Gender and Family Formation in Uttar Pradesh, India

Sunila Claire Wainwright

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Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person where due reference is not made in the text.

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Abstract

While modernising influences affect many facets of the lives of millions of Indian families, there remain deep-rooted socio-cultural practices and traditions that survive and become engendered in new institutional mechanisms. Labour market policy is but one example where age-old ethnic affiliations distort governmental efforts and find new ways of expressing themselves.

Efforts over the past decade to slow the rate of population growth, by encouraging adoption of modern family planning methods have failed to tackle son preference and have caused the sex ratios at birth to be worse than at any other time in the nation's history. This is particularly so in urban India, even among the more educated populace, and it is worsening.

This thesis sets out to assess the way in which such gender considerations affect family formation decisions, primarily concerning the quantity and quality of children, with an appreciation of the dynamic nature of the problem. First we assess how fertility preferences and past child outcomes affect the demand for family planning and how behaviours associated with the greater autonomy of women impact upon this process.

The empirical work makes use of data from the latest round of the National Family Health Survey (NFHS) for India, 1999, for the state of Uttar Pradesh, in a simultaneous equation framework, in an effort to take account of the joint determination of many of the variables inherent in modelling such dynamic processes with cross-sectional data. We find that although women's autonomy has been held up as a means of achieving lower fertility, the two do not necessarily go hand in hand, unless coupled with the wider participation of women.

Unless the primary social and economic motivations for preferring sons are tackled and dismantled through legislation and through changes to social attitudes, superficial policies to promote the well-being of women will have little real impact and may lead to worsening female child outcomes.

One of the policies heralded to achieve the deeper goal of gender equality has been the promotion of education of female children, who as a group lag well behind their male counterparts on both literacy and numeracy rates. We thus

turn our attention to investigating the way in which household time allocation decisions are made, focusing on the parental choice of each child's main activity; to go to school, to work in the home, or in the formal labour market, in an effort to understand how the household's opportunities and resource constraints, along with social norms impact such decisions. While some state governments are offering cash incentives to families to keep their female children in school and unmarried, significant labour market discrimination against women continues and constrains the value of this government investment.

Making use of the same NFHS data for Uttar Pradesh, we estimate each child's trinomial time allocation with competing specifications and then compare the results. The standard multinomial logit model is estimated initially but imposes some fairly tight assumptions on behaviour and the resultant data, that are unlikely to hold in the present application. A Mixed Logit model is then estimated that is able to bring greater flexibility and descriptive richness than is possible with the standard Logit model.

Estimation results are compared and confirm the ability of the Mixed Logit to capture more fully the unobserved heterogeneity inherent in the data and to allow for correlation in the errors across children of the same family that is not permitted within the standard logit setup.

Chapter 1

Introduction

1.1 Summary

This chapter will open with a discussion of some of the background issues relating to the context within which household decisions in India are made, concerning the quantity and quality of children. It pays attention to the historical significance of sociocultural practices, borne out of wider kinship systems and the implications these have for family formation patterns.

While there is broad agreement among the social sciences that at least moderate son preference exists throughout Indian society, there is less consensus as to the origins of the sociocultural practices that engender it, to varying degrees. There are competing theories that give a central role either to agrarian ecology, or long-standing kinship systems that define the context of economic and social relations. Some of the arguments in support of each view are presented. It is not the aim of this thesis to provide an answer to questions on the reasons behind the existence of son preference and low female autonomy but rather to focus on how such considerations condition social and economic behaviours, relating to fertility choice and control and decisions concerning the time allocations of boys and girls and concurrent investments in their schooling.

This first Chapter 1 sheds light on some recent fertility patterns and measures from the state of Uttar Pradesh, concerning the number, timing and spacing of births, with data from the most recent NFHS of 1999. This then leads on to a brief

coverage of the issues facing the Government of India in its National Population Policy and the success of past efforts. A reorientation in policy resulted from the failure of more target-oriented approaches to achieve the desired successes in terms of maternal health and health related practices, particularly in the rural north of the country. The extent to which such organisational level strategic change has filtered through to implementation remains a contentious issue. The discussion is by no means complete and each of the points mentioned will be taken up in later sections of the thesis.

The state and development of the education system in India is then covered, with the presentation of some recent literacy, enrolment and completion rates, for India and for the state of Uttar Pradesh. Although the quantity of both primary and middle schools in India has risen dramatically over the last 30 years, the quality of such provision still remains very low. In addition, significant opportunity costs continue to discourage parents from sending children to school, even where the education is provided free by the state.

The Government of India's education policy is examined in light of the goals set down in the 8th Five Year Plan through the National Policy on Education. Some basic tabulations reveal the great variation in both attendance rates and school quality, by rural and urban residence and by gender, ethnicity and income. The reasons for significant drop-out rates are examined and reveal dissatisfaction with the quality and suitability of the education offered, even where children live in close proximity to schools. There is little incentive to send children to school when they can be gainfully employed in income-earning tasks and contributing to household income.

