0.4456
Permission needed to visit relatives or friends	13284	0.8292	0.3764
Allowed to have money set aside	13284	0.4873	0.4999
Husband may hit wife if she is unfaithful	13284	0.3840	0.4864
Husband may hit wife if her family does not give money	13284	0.0652	0.2469
Husband may hit wife if she goes out without telling him	13284	0.3785	0.4850
Husband may hit wife if she neglects house or children	13284	0.3923	0.4883
Husband may hit wife if she does not cook properly	13284	0.2759	0.4470
Highest education of woman: primary school	13284	0.1640	0.3703

Table 1 (*Continued*)

	Sample size	Mean	S.D.
Highest education of woman: middle school	13284	0.0719	0.2584
Highest education of woman: secondary school or higher	13284	0.0861	0.2805
Highest education of husband: primary school	13284	0.2454	0.4303
Highest education of husband: middle school	13284	0.1471	0.3543
Highest education of husband: secondary school or higher	13284	0.2562	0.4365
Sub-centre in village	13284	0.3626	0.4808
Primary health centre in village	13284	0.1445	0.3516
Community health centre in village	13284	0.0920	0.2891
Government dispensary in village	13284	0.1358	0.3425
Private clinic in village	13284	0.2770	0.4476
Government hospital in village	13284	0.0390	0.1936
Private hospital in village	13284	0.0680	0.2518
Child level variables			
Age of respondent at time of birth: 20–24	18614	0.3832	0.4862
Age of respondent at time of birth: 25–29	18614	0.2909	0.4542
Age of respondent at time of birth: 30–34	18614	0.1296	0.3359
Age of respondent at time of birth: 35–39	18614	0.0509	0.2197
Age of respondent at time of birth: 40–44	18614	0.0148	0.1209
Age of respondent at time of birth: 45–49	18614	0.0045	0.0666
Age of husband at time of birth: 15–19	18614	0.1218	0.3271
Age of husband at time of birth: 20–24	18614	0.3082	0.4617
Age of husband at time of birth: 25–29	18614	0.2631	0.4403
Age of husband at time of birth: 30–34	18614	0.1663	0.3724
Age of husband at time of birth: 35–39	18614	0.0275	0.1634
Age of husband at time of birth: more than 44	18614	0.0321	0.1762
Child dead at the time of the survey	18614	0.0724	0.2591
Age at death[a]	1347	3.2992	5.7511
Hospital delivery	18614	0.2262	0.4184
Low birth weight baby	18614	0.2599	0.4386
Size at birth average	18614	0.1245	0.3302
Size at birth smaller than average	18614	0.6156	0.4865
Size at birth very small	18614	0.2032	0.4024
Child is a girl	18614	0.4810	0.4997
Went for prenatal check up	18614	0.4877	0.4999
Prenatal visit by health worker	18614	0.1859	0.3891
Danger signs in pregnancy	18614	0.1584	0.3652
Received delivery care	18614	0.1937	0.3952
Received new born care	18614	0.1733	0.3785
Given iron tablets during pregnancy	18614	0.4967	0.5000
Given tetanus shot during pregnancy	18614	0.6966	0.4598

[a] Computed only for the Children that are dead at the time of the survey.

given iron tablets and tetanus shots during pregnancy.[8] Parental and household level characteristics include the highest educational attainment of the woman and her husband, the main source of drinking water for the household, the type of toilet in the household, whether the

[8] The size of the child at birth (birth weight) is included as a dummy variable: the child is classified as a low birth weight baby or otherwise. Birth weight is classified as low if the size of the child at birth is smaller than average or is very small.

household has electricity, and variables that are indicative of information availability for the mother (whether the woman reads newspaper and watches television at least once a week). Village level (community) characteristics include the distance to the nearest town, district headquarters, nearest railway station, nearest transport and all weather road.[9] The baseline hazards are specified as splines. The baseline hazard measures the duration dependence for survival and for subsequent birth—the time varying risk of child mortality. The time dependency starts once the child is born. Several specifications of the baseline hazard were tried and I finally chose the one that fitted the data best—with one node at 1 month.

3.2. Measures of bargaining

Economic analysis of bargaining power within the household has typically focused on economic resources that are exogenous to labour supply. They include assets, both current and those brought into marriage (Beegle et al., 2001; Frankenberg and Thomas, 1998; Quisumbing and Maluccio, 2000; Doss, 1999), unearned income (Schultz, 1990; Thomas, 1990) or transfer payments and welfare receipts (Lundberg et al., 1997). Only recently however economists have started using other (non-economic) factors that affect the bargaining power within the household. These include legal rights, educational attainment, skills and knowledge. It must however be noted that the sociological/demographic literature has long used non-economic criteria to characterise the status of women (and hence the relative bargaining power of the different members) within the household. These can be broadly classified into the following two categories: (1) exposure to and interactions with the outside world and (2) degree of autonomy for women within the household (see Dyson and Moore, 1983; Basu, 1989). In this paper, I use the educational attainment of the husband the wife and sociological/demographic measures of the status of the woman within the household as measures of bargaining power, rather than using economic resources.

3.2.1. Educational attainment of husband and wife

It is argued that increased female education is associated with significant improvements in child health and increased probability of using prenatal care and institutional delivery. The literature actually suggests five ways in which education can increase the relative power of women within the household. This in turn has significant effects on reproductive behaviour (including fertility and health care usage) and child mortality.[10] First, education increases women's knowledge of and exposure to the outside world and increases women's decision making authority. Second, educated women generally face fewer constraints to physical mobility in interacting with the outside world. Third, it is argued that education increases the emotional autonomy of women. Finally, education typically increases women's economic independence and improves access to and control over economic resources. It is

[9] In the earlier version health infrastructure variables (health care facilities available in the village) were included as additional explanatory variables. However, these variables turned out to be statistically insignificant, both individually and also jointly. Further, an anonymous referee notes that "it is reasonable to restrict the effect of these variables to be zero with the health inputs held constant". In the revised version therefore I dropped the health infrastructure variables in the child mortality hazard regression.

[10] See Jejeebhoy (1995) and Beegle et al. (2001) for more on this issue.

also argued that the magnitude of the correlation between reproductive health outcomes and female education is generally bigger than the corresponding correlations with male education.

All of these form the basis for the argument that education is a measure of power and the more powerful women assert preferences for increased use of prenatal care, increased hospital delivery and in lower infant mortality. In addition, educational attainment could also have a direct effect on child mortality because more educated women are likely to have more information about health services available and are also more likely to be aware of adverse child health conditions. Since each of these variables of interest are primarily the domain of women, it follows that women benefit more directly from these investments compared to their husbands. The educational attainment of the woman and that of her husband could therefore be used as a measure of relative power within the household. I include three dummies for the highest level of education attained by the wife and three dummies of the highest level of education attained by the husband. The three dummies are: the highest level of education attained is primary school, the highest level of education attained is middle school and the highest level of education attained is secondary school or higher. Including educational attainment of the husband and the wife as explanatory variables also allows me to test the hypothesis that the female education has a stronger correlation compared to male education on increased prenatal care, increased institutional delivery and reduced infant mortality. The descriptive statistics presented in Table 1 show that the majority of women (67.80%) are illiterate and 35.13% of the husbands' are illiterate. Note that 25.62% of the husbands' have secondary schooling or higher, compared to only 8.61% of women.[11]

3.2.2. *Sociological/demographic measures of power*

Following Dyson and Moore (1983) and Basu (1989), I use two sets of criteria to characterise the status of women within the household. The first is the exposure to and interactions with the outside world. To capture this effect I include a set of dummy variables:

- whether the woman needs permission to visit family and friends;
- whether the woman needs permission to go to the market;
- whether the husband hits the woman if she goes out without informing him.

The second is the degree of autonomy for the women (freedom of movements, control over resources, say in matters relating to fertility and family planning and not be subject to domestic violence). To capture this effect I include a set of dummy variables:

- whether the woman is able to have money set aside (control over household resources);
- whether the woman has say in decision regarding cooking, obtaining health care, purchasing jewellery, staying with the family;

[11] Beegle et al. (2001) use education of the wife relative to her husband as an indicator of power. Specifically, they examine whether women who are better educated than their husbands are more or less likely to demand prenatal care holding all other observable characteristics constant. I also included a dummy variable to indicate whether the woman is more educated compared to her husband as an additional explanatory variable—but this variable turned out to be not statistically significant and the marginal probability associated with this variable was also very small. I therefore excluded this variable from the set of explanatory variables.

- whether the husband hits the woman if she is unfaithful, if her family does not provide money, if she neglects house or children or if she does not cook properly.[12]

Defined in this way the power of the woman within the household is likely to be higher if the woman has a role to play in decisions regarding cooking, health care, purchase of jewellery and staying with family and if the woman is able to set money aside (indicative of control over resources). On the other hand the power of the woman within the household is likely to be lower if the woman requires permission to visit family or go to the market or if the husband hits the woman. I include the 12 dummy variables used to measure the relative bargaining power in the prenatal care and hospital delivery regressions. The descriptive statistics presented in Table 1 shed interesting light on the relative power of men and women within the household. 48.73% of the respondents have control over household resources and are able to set money aside. 69.9% of the women have some say over cooking decisions in the household, 34.83% of the women have some say over health care decisions. On the other hand 73% of the women need permission to go to the market and 83% of the women need permission to visit family.

4. Results

I now turn to the regression results. I estimate three sets of regressions: a probit equation characterising the demand for prenatal care, a probit equation characterising hospital delivery and a hazard equation characterising child mortality. It is worth noting that in the child mortality hazard regressions a negative coefficient estimate implies that the relevant variable reduces the hazard of child mortality and a positive estimated coefficient implies that the relevant variable increases the hazard of child mortality. The full set of coefficient estimates are presented in Appendix A (Tables A.1–A.3).

4.1. Unobserved heterogeneity

Self-selection in the demand for prenatal care is reflected in the correlation between the heterogeneity components in the prenatal care and child mortality regressions ($\rho_{\eta_p\eta_m}$) and self-selection in hospital deliveries is found in the correlation between the heterogeneity components in the hospital delivery and child mortality regressions ($\rho_{\eta_h\eta_m}$). I also allow for correlation between the heterogeneity components in the prenatal care and hospital delivery regressions ($\rho_{\eta_p\eta_h}$). These estimates are presented in Table 2—the diagonal elements are standard deviations and the off-diagonal elements are correlation coefficients. Note that the estimates of the heterogeneity structure correspond to the full specification under the assumption of endogenous prenatal care and hospital delivery. The correlations are always statistically significant. The statistical significance of the estimates of the correlation between the heterogeneity coefficients implies that there is evidence of self-selection in the use of both prenatal care and the choice of hospital delivery.

[12] The use of the last set of variables follows Rao (1997) who finds that in India domestic violence (wife beating) is often used to exert power within the household.

Table 2
Heterogeneity structure estimates

	η_p	η_h	η_m
Prenatal care (η_p)	0.9509*** (0.0368)		
Hospital delivery (η_h)	0.5958*** (0.0319)	0.9550*** (0.0463)	
Child mortality (η_m)	0.3693** (0.1456)	0.5469*** (0.1781)	0.5749*** (0.1227)

Note: Standard errors are in parenthesis. Diagonal elements are standard deviation and the off-diagonal elements are correlation coefficients. Estimates of the heterogeneity structure correspond to the full specification under the assumption of endogenous prenatal care and hospital delivery (and birth weight exogenous).

** Significance at 5% level.

*** Significance at 1% level.

Table 3
Effect of ignoring self-selection in child mortality regression

	Exogenous prenatal care and hospital delivery	Endogenous prenatal care and hospital delivery
Went for prenatal check up	−0.3364*** (0.0860)	−0.5214*** (0.1262)
Hospital delivery	−0.0359 (0.1362)	−0.3749*** (0.0827)

Note: Standard errors are in parenthesis.

*** Significance at 1% level.

4.2. *What difference does ignoring self-selection make?*

For the Child mortality hazard regressions I compute and present several sets of coefficient estimates (and associated standard errors). Model I ignores the potential endogeneity of prenatal care and hospital delivery in the child mortality hazard regressions while Model II takes into account the self-selection in the use of health inputs and jointly estimates the demand for health inputs and child mortality, taking into account the heterogeneity structure.[13] The coefficient estimates presented in Table 3 confirm this. It is worth noting that both prenatal care and hospital delivery reduce the hazard of child mortality, though the effect of hospital delivery is weaker. More importantly, not accounting for unobserved heterogeneity and self-selection in the use of health inputs results in significant under-estimation of the effect of health inputs on child mortality. Remember that Model I was estimated under the assumption that both prenatal care and hospital delivery are exogenous. The effect of prenatal care and hospital delivery are both negative (−0.3364 and −0.0359, respectively), though statistically significant only in the demand for prenatal care regressions, but is an under estimate of the true effect obtained in Model II (−0.5214 and −0.3749, respectively), both of which are statistically significant. It is therefore clear that failure to account for self-selection and unobserved heterogeneity results in an under estimation of the true beneficial effect of the use of health inputs on child health.

The finding that increased use of health inputs (like prenatal care or hospital birth) have significantly positive effect on child health has important policy implications. There is however one caveat that one needs to mention: omitted variable bias. If there other health

[13] Two other models are also estimated: Models IIA and III. I will describe these two models later.

Table 4
Education effects

Highest education attained	Woman	Husband	Equality of difference[a]
Demand for prenatal care			
Primary school	0.3808*** (0.0447)	0.2024*** (0.0377)	10.26***
Middle school	0.5482*** (0.0697)	0.3689*** (0.0478)	5.16**
Secondary school or higher	0.9014*** (0.0783)	0.3593*** (0.0471)	31.00***
Hospital delivery			
Primary school	0.3186*** (0.0466)	0.1474*** (0.0449)	9.37**
Middle school	0.3866*** (0.0666)	0.3305*** (0.0529)	0.74
Secondary school or higher	0.6371*** (0.0756)	0.3302*** (0.0528)	9.93**
Hazard of child mortality[b]			
Primary school	−0.0894 (0.0966)	0.0833 (0.0739)	0.46
Middle school	−0.0934 (0.1552)	−0.0475 (0.0971)	1.98
Secondary school or higher	−0.3005 (0.1900)	−0.1739* (0.0955)	11.96***

Note: Standard errors are in parenthesis.
[a] $\chi^2(1)$.
[b] Prenatal care and hospital delivery endogenous. Birth weight exogenous.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

inputs (which might be unobserved) that can affect child health and if these inputs are omitted from the set of explanatory variables that are used to explain child health, the beneficial effects of prenatal care and hospital delivery on child health could be over-estimated. One therefore needs to be careful in designing policies based solely on the results obtained.[14]

4.3. Education effects

Table 4 presents the coefficient estimates and the standard errors for the effect of educational attainment on the demand for prenatal care, hospital delivery and the hazard of child mortality. I examine each in turn.

Both the respondent's educational attainment and her husband's educational attainment have significant positive effects on the demand for prenatal care and hospital delivery. Relative to the baseline category (that the woman has no education or that her educational attainment is missing), if the highest education attainment by the woman is primary school, middle school or secondary school or higher attainment increases the probability that the woman demands prenatal care by 11.81, 16.15 and 24.71% points, respectively.[15] The husband's educational attainment also has a significant and positive effect on the demand for prenatal care. Relative to the baseline category, if the highest educational attainment of the husband is primary school, middle school or secondary school or higher attainment increases the demand for prenatal care by 6.15, 10.80 and 10.02% points, respectively.

[14] I would like to thank Paul Schultz for pointing this out to me.
[15] These probabilities (the marginal effects) were computed by holding all other explanatory variables at the respective sample means.