We then draw on the discussion of Basu(1999) regarding the role and incidence of child labour in India and cover the justifications for the development of international child labour standards. While the banning of child labour is done partly to encourage parents to send their children to school, less drastic measures such as the provision of incentives like free school meals and books, coupled with laws enforcing school enrolment have been more successful in reducing the incidence of child labour. These measures operate by helping to dismantle the conditions

under which child labour becomes necessary and hence tackle the problem at its root.

A Thesis Overview is presented at the close of this first chapter and introduces each of the substantive chapters to follow.

1.2 Background

1.2.1 Economic and Socio-Cultural Influences

Despite a broad and progressive development of the economics literature on the family and its life-cycle behaviour, starting in the early 1960's, economist's suspected and made clear note that there were a number of important supplementary issues that needed addressing were their models to accurately represent life-cycle fertility behaviour. As early as 1973, Theodore Schultz remarked on the success of demographers and other social scientists in asking "key questions, however, on which the economist would be well advised to ponder".

The complexities to which these demographers were referring cover the rich array of sociocultural factors that are specific to different countries but nevertheless impact, to varying degrees, on the way households make decisions and on the demographic outcomes that are observed. Certainly the fundamental motivations for having children in the Indian context consist of elements partly economic but also partly sociocultural and stem from wider kinship systems, tradition and property rights.

India is composed of a variety of castes and religions and the demographic composition of the population across the 26 states varies tremendously. The differing castes have varied kinship systems and laws that define the organisation of social structures and security, both at the macro level and within the family unit. A well supported, though simple pattern of regional variation is proposed by Dyson & Moore (1983), who define a broad north/west - south/east contrast within India "between areas of low female autonomy and unfavourable demographic performance (high birth and death rates), on the one hand, and comparatively high female autonomy and relatively favourable demographic per-

formance, on the other."

The authors clarify the long-term historical consistency of this dichotomy and its expression in the form of earlier age at marriage, higher marital fertility, higher maternal mortality, higher infant and child mortality and more unequal sex ratios in the northern states. Such a classification is acknowledged to be a simplification and the geographical and cultural demarcations are at times difficult to define. Reasons for the existence of this pattern are conceptualised in terms of the differing culture and kinship systems.

While it has been proposed that the agrarian ecology of India is at the root of sociocultural variations existing between the north and the south, it has been the view of a number of authors that the matter is more complex and cannot exclude the role of kinship systems that were and continue to be driving forces for the way in which they set the context of optimal economic and acceptable social interactions. Further, in agreement with others, the authors note the lack of "spatial correspondence between cultural variation on the one hand and differences in agrarian ecology on the other", Dyson & Moore(1983).

The patrilineal kinship systems that define the social structures of the castes that compose the majority of the population in the north of the country encourage exogamic marriages, outwith the village, that assist inter-group alliances and are transacted through dowry payments, (as opposed to bride wealth, which is practiced in the south) made by the inferior "wife-giving family". Throughout the bride's life, her biological father and brothers are expected to contribute financially to her husband's household.

Females are forbidden from inheriting property, or any form of financial assets and have traditionally lacked access to credit. Tradition also dictates they leave the home of their natal parents to marry and take with them a dowry to settle in the home of their husband's family. From an economic perspective, early marriage is encouraged since it "reduces the economic burdens involved in supporting females who will marry out and away", Dyson & Moore (1983). The socially prescribed role for women has implications for optimal health and educational investments in them. Ordinarily, the young wife is not granted control

over money she may earn, or encouraged to take part in household decisions concerning allocation of resources and major purchases. She loses autonomy within the home of her in-laws and is often isolated from natal kin.

The kinship systems also impose restrictive rules governing the movement and socialisation of wives out-with the family home. This has implications for the effectiveness of alternative informational campaigns since many of the women are not exposed to the more modern attitudes and influences that encourage the acceptance and use of health services, particularly in rural areas. Although female autonomy itself is not observable, the authors discuss the use of clever proxies of kinship, such as the mapping of spatial dimensions of the marriage alliance, defined in terms of the median distance between female's natal and marriage homes, as well as the proportion of marriages occurring within females' villages of birth.

1.2.2 Son Preference

In many parts of Asia and South East Asia, and particularly so within the rural areas in the north of India, there is little provision of social/income security, or pension arrangements. As a result, it is thought children are partly defined and demanded as a means of transferring wealth into the future, in order to support their parents in retirement; Atella & Rosati (2000), or to act as incomplete insurance goods, Portner(2001). Resources are invested in the child to the point where the expected discounted future marginal gain from such a plan is equated with costs, in an environment of uncertain child survival.

Because female children in the northern kinship systems of India cannot fulfil this role at the level of the family, due to societal laws governing property rights and inheritance, their future economic worth is constrained. It has been proposed widely also that the demand for unskilled labour services, particularly in rural cultivated areas motivates the demand for male children since they are seen as a more valuable factor input from a fairly early age.

While strong support exists for these two arguments, there exists additional evidence that social norms and culture also explain son preference in India. Gan-

gadharan & Maitra(1999) find clear evidence of son preference in South Africa among the Indian sub-population, despite the fact that they "form a rich, urban upper-middle class." In their study, the traditional arguments invoked to explain son preference; of the old-age security motive, or demand for unskilled farm labour, do not apply. The authors therefore stress the importance of patrilineal customs and social norms in explaining observed behaviour.