At every level of educational attainment the highest level of education attained by the woman has a stronger effect on the demand for prenatal care compared to the highest level of education attained by the husband—verified using standard χ^2 tests for equality of education effects at each level.

Turning to the hospital delivery regressions, I find that the probability of hospital delivery is higher (relative to the reference category of no schooling) by 7.37% points if the highest education attainment by the woman is primary school, higher by 8.91% points if the highest educational attainment by the woman is middle school and is higher by 14.33% points if the highest education attained by the woman is secondary school or higher. Educational attainment by the husband has a similar positive and statistically significant effect on hospital delivery, though the effect is generally not as strong. The coefficient estimates show that the probability of hospital delivery is higher by 2.07% points if the highest education attained by the husband is primary school, is higher by 7.01% points if the highest education attained by the husband is middle school and is higher by 6.55% points if the highest education attained by the husband is secondary school or higher. While the null hypothesis of equality of education effects is generally rejected at every level of educational attainment, there is one notable exception—when the highest education attained by the respondent and her husband is middle school.

Turning to the child mortality hazard regressions, it is worth noting that while educational attainment of the woman and that of her husband reduces the hazard of child mortality, the effects are generally not statistically significant. It is worth noting that the magnitude of the effect increases as educational attainment increases. Educational attainment of the woman never has statistically significant effect on the hazard of child mortality though the coefficient estimate is always negative. The husband's education is statistically significant (but only at the 10% level) and only if the highest education attained by the husband is secondary schooling or higher. There is therefore some evidence of a threshold level of education that must be attained before educational attainment has a statistically significant effect on the hazard of child mortality. Of course one must bear in mind that this measures the direct (residual) effect of educational attainment on child mortality hazard—there is an indirect effect in that educational attainment increases the demand for prenatal care and hospital delivery, which in turn significantly reduces the hazard of child mortality.

4.4. Effect of bargaining variables

Several of the variables that measure the power of women within the household have significant effects on the demand for prenatal care. The coefficient estimates are presented in Table 5. Control over resources (if the woman is able to set money aside) or if the woman has a role to play in the household decisions regarding health care both increase the demand for prenatal care. Both of these variables are indicative of more power for the woman within the household. On the other hand the demand for prenatal care is lower if a woman requires permission to visit her family or the market or if the husband hits the woman if she is unfaithful, each of which are indicative of low power for the woman within the household. Control over resources by the woman (if the woman is able to set money aside) also has a positive and statistically significant effect on the probability of hospital delivery. The probability of hospital delivery is significantly lower if the husband hits the woman she is

Table 5
Bargaining power and health inputs

Measures of bargaining	Prenatal care	Hospital delivery
Allowed to have money set aside	0.1000*** (0.0302)	0.0801** (0.0346)
Woman or jointly with husband decides on		
Health care	0.0750** (0.0364)	−0.049 (0.0415)
What to cook	−0.0392 (0.0345)	−0.0584 (0.0383)
Jewellery purchase	0.0028 (0.0439)	0.026 (0.0501)
Respondent staying with family	0.0115 (0.0458)	0.0542 (0.0515)
Permission needed to		
Go to market	0.0711 (0.0435)	0.0358 (0.0487)
Visit relatives or friends	−0.0893* (0.0521)	−0.1008* (0.0566)
Husband may hit wife if		
She is unfaithful	−0.0678** (0.0337)	−0.0818** (0.0384)
Her family does not give money	−0.0673 (0.0607)	−0.1436** (0.0725)
She goes out without telling him	−0.0277 (0.0426)	−0.0354 (0.0486)
She neglects house or children	0.0086 (0.0476)	0.0623 (0.0521)
She does not cook properly	0.0202 (0.0454)	0.0000 (0.0519)
Joint significance of "power" variables[a]	29.51***	27.20***

Note: Standard errors are in parenthesis. Prenatal care and hospital delivery endogenous. Birth weight exogenous.
[a] $\chi^2(12)$.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

unfaithful or if her family does not provide money or if the woman requires permission to visit family and friends, which again are indicative of low power for the woman within the household. It is worth noting that the bargaining power variables are jointly significant in both the prenatal care and the hospital delivery regressions (both at 1% level). Note that not many of the bargaining variables are statistically significant, indicating perhaps multicollinearity between these variables. However the fact that they are jointly statistically significant implies that they do (jointly) have significant effects on health care usage.

An alternative to using these twelve measures of bargaining power as explanatory variables is to create an index of bargaining power. I compute this index using principal components analysis and use this index as an explanatory variable in the prenatal care and hospital delivery regressions instead of the 12 dummy variables characterising the relative bargaining power within the household. An increase in the value of bargaining index implies an improvement in the bargaining power of women within the household. The regression results (not presented but available on request) show that a unit increase in the bargaining index significantly increases both the demand for prenatal care and the probability of hospital delivery. I also computed the associated marginal effects that show that a unit increase in the bargaining index increases the demand for prenatal care by 40% points and the probability of hospital delivery by 25% points.

I have so far assumed that bargaining power does not directly affect child mortality, rather it has only an indirect effect on child mortality by affecting health inputs. To examine the

Table 6
Effect of health infrastructure availability

Service	Coefficient
Demand for prenatal care	
Sub-centre in village	0.0209 (0.0380)
Primary health centre in village	0.2356*** (0.0549)
Community health centre in village	−0.0713 (0.0639)
Government dispensary in village	0.0155 (0.0537)
Private clinic in village	0.0268 (0.0422)
Joint significance of health infrastructure availability[a]	34.18***
Hospital delivery	
Government hospital in village	−0.087 (0.1009)
Private hospital in village	0.1874** (0.0768)
Primary health centre in village	−0.0807 (0.0559)
Joint significance of health infrastructure availability[b]	7.07*

Note: Standard errors are in parenthesis. Prenatal care and hospital delivery endogenous. Birth weight exogenous.
[a] $\chi^2(5)$.
[b] $\chi^2(3)$.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

robustness of this assumption I re-estimated the model by:[16] (1) including the bargaining variables in the child mortality hazard regressions also (in addition to the prenatal care and hospital delivery probits); and (2) including the bargaining variables in the child mortality hazard regressions only (and not in the prenatal care and hospital delivery probits). I conducted standard likelihood ratio tests to examine the joint significance of the bargaining power variables on the hazard of child mortality. In case 1, the bargaining power variables are not jointly statistically significant (P-value = 0.2513), though they are in Case 2 (P-value = 0.0003). This essentially implies that bargaining power within the household does have an effect on child mortality, but the effect is not direct—rather it is through the effect on the use of health inputs.

4.5. Health infrastructure availability

Does health service availability have a significant effect on the demand for prenatal care and on hospital delivery? Table 6 presents the coefficients and standard errors. The regression results show that the presence of a Primary Health Centre in the village has a positive and statistically significant effect on the demand for prenatal care. None of the other supply side variables are statistically significant and interestingly the presence of a community health centre in the village and a government dispensary within the village actually appear to reduce the demand for prenatal care. Turning to the hospital delivery regressions, the presence of a private hospital in the village increases the probability of

[16] Here, I use the 12 dummy variables and not the index.

hospital delivery. None of the other supply side variables are statistically significant in several cases the presence of specific health services (presence of a government hospital in the and the presence of a primary health centre in the village) appear to reduce the probability of hospital delivery, though the effect is never statistically significant. While the health infrastructure variables are individually not always statistically significant, they are jointly significant in both the prenatal care and hospital delivery regressions (with associated *P*-values of 0.0000 and 0.0050, respectively). The individual insignificance of the health service variables possibly reflects multicollinearity between their village level aggregates.

Note that the fact that health inputs is only weakly correlated with the health infrastructure variables is neither surprising nor new. Indeed several studies (summarised in Strauss and Thomas (1998)) have argued that local infrastructure could be endogenous in the child health regressions. This could happen because of two reasons. First, individuals might choose their residence based on the availability of public health services (see Rosenzweig and Wolpin, 1988). Second, local infrastructure itself might be placed selectively by public policy, perhaps in response to local health conditions (see Rosenzweig and Wolpin, 1986). The first issue is unlikely to be particularly important for a country like India because migration in this case would have to be correlated with the unobserved factors that are correlated with health in a location, such as availability of clinics, over and above other measures included in wage differentials. See Strauss and Thomas (1998). Selective placement of health services is however potentially a much more important issue. While I acknowledge this potential endogeneity of the local infrastructure variables I ignore this issue in the estimation because of the lack of good instruments.

4.6. Other results

Let me now briefly discuss some of the other results. The full set of estimates are presented in Appendix A (Tables A.1–A.3).[17]

4.6.1. Demand for prenatal care and hospital delivery

I find that both the demand for prenatal care and the probability of hospital delivery are lower for children of higher birth order (children born later) and interestingly the effect is monotonic. Both the demand for prenatal care and the probability of hospital delivery are significantly higher if the woman watches television at least once a week. Additionally, the demand for prenatal care is significantly higher if the woman reads newspaper at least once a week. Note that reading newspaper at least once a week also increases the probability of hospital delivery, though the effect is not statistically significant. Watching television and reading the newspaper are indicative of information availability and these results imply that access to information increases the demand for prenatal care and hospital delivery.[18]

[17] I only discuss the results for Model II.

[18] One must however be careful in interpreting “watching television” merely as an information availability variable—indeed it might also be capturing a wealth effect, since wealthier households are likely to have access to television. I would like to thank Stephen Smith for pointing this out to me.

The age of the woman at the time of birth has a statistically significant effect on the demand for prenatal care and on hospital delivery. Relative to women aged 15–19 at the time of delivery, the demand for prenatal care and the probability of hospital delivery is higher for women aged 20 or higher. The effect of the age of the husband at the time of birth on the demand for prenatal care and hospital delivery is however not strong and in fact none of the age of the husband dummies are statistically significant in explaining the probability of hospital delivery. Interestingly notice that the primary occupation of the husband does not generally affect the demand for prenatal care or hospital delivery—the only exception is that the demand for prenatal care is significantly lower if the father is self employed in agriculture.

There are significant regional variations in the demand for prenatal care and the probability of hospital delivery, captured by the state dummies that are included as additional explanatory variables. The reference category is that the household resides in the state of Uttar Pradesh, the largest state in India. All of the state dummies are positive and with the exception of Bihar are all statistically significant. Turning to the hospital delivery regressions, I find similar evidence of regional variation. Relative to a woman residing in Uttar Pradesh, the probability of hospital delivery is significantly lower for a woman residing in Haryana and significantly higher in Andhra Pradesh, Gujarat, Kerala, Maharashtra, Rajasthan, Sikkim, Tamil Nadu and West Bengal. There are also significant religious and ethnic differences in the demand for prenatal care and the probability of hospital delivery. The demand for prenatal care is higher for Sikhs and lower for Buddhists and the probability of hospital delivery is higher for Sikhs and lower for Buddhists and Muslims. Both the demand for prenatal care and the probability of hospital delivery is lower for women belonging to a Scheduled Caste or a Scheduled Tribe.

Finally it is worth noting that the probability of hospital delivery is significantly higher if the woman had danger signs during pregnancy. This is not surprising because the level of care and medical attention is likely to be higher in hospitals and therefore women who have danger signs during pregnancy are more likely to choose to deliver the baby in a hospital.

4.6.2. Child mortality hazard

The following results are worth noting:

1. The age of the mother at the time of birth has a significant effect on the hazard of child mortality.
2. The hazard of child mortality is significantly lower if the age of the woman at the time of the birth is between 20–39.
3. There is evidence of regional and religious differences in the hazard of child mortality. The hazard of child mortality is significantly lower for residents of Kerala and Sikkim. Interestingly the hazard of child mortality is low for Muslim households.
4. Birth weight has a statistically significant effect on the hazard of child mortality. The regression estimates show that the hazard of child mortality is significantly higher if the child is of low birth weight. Low birth weight is typically indicative of severe health problems in the mother and/or the child and hence associated with higher child mortality levels.

5. The hazard of child mortality is significantly lower if a health worker visited the woman during pregnancy or if the woman was given tetanus shots while pregnant.
6. Finally it is worth noting that the gender of the child dummy, though positive is not statistically significant. This implies that there is no statistically significant difference in the child mortality rates between boys and girls.

4.7. Potential endogeneity of birth weight

One could argue that prenatal care affects child mortality primarily through birth weight effects. The analysis conducted so far examining child mortality after controlling for observed birth weight effects. However as an anonymous referee has pointed out, given the (possible) relationship between prenatal care, birth weight and child mortality, birth weight is likely to be endogenous in the child mortality regression. To account for this (potential) endogeneity, I re-estimate the system of equations by

1. Ignoring the low birth weight dummy from the set of explanatory variables in the child mortality hazard equation. This is Model IIA.
2. Estimate a four equation system where birth weight is defined by a fourth equation. This is Model III.

For the purposes of Model III, I add a fourth equation to the system of equations:

$$\text{LOWBRTHWGT} = \delta_0 + \delta_1 \tilde{Z}_w + \eta_w + \varepsilon_w \tag{19}$$

Here, LOWBRTHWGT is a binary variable defined as follows:

$$\text{LOWBRTHWGT} = \begin{cases} 1 & \text{if the size of the child at birth is smaller than average or} \\ & \quad\text{the size at birth is very small.} \\ 0 & \text{otherwise} \end{cases}$$

Once again, $\tilde{Z}_w = (I_w, H_w, C_w)$ denotes a set of individual and household characteristics and health inputs that are likely to affect the birth weight of the child. η_w captures mother level unobserved heterogeneity and $\varepsilon_w \sim \text{IIDN}(0, 1)$ captures all other residual variation. With prenatal care, hospital delivery and birth weight all endogenous, the joint marginal likelihood is written as

$$\int_{\eta_p}\int_{\eta_h}\int_{\eta_w}\int_{\eta_m}\left[\prod L^p(\eta_p)\prod L^h(\eta_h)\prod L^w(\eta_w)\prod L^m(\eta_m)\right] \times f(\eta_p, \eta_h, \eta_w, \eta_m)\,\mathrm{d}\eta_p\,\mathrm{d}\eta_h\,\mathrm{d}\eta_w\,\mathrm{d}\eta_m \tag{20}$$

where $f(\eta_p, \eta_h, \eta_w, \eta_m)$ denotes the joint distribution of the unobserved heterogeneity components and is assumed to be a four dimensional normal distribution characterised as follows:

$$\begin{pmatrix} \eta_p \\ \eta_h \\ \eta_w \\ \eta_m \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_p^2 & & & \\ \rho_{ph}\sigma_p\sigma_h & \sigma_h^2 & & \\ \rho_{pw}\sigma_p\sigma_w & \rho_{hw}\sigma_h\sigma_w & \sigma_w^2 & \\ \rho_{pm}\sigma_p\sigma_m & \rho_{hm}\sigma_h\sigma_m & \rho_{wm}\sigma_w\sigma_m & \sigma_m^2 \end{bmatrix}\right) \tag{21}$$

Table 7
Effect of birth weight on child mortality

	Coefficient
Exogenous prenatal care, hospital delivery and low birth weight[a] (Model I)	0.5646*** (0.0595)
Endogenous prenatal care, hospital delivery and exogenous low birth weight[a] (Model II)	0.5629*** (0.0600)
Endogenous prenatal care, hospital delivery and low birth weight[a] (Model III)	0.6282*** (0.1010)

Note: Standard errors are in parenthesis.
[a] Low birth weight = 1 if size of child at birth is average or below average, 0 otherwise.
*** Significance at 1% level.

Once again the full specification model is estimated jointly using Full Information Maximum Likelihood (FIML) method.