It is tradition that dictates early exogamic marriage for girls and a life within the in-laws home, thus dampening incentives to invest in their schooling. A further reason given for the lower schooling of girls is that labour market discrimination reduces the returns to any educational investment. Yet such macro discrimination itself is rooted in social norms/traditions.

An alternative explanation given for the greater autonomy of women in the south of India points to their valuable economic participation in rice-based agriculture. However, as pointed out by Das Gupta (1987) on the motivation for son preference, "women's labour force participation has coexisted with excess female child mortality, so there does not seem to be any clear relationship between the two." Using census data from the Ludhiana District of Punjab, the author notes the most unequal sex ratios were found among the major land-owning castes (Jats, Rajputs, Gujars); Untouchable castes had much more equal sex ratios. "In no way do the marked regional differences within India in sex ratio imbalances correspond to regional differences in per capita income."

In common with Bhargava (2003), the author finds evidence that sex discrimination is focused on higher order births of girls, who are born in an effort to obtain the desired number of sons: Sex differentials in mortality by birth order are shown to be far higher than by socioeconomic status. Target family size considerations are seen to be driving higher order births; if female, the child is thus considered excessive. The hypothesis that receives the most support by authors relates son preference to cultural factors and the patrilineal descent of the kinship system, which in turn organises labour, economics, law and social policy. The dowry system is part of this lineage and all are seen to work together to create such bias.

1.3 Some Recent Fertility Patterns of Timing, Number and Spacing

Patterns of marriage and social organisation in India, in conjunction with economic and environmental conditions determine the lifecycle profiles of households and the fertility paths chosen by them. The fertility exposure of women is affected by marriage practices, since childbirth outside marriage is not overly common, or socially acceptable. The notes below outline some recent trends that together determine the number, timing and spacing of births. This information is taken from the NFHS All-India and State-Level final reports, 1998-99.

1.3.1 Age at First Marriage, Age at First Cohabitation

The long-standing pattern of childbearing in the north of India has been for the women to marry young and commence child-bearing shortly after, without any attempt to avert conception. The median age at first marriage is defined as the age by which half the women of a particular cohort marry. In Uttar Pradesh, the median age at first marriage for rural women aged 20-49 years in 1999 was only 14.7 years but substantially higher for urban women at 18.3 years. For the whole of India the median age at marriage is still relatively low at 16.7 years, despite a national legal minimum age of 18 years.

Although median age at first cohabitation with the husband is generally higher, at 16.7 years in Uttar Pradesh, such early marital arrangements are seen to contribute directly to higher marital fertility since they extend the exposure window. If it were realistically possible to encourage a delay in first births, within the marriage environment, overall fertility could be lessened. However, such outcomes are very unlikely given the low status of young married women, as mentioned in the opening section of this chapter. Hence, the emphasis is on delaying early marriage, which also works to improve the rights and autonomy of girls, by enabling them to stay in education longer.

Births to very young women are known to exacerbate infant mortality greatly and there has been effort to encourage later marriage and cohabitation, through

legal enforcement of the Child Marriage Restraint Act of 1976. The Commission on Population and Development, 2000, hosted by the Department of Family Welfare, India notes that some states now offer a cash incentive, to be given to the parents of a girl child and deposited in an interest bearing account, redeemable if the girl child is unmarried at the age of 18. The state of Tamil Nadu, in the south of India also provides financial assistance to families to enable them to marry off their daughters after they attain the legal age of marriage.

1.3.2 Age at First and Last Birth

The ages at which women start and stop childbearing have direct effects on total fertility. Table 1.1 offers the median age at first birth for women aged 25-49 years. It is lower among women with a low standard of living. Age groups below 25 years are not calculated because less than half the women had their first birth by age 20. At each higher level of education of the woman, median age at first birth increases. It is also highest among urban women and those not coming from the designated scheduled castes/tribes or other backward classes. Median age at last birth for women aged 40-49 years at the time of the survey is 32.2 years and there are still significant numbers of women giving birth in their thirties, despite such early initiation.

1.3.3 Current Fertility Levels, Fertility Differentials and Trends

The NFHS 1999 provides estimates of age-specific fertility rates (ASFR), total fertility rates (TFR), and crude birth rates (CBR) for the three-year period preceding the survey, which, in Uttar Pradesh corresponds to 1996-1998. The ASFR is calculated for each of the seven 5-year age cohorts, by dividing the total number of births to these women during the previous three years by the number of woman years lived by these women in these three years. It is thus an average birth rate per year for each cohort. This will vary due to the lifecycle effects of childbearing, wherein the older cohorts of women have largely completed their

Background characteristic	Age at first birth
Residence	
Urban	20.3
Rural	18.7
Education	
Illiterate	18.5
Literate, < mid. school	19.1
Middle school complete	19.8
High school complete or +	22.3
Caste/tribe	
Scheduled caste	18.5
Scheduled tribe	18.7
Other disadvantaged class	18.6
Other (non disadvan.)	19.5
Standard of living index	
Low	18.2
Medium	18.9
High	20.7
Total	**19.0**
Note: women aged 20-24 not included because	
less than 50% had 1st birth by age 20.	