As an alternative to the binary characterisation of low birth weight, I also characterise birth weight as a categorical variable as follows:

$$\mathrm{SIZBRTH} = \begin{cases} 0 & \text{size at birth is larger than average (the base category)} \\ 1 & \text{the size at birth is average} \\ 2 & \text{the size at birth is smaller than average} \\ 3 & \text{the size at birth is very small} \end{cases}$$

In this case, I replace Eq.((19)) by

$$\mathrm{SIZBRTH} = \delta_0 + \delta_1 \tilde{Z}_w + \eta_w + \varepsilon_w \tag{22}$$

and estimate it using ordered probit.[19] The full set of estimates for the low birth weight probit and the size at birth ordered probit regressions are presented in Table A.4.

Table 7 presents the effects of birth weight on the hazard of child mortality. Notice that in each of the three models (Models I, II and III), the low birth weight dummy is positive and statistically significant, implying that the hazard of child mortality is significantly higher for low birth weight babies. Endogenising birth weight actually increases the magnitude of the effect—the coefficient estimate increases in magnitude from 0.5629 (Model II) to 0.6282 (Model III). So, holding the observed birth weight effects constant results in a slight under estimation of the effect of birth weight on child mortality. Table 8 re-examines the effect of health inputs (prenatal care and hospital delivery) on child mortality hazard under the alternative specifications. Notice that endogenising health inputs leads to a significantly stronger effect on child mortality (also see Table 3), but interestingly once prenatal care and hospital delivery are endogenised it does not matter whether birth weight is exogenous, excluded or endogenous in the child mortality hazard regressions. The corresponding results using the ordered probit specification are not presented but are available on request. The qualitative results remain unaffected. A look at Table A.3 shows that the remaining results are robust across Models II, IIA and III and are not discussed.

[19] The child mortality hazard regression is also re-estimated with SIZBRTH as the relevant regressor.

Table 8
Re-examining the effect of health inputs on child mortality

	Prenatal care	Hospital delivery
Exogenous prenatal care, hospital delivery and low birth weight[a] (Model I)	−0.3364*** (0.0860)	−0.0359 (0.1362)
Endogenous prenatal care, hospital delivery and exogenous low birth weight[a] (Model II)	0.5214*** (0.1262)	−0.3749*** (0.0827)
Endogenous prenatal care, hospital delivery and exclude low birth weight[a] (Model IIA)	−0.5161*** (0.1260)	−0.3667*** (0.0830)
Endogenous prenatal care, hospital delivery and low birth weight[a] (Model III)	−0.5221*** (0.1265)	−0.3766*** (0.0850)

Note: Standard errors are in parenthesis. Does endogenising birth weight make a difference?
[a] Low birth weight = 1 if size of child at birth is average or below average, 0 otherwise.
*** Significance at 1% level.

Table A.4 presents the probit and ordered probit estimates of birth weight and size at birth. The following results are worth noting:

1. Birth weight is likely to be lower for girls.
2. Relative to teenage mothers, mothers aged 20 or higher are less likely to give birth to low birth babies.
3. Relative to a woman with no schooling, educated women are less likely to give birth to low birth weight babies. Further the effect is the strongest when the mother has secondary schooling or more. Similar results are obtained for father's education.
4. Interestingly women who chose to have prenatal care are less likely to give birth to low birth weight babies, though the effect is not statistically significant.

5. Conclusion

The primary objective of this paper is to examine the relationship between the status of women in the household, the use of health care and child mortality in India. Parents care about the health of their children but cannot directly affect child health by their actions. Instead they can, through their actions, affect health inputs. Parental bargaining therefore affects decisions about the use of prenatal care and hospital delivery, which in turn are likely to affect child mortality. I jointly estimate the decision to use prenatal care, the decision to deliver the baby in hospital and child mortality. The primary reason for joint estimation is self-selection. Women who demand health care (prenatal care or choose hospital delivery) might not necessarily be a random subset of all mothers. It might be that these women are those who anticipate complications at birth or other factors that might lead to an increased risk of child mortality and hence are more like to seek health care (remember that health is private information to the woman and unobserved to the researcher). It could also be the case that these women might be low risk women, with a strong preference for healthy children. Both prenatal care and hospital delivery significantly reduces the hazard of child mortality and the coefficient estimates show that failure to account for self-selection and ignoring the correlation between the heterogeneity terms results in significant underestimation of the true beneficial effect of prenatal care and hospital delivery on child health. Turning to the other results, I find that a woman's education has a stronger effect on health care usage relative to that of her husband. A woman's control over household resources (ability to keep money aside) has a significant positive effect on both the demand for prenatal care and the probability of hospital delivery, and the demand for prenatal care is significantly higher if the woman has say in decisions regarding health care.

From a policy point of view this is an extremely important issue. Both researchers and policy makers agree that increasing the stock of human capital is essential to increase the rate of growth of any economy. Good health is now regarded as a basic pre-requisite for human capital formation and thereby increasing the income levels in a country. Poor child health therefore has long-term implications in the form of poor adult health and low levels human capital formation. The finding hat increased use of health inputs (like prenatal care or hospital birth) have significantly positive effect on child health, implies that one has in principle identified an extremely important policy instrument.

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Appendix A

The full set of coefficient estimates are presented in Tables A.1–A.4. .

Table A.1
Demand for prenatal care

Constant	−1.1112*** (0.1281)
Age of respondent: 20–24	0.1028** (0.0506)
Age of respondent: 25–29	0.1450** (0.0623)
Age of respondent: 30–34	0.2193*** (0.0768)
Age of respondent: 35–39	0.2578*** (0.0998)
Age of respondent: 40–44	0.2979** (0.1480)
Age of respondent: 45–49	0.2368 (0.2461)
Highest education of woman: primary school	0.3808*** (0.0447)
Highest education of woman: middle school	0.5482*** (0.0697)
Highest education of woman: secondary school or higher	0.9014*** (0.0783)

Table A.1 (*Continued*)

Age of husband: 15–19	−0.2229 (0.1890)
Age of husband: 20–24	0.0424 (0.0750)
Age of husband: 25–29	0.1621** (0.0632)
Age of husband: 30–34	0.1472** (0.0594)
Age of husband: 35–39	0.1645*** (0.0581)
Age of husband: more than 44	−0.0345 (0.1044)
Highest education of husband: primary school	0.2024*** (0.0377)
Highest education of husband: middle school	0.3689*** (0.0478)
Highest education of husband: secondary school or higher	0.3593*** (0.0471)
Occupation of husband: professional/technical/management	0.0306 (0.1068)
Occupation of husband: clerical	0.1349 (0.1398)
Occupation of husband: sales	0.0208 (0.0972)
Occupation of husband: agriculture self-employed	−0.2550*** (0.0841)
Occupation of husband: services	0.0619 (0.1136)
Occupation of husband: skilled manual	−0.0568 (0.0876)
Occupation of husband: unskilled manual	−0.1423 (0.0917)
Birth order = 2	−0.2488*** (0.043)
Birth order = 3	−0.3771*** (0.0495)
Birthorder = 4	−0.4813*** (0.0596)
Birth order = 5	−0.4883*** (0.0691)
Birth order ≥ 6	−0.6552*** (0.0718)
Woman reads newspaper at least once a week	0.2299*** (0.0652)
Woman watches television at least once a week	0.4272*** (0.0384)
Woman or jointly with husband decides on health care	0.0750** (0.0364)
Woman or jointly with husband decides what to cook	−0.0392 (0.0345)
Woman or jointly with husband decides on jewellery purchase	0.0028 (0.0439)
Woman or jointly with husband decides about respondent staying with family	0.0115 (0.0458)
Permission needed to go to market	0.0711 (0.0435)
Permission needed to visit relatives or friends	−0.0893* (0.0521)
Allowed to have money set aside	0.1000*** (0.0302)
Husband may hit wife if she is unfaithful	−0.0678** (0.0337)
Husband may hit wife if her family does not give money	−0.0673 (0.0607)
Husband may hit wife if she goes out without telling him	−0.0277 (0.0426)
Husband may hit wife if she neglects house or children	0.0086 (0.0476)
Husband may hit wife if she does not cook properly	0.0202 (0.0454)
Residence: Andhra Pradesh	2.2971*** (0.1052)
Residence: Bihar	0.0215 (0.0573)
Residence: Gujarat	1.0391*** (0.0831)
Residence: Haryana	0.4717*** (0.0813)
Residence: Karnataka	1.2649*** (0.3948)
Residence: Kerala	2.9153*** (0.2916)
Residence: Madhya Pradesh	0.7984*** (0.0599)
Residence: Maharashtra	1.9774*** (0.1009)
Residence: Orissa	1.4588*** (0.0797)
Residence: Punjab	0.7864*** (0.1188)
Residence: Rajasthan	0.3209*** (0.0599)
Residence: Sikkim	1.4646*** (0.1362)
Residence: Tamil Nadu	2.7178*** (0.1317)
Residence: West Bengal	2.3831*** (0.1036)
Religion: Muslim	−0.0280 (0.0577)

Table A.1 (*Continued*)

Religion: Christian	0.0926 (0.1659)
Religion: Sikh	0.4118*** (0.1243)
Religion: Buddhist	−0.5642*** (0.1638)
Scheduled caste/scheduled tribe	−0.1071*** (0.0412)
Other backward caste	−0.0298 (0.0404)
Sub-centre in village	0.0209 (0.0380)
Primary health centre in village	0.2356*** (0.0549)
Community health centre in village	−0.0713 (0.0639)
Government dispensary in village	0.0155 (0.0537)
Private clinic in village	0.0268 (0.0422)

Note: Standard errors are in parenthesis.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A.2
Hospital delivery

Constant	−1.6672*** (0.1518)
Age of respondent: 20–24	0.2263*** (0.0562)
Age of respondent: 25–29	0.3905*** (0.0703)
Age of respondent: 30–34	0.5717*** (0.0897)
Age of respondent: 35–39	0.6625*** (0.1214)
Age of respondent: 40–44	0.4989*** (0.1919)
Age of respondent: 45–49	1.1376*** (0.2763)
Highest education of woman: primary school	0.3186*** (0.0466)
Highest education of woman: middle school	0.3866*** (0.0666)
Highest education of woman: secondary school or higher	0.6371*** (0.0756)
Age of husband: 15–19	0.1620 (0.1853)
Age of husband: 20–24	0.0907 (0.0909)
Age of husband: 25–29	0.1423* (0.0792)
Age of husband: 30–34	0.1418* (0.0761)
Age of husband: 35–39	0.1272* (0.0759)
Age of husband: more than 44	−0.0119 (0.1300)
Highest education of husband: primary school	0.1474*** (0.0449)
Highest education of husband: middle school	0.3305*** (0.0529)
Highest education of husband: secondary school or higher	0.3302*** (0.0528)
Occupation of husband: professional/technical/management	0.0043 (0.1129)
Occupation of husband: clerical	0.0375 (0.1480)
Occupation of husband: sales	0.0955 (0.1039)
Occupation of husband: agriculture self-employed	−0.2157** (0.0930)
Occupation of husband: services	0.0197 (0.1220)
Occupation of husband: skilled manual	−0.0459 (0.0949)
Occupation of husband: unskilled manual	−0.2123** (0.1053)
Birth order = 2	−0.6090*** (0.0465)
Birth order = 3	−0.8254*** (0.0575)
Birth order = 4	−0.9102*** (0.0713)
Birth order = 5	−0.9547*** (0.0865)

Table A.2 (*Continued*)

Birth order $\geq$ 6	−0.9901*** (0.0905)
Woman reads newspaper at least once a week	0.0383 (0.0588)
Woman watches television at least once a week	0.3702*** (0.0403)
Woman or jointly with husband decides on health care	−0.0490 (0.0415)
Woman or jointly with husband decides what to cook	−0.0584 (0.0383)
Woman or jointly with husband decides on jewellery purchase	0.0260 (0.0501)
Woman or jointly with husband decides about respondent staying with family	0.0542 (0.0515)
Permission needed to go to market	0.0358 (0.0487)
Permission needed to visit relatives or friends	−0.1008* (0.0566)
Allowed to have money set aside	0.0801** (0.0346)
Husband may hit wife if she is unfaithful	−0.0818** (0.0384)
Husband may hit wife if her family does not give money	−0.1436** (0.0725)
Husband may hit wife if she goes out without telling him	−0.0354 (0.0486)
Husband may hit wife if she neglects house or children	0.0623 (0.0521)
Husband may hit wife if she does not cook properly	0.0000 (0.0519)
Residence: Andhra Pradesh	1.1623*** (0.0909)
Residence: Bihar	0.0083 (0.0701)
Residence: Gujarat	0.9341*** (0.0869)
Residence: Haryana	−0.2610*** (0.1013)
Residence: Karnataka	0.6316 (0.4447)
Residence: Kerala	2.9744*** (0.1725)
Residence: Madhya Pradesh	0.1381* (0.0719)
Residence: Maharashtra	0.8501*** (0.0929)
Residence: Orissa	0.3278*** (0.0897)
Residence: Punjab	0.0343 (0.1288)
Residence: Rajasthan	0.3235*** (0.0690)
Residence: Sikkim	0.7146*** (0.1376)
Residence: Tamil Nadu	2.1299*** (0.1115)
Residence: West Bengal	0.9123*** (0.0944)
Religion: Muslim	−0.2857*** (0.0678)
Religion: Christian	0.0333 (0.1696)
Religion: Sikh	0.8690*** (0.1331)
Religion: Buddhist	−0.3872** (0.1867)
Scheduled caste/scheduled tribe	−0.2820*** (0.0471)
Other backward caste	−0.0142 (0.0435)
Government hospital in village	−0.0870 (0.1009)
Private hospital in village	0.1874** (0.0768)
Primary health centre in village	−0.0807 (0.0559)
Danger signs in pregnancy	0.2938*** (0.0430)

Note: Standard errors are in parenthesis.