Table 1.1: Median age at first birth among women age 25-49 by selected background characteristics, Uttar Pradesh, 1999

	NFHS 2 1996-1998			SRS 1997		
Age	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
15-19	0.057	0.137	0.120	0.025	0.043	0.040
20-24	0.195	0.272	0.256	0.198	0.260	0.248
25-29	0.173	0.217	0.208	0.221	0.281	0.271
30-34	0.095	0.137	0.127	0.152	0.208	0.198
35-39	0.040	0.071	0.064	0.075	0.124	0.115
40-44	0.012	0.020	0.018	0.047	0.066	0.062
45-49	0.004	0.006	0.006	0.014	0.025	0.023
TFR 15-49	**2.88**	**4.31**	**3.99**	**3.66**	**5.04**	**4.79**

Table 1.2: Age-specific and total feritlity rates from NFHS 1996-98 comparison with SRS 1997, by residence, Uttar Pradesh

fertility and thus would have a lower rate.

The TFR is a summary measure, based on the ASFRs for each cohort that gives the total number of children a woman would bear during her reproductive years were she to experience the ASFRs prevailing at the time of the survey. Based on this procedure, the TFR for Uttar Pradesh is calculated to be 3.99 births per woman. It is noted however that this rate underestimates fertility due to the misreporting of recent births and a more accurate figure is provided by the Sample Registration System (SRS) that is maintained by the Office of the Registrar General and calculated as the births occur. The equivalent 1997 TFR in the state of Uttar Pradesh, as measured by the SRS, is in the order of 4.79 births per woman (3.66 Urban, 5.04 Rural), well in excess of the All-India replacement level of 2.1 births. Table 1.2 gives these current ASFRs and TFR: The majority of fertility occurs between the ages of 20-29 and is concentrated among women from rural areas.

There is wide variation in fertility among population groups and regions. The percent of the population living in rural areas varies over the regions and this partly explains the divergence. Both the ASFRs for all cohorts and the TFR are far higher among rural women. Fertility falls markedly with maternal education levels and with improved standards of living. It also varies by religion and caste/tribe. The TFR estimates suggest a decline of about 17 percent between NFHS 1 (1993) and NFHS 2 (1999), over a 6-year period. Table 1.3 shows that

Background characteristic	**Total Fertility Rate**	**Percent currently pregnant**	**Mean no. children to women 40-49yrs**
Residence			
Urban	2.88	4.8	5.17
Rural	4.31	7.4	5.94
Region			
Hill	2.69	3.6	4.16
Western	4.17	7.7	5.74
Central	3.89	7.4	5.9
Eastern	4.02	6.1	5.94
Bundelkhand	3.95	6.5	5.84
Education			
Illiterate	4.54	7.7	6.13
Literate, <mid sch.	3.36	5.8	5.34
Middle school	3.12	5.0	4.46
High school or +	2.49	4.9	3.45
Religion			
Hindu	3.87	6.5	5.59
Muslim	4.76	8.3	6.81
Sikh	2.34	8.8	too few obs.
Caste/tribe			
Scheduled caste	4.44	6.8	5.90
Scheduled tribe	4.83	7.6	6.20
Other disadv. class	4.12	7.5	6.00
Other (not disadv.)	3.77	6.5	5.44
Standard of Living			
Low	4.91	8.4	6.20
Medium	3.97	6.7	5.95
High	2.8	4.8	4.73
Total	**3.99**	**6.8**	**5.76**

Table 1.3: TFR for 3 yrs preceding survey by background characteristics

the average number of children born to a woman, (calculated using the 3-yr ASFRs) of 3.99 is substantially below the figure of 5.76 per woman for women age 40-49 at the time of the survey. This does suggest the ASFRs they experienced as younger mothers were higher than those calculated from current younger cohorts, a further indicator of declining fertility.

1.3.4 Birth Order

The distribution of births by birth order is a further way to assess patterns of fertility. In Uttar Pradesh, 40 percent of all births are of order four or higher, compared with a national average of 28 percent. This follows higher levels of mortality, as women replace lost (and the expected loss of) children. This proportion is highest among rural women, illiterate women, those from either scheduled caste, tribe, or other backward class, Muslim women and those from households with a low standard of living. Notably, the proportion is lowest in the Hill region, which incidentally has the lowest infant mortality rate.

One measure of the spacing of births is the inter-birth interval, defined as the length of time between two successive live births. Short birth intervals have been linked to heightened maternal and child mortality and one of the aims of the Reproductive and Child Health Programme is to encourage longer birth intervals, of the order of two or more years. In Uttar Pradesh, 29 percent of births during the five years preceding the NFHS 1998/99 survey occurred within 24 months of a previous birth. However, the median birth interval is 30.4 months. This statistic does not take into account stillbirths, or, of course unreported deaths (such as those due to infanticide). An alternative measure is the conception interval, that takes account of all births and provides a more accurate picture of the pace of child-bearing.