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

Table A.3
Log hazard of child mortality

	Prenatal care and hospital delivery exogenous; birth weight exogenous (Model I)	Prenatal care and hospital delivery endogenous; birth weight exogenous (Model II)	Prenatal care and hospital delivery endogenous; birth weight excluded (Model IIA)	Prenatal care, hospital delivery and birth weight endogenous (Model III)
DUR0	−4.1540*** (0.1067)	−4.1514*** (0.1077)	−4.1598*** (0.1074)	−4.1502*** (0.1081)
DUR1	−0.0573*** (0.0074)	−0.0573*** (0.0075)	−0.0579*** (0.0075)	−0.0573*** (0.0075)
Constant	−0.9286*** (0.2861)	−0.8302*** (0.2880)	−0.5873** (0.2894)	−0.8547*** (0.2901)
Child is a girl	0.0494 (0.0580)	0.0520 (0.0586)	0.0700 (0.0585)	0.0489 (0.0588)
Age of respondent: 20–24	−0.2636*** (0.0896)	−0.2465*** (0.0906)	−0.2603*** (0.0906)	−0.2451*** (0.0909)
Age of respondent: 25–29	−0.5252*** (0.1106)	−0.5037*** (0.1120)	−0.5292*** (0.1119)	−0.4993*** (0.1129)
Age of respondent: 30–34	−0.5380*** (0.1379)	−0.5076*** (0.1401)	−0.5435*** (0.1401)	−0.5038*** (0.1408)
Age of respondent: 35–39	−0.4423*** (0.1711)	−0.4091** (0.1735)	−0.4325** (0.1738)	−0.4093** (0.1742)
Age of respondent: 40–44	−0.1531 (0.2250)	−0.1256 (0.2265)	−0.1622 (0.2242)	−0.1197 (0.2282)
Age of respondent: 45–49	−2.5778** (1.0447)	−2.5217** (1.0622)	−2.5346** (1.0553)	−2.5157** (1.0686)
Highest education of woman: primary school	−0.1282 (0.0958)	−0.0894 (0.0966)	−0.1094 (0.0964)	−0.0885 (0.0970)
Highest education of woman: middle school	−0.1427 (0.1522)	−0.0934 (0.1552)	−0.0948 (0.1550)	−0.0913 (0.1562)
Highest education of woman: secondary school or higher	−0.3900** (0.1859)	−0.3005 (0.1900)	−0.3411* (0.1901)	−0.2920 (0.1909)
Highest education of husband: primary school	0.0672 (0.0732)	0.0833 (0.0739)	0.0725 (0.0739)	0.0850 (0.0742)
Highest education of husband: middle school	−0.0826 (0.0951)	−0.0475 (0.0971)	−0.0658 (0.0968)	−0.0481 (0.0973)
Highest education of husband: secondary school or higher	−0.2094** (0.0936)	−0.1739* (0.0955)	−0.1898** (0.0953)	−0.1714* (0.0960)
Birth order = 2	−0.0630 (0.0868)	−0.1078 (0.0885)	−0.1112 (0.0886)	−0.1074 (0.0887)
Birth order = 3	−0.0913 (0.0988)	−0.1502 (0.1015)	−0.1459 (0.1015)	−0.1494 (0.1019)
Birth order = 4	−0.0782 (0.1201)	−0.1394 (0.1219)	−0.1334 (0.1218)	−0.1396 (0.1222)
Birth order = 5	−0.0233 (0.1396)	−0.0868 (0.1418)	−0.0857 (0.1410)	−0.0864 (0.1426)
Birth order $\geq$ 6	0.0917 (0.1374)	0.0220 (0.1400)	0.0282 (0.1398)	0.0246 (0.1405)
Residence: Andhra Pradesh	0.0403 (0.1887)	0.2057 (0.1995)	0.1419 (0.1987)	0.2104 (0.2002)
Residence: Bihar	−0.1038 (0.1040)	−0.1013 (0.1045)	−0.1171 (0.1037)	−0.0984 (0.1050)
Residence: Gujarat	−0.0801 (0.1813)	0.0323 (0.1870)	0.0777 (0.1874)	0.0278 (0.1879)
Residence: Haryana	0.1481 (0.1785)	0.1561 (0.1807)	0.1293 (0.1807)	0.1570 (0.1818)
Residence: Karnataka	0.0325 (0.7489)	0.1240 (0.7627)	0.2622 (0.7635)	0.0943 (0.7666)
Residence: Kerala	−1.2787*** (0.4210)	−1.0886** (0.5039)	−1.0332** (0.5020)	−1.0902** (0.5057)
Residence: Madhya Pradesh	0.1419 (0.1171)	0.1801 (0.1191)	0.2628** (0.1191)	0.1698 (0.1202)
Residence: Maharashtra	−0.3288 (0.2072)	−0.1977 (0.2144)	−0.1616 (0.2120)	−0.2010 (0.2162)
Residence: Orissa	0.1632 (0.1413)	0.2466* (0.1482)	0.2538* (0.1474)	0.2472* (0.1490)

Residence: Punjab	0.2080 (0.2391)	0.2535 (0.2427)	0.2451 (0.2434)	0.2574 (0.2447)
Residence: Rajasthan	−0.0006 (0.1154)	0.0214 (0.1166)	0.0949 (0.1159)	0.0128 (0.1172)
Residence: Sikkim	−0.8059** (0.3319)	−0.6990** (0.3416)	−0.7084** (0.3417)	−0.6901** (0.3440)
Residence: Tamil Nadu	−0.4449* (0.2411)	−0.1649 (0.2535)	−0.0776 (0.2533)	−0.1733 (0.2542)
Residence: West Bengal	−0.3984* (0.2080)	−0.2477 (0.2154)	−0.2193 (0.2160)	−0.2508 (0.2162)
Religion: Muslim	−0.2157* (0.1129)	−0.2256** (0.1144)	−0.2273** (0.1142)	−0.2214* (0.1148)
Religion: Christian	0.0522 (0.3112)	0.0667 (0.3172)	0.0366 (0.3153)	0.0667 (0.3197)
Religion: Sikh	−0.436 (0.2800)	−0.3518 (0.2837)	−0.3398 (0.2841)	−0.3551 (0.2860)
Religion: Buddhist	0.4757 (0.3849)	0.4383 (0.3936)	0.4458 (0.3992)	0.4352 (0.3952)
Scheduled caste/scheduled tribe	0.0298 (0.0804)	0.0092 (0.0812)	0.0080 (0.0810)	0.0097 (0.0816)
Other backward caste	0.0535 (0.0788)	0.0440 (0.0796)	0.0499 (0.0794)	0.0447 (0.0799)
Has electricity	−0.0465 (0.0748)	−0.0511 (0.0754)	−0.0507 (0.0751)	−0.0500 (0.0757)
Source of drinking water: piped into residence	0.0203 (0.1612)	0.0152 (0.1629)	0.0248 (0.1632)	0.0173 (0.1636)
Source of drinking water: public tap	−0.074 (0.1549)	−0.0793 (0.1560)	−0.0748 (0.1563)	−0.0747 (0.1566)
Source of drinking water: private hand pump	0.1382 (0.1370)	0.1276 (0.1377)	0.1187 (0.1378)	0.1309 (0.1381)
Source of drinking water: public hand pump	0.1204 (0.1211)	0.1096 (0.1218)	0.1246 (0.1217)	0.1152 (0.1221)
Source of drinking water: private open well	−0.0237 (0.1661)	−0.0278 (0.1685)	−0.0053 (0.1679)	−0.0178 (0.1692)
Source of drinking water: public open well	0.1095 (0.1285)	0.1005 (0.1293)	0.1356 (0.1285)	0.1060 (0.1304)
Toilet: own flush toilet	−0.0832 (0.2596)	−0.0942 (0.2611)	−0.1498 (0.2629)	−0.0928 (0.2624)
Toilet: own pit toilet/latrine	−0.3490 (0.2734)	−0.3610 (0.2749)	−0.4070 (0.2763)	−0.3632 (0.2760)
No toilet facilities at home	−0.1774 (0.2191)	−0.1960 (0.2198)	−0.2526 (0.2221)	−0.1970 (0.2206)
Woman reads newspaper at least once a week	0.1087 (0.1461)	0.1220 (0.1487)	0.1215 (0.1492)	0.1158 (0.1497)
Woman watches television at least once a week	−0.0824 (0.0849)	−0.0412 (0.0863)	−0.0334 (0.0862)	−0.0429 (0.0866)
Distance to nearest town	0.0016 (0.0023)	0.0019 (0.0023)	0.0018 (0.0023)	0.0019 (0.0023)
Distance to district headquarter	−0.0013 (0.0012)	−0.0012 (0.0012)	−0.0013 (0.0012)	−0.0012 (0.0012)
Distance to nearest railway station	−0.0002 (0.0013)	−0.0001 (0.0013)	−0.0002 (0.0013)	−0.0001 (0.0014)
Distance to transport	0.0013 (0.0016)	0.0012 (0.0016)	0.0015 (0.0016)	0.0012 (0.0016)
Distance to nearest all-weather road	−0.0008 (0.0016)	−0.0007 (0.0016)	−0.0010 (0.0016)	−0.0008 (0.0016)
Prenatal visit by health worker	−0.1699* (0.0898)	−0.1699* (0.0906)	−0.1772* (0.0906)	−0.1695* (0.0910)
Danger signs in pregnancy	−0.0085 (0.1244)	0.0118 (0.1258)	0.0092 (0.1256)	0.0143 (0.1266)
Received delivery care	0.0010 (0.1344)	0.0012 (0.1358)	0.0002 (0.1357)	0.0011 (0.1363)
Received new born care	0.0698 (0.1373)	0.0757 (0.1384)	0.0746 (0.1384)	0.0746 (0.1388)
Given iron tablets during pregnancy	−0.0092 (0.0803)	−0.0097 (0.0813)	−0.0178 (0.0813)	−0.0087 (0.0815)
Given tetanus shot during pregnancy	−0.4653*** (0.0750)	−0.4668*** (0.0757)	−0.4691*** (0.0757)	−0.4653*** (0.0759)
Low birth weight baby	0.5646*** (0.0595)	0.5629*** (0.0600)		0.6282*** (0.1010)
Went for prenatal check up	−0.3364*** (0.0860)	−0.5214*** (0.1262)	−0.5161*** (0.1260)	−0.5221*** (0.1265)
Hospital delivery	−0.0359 (0.1362)	−0.3749*** (0.0827)	−0.3667 (0.0830)	−0.3766*** (0.0850)

Table A.3 (*Continued*)

	Prenatal care and hospital delivery exogenous; birth weight exogenous (Model I)	Prenatal care and hospital delivery endogenous; birth weight exogenous (Model II)	Prenatal care and hospital delivery endogenous; birth weight excluded (Model IIA)	Prenatal care, hospital delivery and birth weight endogenous (Model III)
σ_p^2		0.9509*** (0.0368)	0.9507*** (0.0368)	0.9506*** (0.0370)
σ_h^2		0.9550*** (0.0463)	0.9547*** (0.0463)	0.9555*** (0.0465)
σ_m^2		0.5749*** (0.1227)	0.5579*** (0.1232)	0.5777*** (0.1233)
σ_w^2				0.6674*** (0.0357)
$\rho_{ph}\sigma_p\sigma_h$		0.5958*** (0.0319)	0.5959*** (0.0319)	0.5961*** (0.0320)
$\rho_{pm}\sigma_p\sigma_m$		0.3693** (0.1456)	0.3562** (0.1489)	0.3701** (0.1453)
$\rho_{hm}\sigma_h\sigma_m$		0.5469*** (0.1781)	0.5643*** (0.1875)	0.5411*** (0.1782)
$\rho_{pw}\sigma_p\sigma_w$				−0.1365** (0.0592)
$\rho_{hw}\sigma_h\sigma_w$				−0.0240 (0.0631)
$\rho_{mw}\sigma_m\sigma_w$				−0.1408 (0.1539)

Note: Standard errors are in parenthesis.

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

Table A.4
Probit and ordered probit estimates of birth weight of child

	Probit estimates of low birth weight	Ordered probit estimates of size at birth
Constant	−0.7323*** (0.0590)	
Child is a girl	0.1247*** (0.0242)	0.1047*** (0.0185)
Age of respondent: 20–24	−0.0656 (0.0422)	−0.0695** (0.0325)
Age of respondent: 25–29	−0.1770*** (0.0498)	−0.1516*** (0.0382)
Age of respondent: 30–34	−0.2180*** (0.0619)	−0.1565*** (0.0466)
Age of Respondent: 35–39	−0.1620** (0.0768)	−0.1667*** (0.0587)
Age of Respondent: 40–44	−0.2337** (0.1161)	−0.1208 (0.0930)
Age of Respondent: 45–49	−0.0489 (0.1833)	−0.1586 (0.1412)
Highest education of woman: primary school	−0.0842** (0.0385)	−0.0433 (0.0292)
Highest education of woman: middle school	−0.0445 (0.0537)	−0.0274 (0.0405)
Highest education of woman: secondary school or higher	−0.2809*** (0.0601)	−0.1879*** (0.0456)
Highest education of husband: primary school	−0.0419 (0.0333)	−0.0359 (0.0258)
Highest education of husband: middle school	−0.0635 (0.0401)	−0.0685** (0.0311)
Highest education of husband: secondary school or higher	−0.1024*** (0.0389)	−0.0882*** (0.0297)
Birth order = 2	−0.0054 (0.0361)	−0.0060 (0.0277)
Birth order = 3	−0.0144 (0.0429)	−0.0283 (0.0328)
Birth order = 4	0.0472 (0.0519)	0.0410 (0.0403)
Birth order = 5	0.0395 (0.0606)	0.0178 (0.0462)
Birth order ≥ 6	0.0409 (0.0616)	0.0449 (0.0478)
Residence: Andhra Pradesh	−0.4053*** (0.0827)	−0.3805*** (0.0651)
Residence: Bihar	−0.1430*** (0.0470)	−0.2122*** (0.0375)
Residence: Gujarat	0.2633*** (0.0700)	−0.0644 (0.0534)
Residence: Haryana	−0.1205 (0.0740)	0.0041 (0.0702)
Residence: Karnataka	0.8563* (0.4657)	0.2035 (0.4144)
Residence: Kerala	0.4428*** (0.0977)	0.0204 (0.0713)
Residence: Madhya Pradesh	0.4529*** (0.0488)	0.1271*** (0.0369)
Residence: Maharashtra	0.1413* (0.0768)	0.0210 (0.0580)
Residence: Orissa	−0.0319 (0.0655)	−0.2448*** (0.0511)
Residence: Punjab	−0.1323 (0.1087)	−0.0428 (0.1003)
Residence: Rajasthan	0.4214*** (0.0479)	0.1799*** (0.0377)
Residence: Sikkim	−0.1326 (0.1162)	−0.3725*** (0.0861)
Residence: Tamil Nadu	0.4292*** (0.0849)	−0.0075 (0.0640)
Residence: West Bengal	0.0838 (0.0768)	−0.0670 (0.0573)
Religion: Muslim	−0.0578 (0.0456)	−0.0638* (0.0351)
Religion: Christian	−0.1112 (0.1157)	−0.1754** (0.0806)
Religion: Sikh	0.0893 (0.1193)	0.0812 (0.1082)
Religion: Buddhist	−0.0667 (0.1693)	−0.0854 (0.1211)
Scheduled caste/scheduled tribe	0.0093 (0.0353)	0.0075 (0.0274)
Other backward caste	0.0282 (0.0343)	0.0300 (0.0265)
Went for prenatal check up	0.0431 (0.0528)	0.0224 (0.0407)
Prenatal visit by health worker	−0.0425 (0.0358)	0.0553** (0.0273)
Danger signs in pregnancy	−0.0558 (0.0392)	−0.0580** (0.0288)

Table A.4 (*Continued*)

	Probit estimates of low birth weight	Ordered probit estimates of size at birth
Given iron tablets during pregnancy	−0.0615* (0.0333)	−0.0535** (0.0257)
Given tetanus shot during pregnancy	−0.0268 (0.0332)	−0.0537** (0.0259)
τ_1		−1.5342*** (0.0482)
τ_2		0.5357*** (0.0461)
τ_3		1.6629*** (0.0490)
σ_p^2	0.9506*** (0.0370)	0.9509*** (0.0370)
σ_h^2	0.9555*** (0.0465)	0.9546*** (0.0464)
σ_m^2	0.6674*** (0.0357)	0.5340*** (0.0214)
σ_w^2	0.5777*** (0.1233)	0.5630*** (0.1266)
$\rho_{ph}\sigma_p\sigma_h$	0.5961*** (0.0320)	0.5974*** (0.0320)
$\rho_{pm}\sigma_p\sigma_m$	0.3701** (0.1453)	0.3684** (0.1502)
$\rho_{hm}\sigma_h\sigma_m$	0.5411*** (0.1782)	0.5492*** (0.1857)
$\rho_{pw}\sigma_p\sigma_w$	−0.1365** (0.0592)	−0.0922 (0.0576)
$\rho_{hw}\sigma_h\sigma_w$	−0.0240 (0.0631)	0.0065 (0.0623)
$\rho_{mw}\sigma_m\sigma_w$	−0.1408 (0.1539)	−0.1122 (0.1483)

Note: Standard errors are in parenthesis.

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

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