From the report, median birth intervals do not vary greatly by background characteristics; they are almost identical for both rural and urban populations and education levels of the mother. They vary from 30.2 months to 30.9 months for women with a low and high standard of living, respectively. Median birth intervals are about one and a half months longer where the preceding birth was

a boy; this is thought to result from the shorter duration of breastfeeding offered to female children and is one culmination of son preference. Short birth intervals also vary with the survival status of the previous child, (25 months versus 31.4 months where the previous child survives) where the shortening of post-partum amenorrhoea leads to more rapid re-conception. It is also indicative of conscious ex-post replacement, see Panis (1992) for a discussion of differing replacement mechanisms.

1.3.5 Postpartum Amenorrhoea, Abstinence, Insusceptibility and Menopause

A woman's biological fecundity can be considered largely exogenous, although reproductive health problems that curtail fecundity may go untreated in certain groups of women more than others. Insusceptibility due to reproductive health problems is also reported in the NFHS data. 38 percent of married women in Uttar Pradesh self-report a reproductive health problem in the three months preceding the survey, yet almost three quarters of these women did not seek any form of treatment. It is also thought that only those women familiar with modern health services are willing to admit and discuss their experience of such health concerns and hence represent an underestimate of the proportion of women living with reproductive health problems.

The natural post-partum amenorrhoea after birth is extended by breast feeding and many women choose sexual abstinence for a period following birth. Approximately three quarters of women are still insusceptible three months following birth and about half of all women remain in this category six months later. The percentage declines fairly rapidly thereafter. Sexual abstinence is fairly short so does not usually prolong natural temporary sterility.

Because women in Uttar Pradesh bear a large number of children at early ages, the age at menopause does not usually curtail family size. By age 42-43 only a third of all women are menopausal.

1.4 Institutional Background

1.4.1 National Population Policy 2000

Despite the Government of India having been one of the earlier countries to adopt family planning and reproductive health as part of a national policy through the Five Year Plans starting in 1951, it has achieved only limited success, failing to reach stated objectives in terms of population coverage of health service provision and a continuing reduction in the birth and death rates. India now lags well behind a number of other developing countries with regard these measures. The 1974-1979 Minimum Needs Programme attempted to incorporate family planning with maternal, child and nutritional health services, in an effort to provide at least a basic level of services.

In response to the World Bank Report on Infant and Child Mortality, the National Child Survival and Safe Motherhood Programme was initiated in 1992-93, incorporating survival interventions and reproductive health with other family planning activities. In 1996 these were incorporated into the Reproductive and Child Health Programme, through the National Family Welfare Programme, in an effort to steer away from past target-oriented approaches to contraceptive acceptance levels among eligible couples and to provide a more complete reproductive health service.

The aim was to provide high quality, need-based care tailored to the individual and integrated so as to cover all aspects of reproductive and child health. It covered maternal, child and reproductive health and fertility regulation interventions for both men and women. Important elements of the programme included adequate provision of ante-natal care, inclusive of nutritional supplements, vaccinations and the monitoring of maternal health. The presence of trained personnel at all births and post-natal care with a minimum of three visits and identification and management of reproductive and sexually transmitted diseases was to be achieved.

Public service provision in India has been organised in rural areas through a network of Community and Primary Health Centres and sub-centres that are

staffed by auxiliary nurse midwives, male health workers and female health visitors. In urban areas provision is via government or municipal hospitals and urban health posts. Private provision occurs through Non Governmental Organisations and other private maternity homes, hospitals and doctors in both rural and urban areas.

In 2000, in addition to the RCH Programme, a new National Population Policy was formulated with a stated immediate objective to address the "unmet need" for family planning, in an effort to bring down the TFR to replacement levels by 2010. The unmet need for family planning is identified as the situation where the woman is fecund and sexually active but not using any form of contraception, despite expressing a desire to have a) no further children ever, defined as the unmet need for limiting fertility, or b)no further children at the present time or within the next two years, defined as the unmet need for spacing.

For this purpose, its aim was to achieve universal access to information, counselling and support services for fertility regulation. However, as outlined in the National Health Policy Report, 2002, by the Ministry of Health and Family Welfare, the general shortage of medical personnel occurs in the areas of most need, where fertility is the highest.

The content of the NFHS surveys has changed in response to the need for more detailed information on the quality and availability of reproductive health services. The stated aim of the research is to "provide state and national estimates of fertility, the practice of family planning, infant and child mortality, maternal and child health, and the utilisation of health services provided to mothers and children in an effort to gauge the success of policy efforts." The latest survey provides indicators of the quality of health and family welfare services, information pertaining to the women's experience of reproductive health problems and domestic violence. Some basic frequencies on source of health care, quality of personnel and facilities, as well as matters discussed during the visits are presented in Table 1.4.

It shows the main source of health care for family members when they become ill. It does not suggest that each sickness episode is treated, for each family

Source	Residence		Standard of living Index			
	Urban	Rural	Low	Medium	High	Total
Public med. sector	15.3	10.4	9.1	11.9	14.9	11.4
Govt/municipal hosp.	10.9	3.7	3.7	5.0	8.7	5.2
Govt dispensary	0.7	0.3	0.1	0.5	0.7	0.4
Urban Hlth Cntr, Hlth Post	2.7	0.3	0.2	0.9	1.6	0.8
Community Hlth Cntr, rural, PHC	0.9	5.8	4.8	5.2	3.4	4.7
Sub-centre	0.0	0.3	0.2	0.2	0.3	0.2
Other public medical	0.1	0.0	0.0	0.0	0.2	0.0
NGO or Trust	0.3	0.1	0.2	0.1	0.4	0.2
Private medical sector	83.8	89.0	90.2	87.6	83.8	87.9
Private hosp/clinic	18.1	14.2	13.0	14.8	20.1	15.0
Private doctor	62.6	71.3	73.2	69.7	60.8	69.5
Private mobile clinic	0.3	0.3	0.2	0.2	0.4	0.3
Private paramedic	0.8	1.3	1.4	1.1	0.7	1.1
Vaidya/homeopath	1.5	0.6	0.9	0.5	1.5	0.8
Traditional healer	0.0	1.1	1.1	1.0	0.1	0.8
Pharmacy	0.5	0.1	0.2	0.2	0.2	0.2
Other priv. medical sector	0.1	0.2	0.2	0.1	0.1	0.1
Other Source	0.6	0.5	0.5	0.4	0.9	0.5
Shop	0.3	0.1	0.2	0.1	0.2	0.1
Home Treatment	0.3	0.4	0.4	0.2	0.7	0.3
Missing	0.0	0.1	0.0	0.1	0.0	0.0
Total Percent	100.00	10.00	100.00	100.00	100.00	100.00
Note: Total percent includes 185 households with missing info on stand. of liv index.						

Table 1.4: Percent distribution of households by main source of health care when household members get sick, according to residence and the standard of living index, Uttar Pradesh 1999

member; only if treated, where they go. The main source of health care for 88 percent of the state's population remains the private health sector; this reliance is higher in rural areas and greater than that for All-India, at 69 percent. The use of public sector facilities is higher in urban areas at 15.3 percent, compared to 10.4 percent for rural areas. Use of the public medical sector also increases with standard of living from 9 percent for those classed as having a low standard of living to 15 percent for those with a high standard of living. This echoes the above caution that services, both public and private are not directed at those most in need but provided based on either geographic or willingness to pay criteria.

As part of the RCH Programme, health and family planning workers are expected to visit each home in their designated area on a regular basis, in order to monitor aspects of maternal and child health, to provide information and appropriate treatments, as well as to support and inform the mothers about alternative family planning practices. Yet figures for 1999 suggest only 3 percent of women had received any form of home visit in the last 12 months, well short of universal coverage and lower than the figure for All India of 13 percent.

The quality of home visits, though difficult to measure was recorded through noting levels of satisfaction with service and with the behaviour of health workers. Satisfaction with service provision was fairly high at 86 percent but with practitioner behaviour it was significantly lower. Of the small proportion of women who were visited at home, only 22 percent received any family planning services in the form of information, provision or advice on contraceptive methods.

Of those women who visited a health facility during the last 12 months, the figure was even lower at only 2 percent. Indeed, discussion of family planning was seen to be lowest among the very women who appeared to have the greatest need, in terms of their exposure and use status; pregnant women, women with children under the age of three and non-users. On only a few occasions did mothers indicate they were given advice and information about alternatives and health side-effects, when the topic was discussed. Urban women reported discussion of each of the alternatives more often than rural women.

Physical supply problems are mentioned in only a minority of cases, even in

rural areas: Between 1 and 3 percent of all users of temporary methods ever report having a problem in obtaining supply. Yet "Knows No Source of Supply" is mentioned as a reason for not using among women who were non-users, see Table 4.1 of Chapter 4. Unfortunately there is no information on the cost of contraceptive methods, although the majority are provided at highly subsidised rates in the public sector, where they are available.

The RCH has been only a limited success, failing to achieve the levels of coverage and quality laid down in it's conception. There are very obvious biases inherent in the current distribution of public health services in India that may inhibit efforts to reduce fertility further. Data on the future intentions of the women with regard contraceptive uptake indicate there may be substantial latent demand that, given the right information and support, may be mobilised.

In Chapter 5 of the NFHS state level report for Uttar Pradesh, it is recognised that the heavy reliance on sterilisation is failing to meet the needs of both women who are in the earlier stages of their fertility cycle (and have a demand to delay or space births) and those who are unsure as to whether they desire further children and hence do not wish to use such an irreversible procedure as sterilisation.

More recent fertility research by Pathak, Feeney & Luther (1998) notes that likely further reductions in fertility cannot be expected to occur through a continued reliance on permanent sterilisation methods and that no further reduction in fertility can be expected through encouraging longer birth intervals, until a more substantial portion of the Indian population make use of the temporary methods.

As the authors note, the relationship between use of temporary methods, birth spacing and fertility is complex. "Except in populations with very high fertility, longer birth intervals may simply spread the same number of births out over more of the reproductive age span, producing little or no effect on the total number of children born." : Pathak et al (1998). In their cross-sectional, 27-country analysis, they also find little relationship between temporary method use and length of birth intervals. In India, the overwhelming majority of temporary method users are using in order to limit fertility, not to delay or space their births. Details regarding this pattern of use will be presented in Chapter 4 on

background to contraceptive practices.

Figures from the state level report suggest that 25 percent of currently married women in Uttar Pradesh have an unmet need for family planning; 12 percent for spacing and 13 percent for limiting births. While an Indian population policy should encourage a delay in first births and a spacing of subsequent ones, in order to address overall patterns of marital fertility, it must first give priority to the primary inability of women to curb their family sizes.

1.5 Child Schooling and Child Labour in India

The Government of India has taken a number of steps in recent years to re-deliver on it's 1950 decadal promise of universal primary and elementary education for children aged 6-14 years, building it more concretely into the Indian Constitution with the signing of the "Education For All" declaration at the 1990 World Conference on Education in Jomtien, Thailand, whose stated goal was to universalise primary education and greatly reduce global illiteracy before the end of the decade.

Although progress has come through a record increase in the quantity of primary schools throughout India, where more than 90 percent of the Indian population are now said to live within one kilometer of a primary school, the physical quality of the schools remains very low, with most lacking running water and toilets, Bajpai & Goyal (2004). According to an optimistic World Bank study (1997), 54 percent of schools in Uttar Pradesh did not have running water and 80 percent lacked toilets. Grover & Singh (2002) quote even higher figures in their study of two districts in the southern state of Tamil Nadu.

In addition, poor teacher training and incentives, coupled with very high pupil-teacher ratios (50:1) and teacher absenteeism, mean that even where children attend school for the five grades of primary school (ages 6 to 11 years), they often leave without functional literacy or numeracy. The drop-out rates that create waste in the education system stand as high as 75 percent in some parts of India and the participation and performance of children depends sharply on

their gender, place of residence and ethnicity, as well as family income. Social attitudes towards children of lower ethnic castes are "reproduced inside schools", with the quality of teaching imparted dependent on such factors.

The general administration and accountability of the education system and school management is not free from the corruption and fund misappropriation inherent to other governmental departments and as noted by Bajpai & Goyal (2004), the market in public employment means that the recruitment of friends and relatives as teachers is not uncommon.

The Public Report on Education (PROBE) of 1999 noted that in over half the schools visited, no teaching was taking place, or the school was physically closed. Although public expenditure on education in 2001-2002 stood at around 4 percent of GDP and 13 percent of total government spending for India as a whole, most of this went to secondary and tertiary education projects and was less than projected in the national budget.

The Ministry of Education for the Government of India launched the District Primary Education Programme (DPEP) in1994, to support the achievement of universal primary and elementary education through implementation of changes to the planning and management of schooling and in the quality of teachers and facilities. The central Government of India provides 85 percent of the funds via both soft loans and grants from international funding bodies, with the balance coming from state governments. There are reported NIEPA (1998) improvements in enrolment rates and a reduction in repetition rates for the states and districts that were signed up for the DPEP, especially for girls .

In 2001 the central government launched the Sarva Shiksha Abhiyan (SSA) program, an entirely domestically funded initiative, whose aims cover literacy targets for both primary and elementary education and the achievement of greater community participation and decentralisation of the school system. It serves as an umbrella to the further state-level programs but burdens them with a 50 percent funding obligation, in an environment of heavy state debt burdens and fiscal deficits. Only in 2001 did the government of India make the provision of mid-day meals compulsory, with liability resting on the state governments.

Year	Male	Female	Persons
1991(age 7 years +)			
Rural	57.87	30.62	44.69
Urban	81.09	64.05	73.08
Total	64.13	39.29	52.21
2001(age 7 years +)			
Rural	71.18	46.58	59.21
Urban	86.42	72.99	80.06
Total	75.85	54.16	65.38
Source: Census of India, 1991, 2001			

Table 1.5: All-India Rural-Urban Literacy Rates 1991-2001

The effects of this provision have been positive, improving enrolment and attendance rates, particularly for girls. There has been a continued narrowing of the gender gap in crude literacy rates to 21.7 percent in 2001, see Table 1.5 above. These aggregate figures hide significant variation across states and in Uttar Pradesh, the gender gap in literacy is among the largest in All India at over 27 percentage points; the crude literacy rate for males in Uttar Pradesh in 2001 stands at 70.2 percent with females at 43 percent. This rate also varies widely between rural and urban populations. The gross primary school enrolment rates for 2001-2002 also favour boys but there been steady improvement over the decade to 2001. This enrolment rate in Uttar Pradesh in 2001-2002 of 62.3 percent is well below the All-India average of 89.7 percent.

In Uttar Pradesh, 1999/2000 drop-out rates stand at 49.85 percent, compared with a national average of 39.74 percent. State drop-out rates for boys of 45.98 are lower than 55.98 for girls.

A Compulsory Education Policy has been on the agenda and is seen as one contributory factor in reducing the incidence of child labour. It is estimated that up to 115 million children in India are working and the globalisation of production is increasing the demand for unskilled labour further. As of the New Delhi Declaration of 2003, The Government of India has still not ratified the ILO Convention 182, on the worst forms of child labour but intends to do so.

The 2001 Census of India, although known to provide under-estimates of the incidence of child labour, due to reporting procedures, provides a sectoral

breakdown of child labour that highlights significant change since the Census of 1981. Figures now suggest the majority of children work in manufacturing and repairs, followed by the rural agriculture sector, which historically accounted for the majority of child workers, in turn followed by wholesale and retail trade, personal services and then construction. These figures of course do not include work performed in the household, which falls largely on female children.

There exist a multitude of arguments for why parents do not send children to school; some rooted in the opportunity costs of child labour, others in the poor quality of schooling and it's lack of relevance. Expenses in terms of transport, books etc are too great for many families, even where schools are made available. Programs underway are seeking to cover the costs of school uniforms, books and free mid-day meals. Any legislation on school attendance would need to be integrated into a wider assistance and monitoring program.

Basu (1999) points to the need to be cautious in the implementation of outright bans on child labour in all but the worst cases and to be wary of policies aimed at the boycott of goods produced by children, for the damaging impacts such trade restrictions impose on the economic well-being of the working children and their families. Rather, policies aimed at improving conditions in the adult labour market, changes in technology and the availability of appropriate schooling can lead to voluntary withdrawal of children by their parents, under more sustainable conditions. Any compulsory school policy is a more effective tool and more easily monitored.

1.6 Thesis Overview

The following chapter presents a non-rigorous treatment of the theoretical frameworks adopted in the modelling of life-cycle behaviour, concerning the quantity and quality of children and the costs inherent in controlling the supply of births. We offer a presentation of some of the optimal fertility rules, in light of prices, incomes and imperfect and costly contraception. With our focus on the role of intra-household bargaining, son preference and the autonomy of women in assess-

ing fertility outcomes, we choose papers that address these additions in particular.

A schema setting out the development of the analytical fertility models provides information on how and in what ways the models were developed and enriched. New insights were taken from the biological sciences concerning reproduction, and from other social sciences, concerning the role of intra-household processes. Although a lack of data precluded the testing of many of the analytical relationships derived in the models, new econometric techniques and advances in computational science made it possible to include important processes and so obtain unbiased, albeit simpler estimates.

Chapter 3 then focuses on the recent debate surrounding family formation and the role of contraception and female autonomy in regulating fertility. The work suggests the existence of an element of fertility that may be considered excessive, from the woman's point of view. Several reasons for this are proposed. For example, where contraception is unavailable at acceptable cost it may be optimal to continue to higher parities. That the women then report these births as excessive depends upon which perspective one takes. Do women state their fertility intentions in the knowledge of the costs of contraception or do they express an ideal, assuming away such complications ? We also cover the role of family opposition to the ceasing of fertility and how this may be operationalised as a further non-monetary cost of contracepting.

We define some of the constructs used by social scientists, such as the concept of unmet need and it's correlates and describe the fertility intentions data commonly used to test hypotheses about behaviour. Tabulations of women's stated desires for additional children reveal significant gender bias in future births that suggests son preference is not abating. The use of such subjective data requires caution and while concepts such as an ideal family size may help identify variation in tastes for children, they need careful interpretation.

We cover statistics on the use and knowledge of differing types of contraception in the state of Uttar Pradesh and set forth some of the policy arguments for alternative models for the provision of family planning products and education.

With this background, we then investigate the role of women's autonomy in

explaining fertility patterns and the use of contraception in the first empirical paper of Chapter 4. If mechanisms exist whereby different preferences/optimal choices emerge among members of the household, for whatever reason and over whatever dimensions, (such as the preference for child quality relative to child quantity) and members are constrained from implementing these, due to say low relative bargaining power, it might be important to investigate how changes in relative bargaining power operate to change the outcomes of these processes, such as the number and quality of children.

We therefore assess how fertility preferences and past child outcomes affect the demand for family planning and how behaviours associated with the greater autonomy of women impact upon this process. The empirical work makes use of data from the latest round of the National Family Health Survey (NFHS) for India, 1999, for the state of Uttar Pradesh, in a simultaneous equation framework, in an effort to take account of the joint determination of many of the variables inherent in modelling such dynamic processes with cross-sectional data. We find that although women's autonomy has been held up as a means of achieving lower fertility, the two do not necessarily go hand in hand, unless coupled with the wider participation of women. The estimation resutls confirms the difficulties inherent in estimating meaningful cross sectional relationships from data that no doubt contain dynamic behavioural responses.

One of the policies heralded to achieve the deeper goal of gender equality has been the promotion of education of female children, who as a group lag well behind their male counterparts on both literacy and numeracy rates. We thus turn our attention in Chapter 5 to investigating the way in which household time allocation decisions are made, focusing on the parental choice of each child's main activity; to go to school, to work in the home, or in the formal labour market, in an effort to understand how the household's opportunities and resource constraints, along with social norms impact such decisions. While some state governments are offering cash incentives to families to keep their female children in school and unmarried, significant labour market discrimination against women continues and constrains the value of this government investment.

Making use of the same NFHS data for Uttar Pradesh, we estimate each child's trinomial time allocation with competing specifications and then compare the results. The standard multinomial logit model is estimated initially but imposes some fairly tight assumptions on behaviour that are unlikely to hold in the present application. A Mixed Logit model is then estimated that is able to bring greater flexibility and descriptive richness than is possible with the standard Logit model.

Estimation results are compared and confirm the ability of the Mixed Logit to capture more fully the unobserved heterogeneity inherent in the data and to allow for correlation in the errors across children of the same family that is not permitted within the standard logit setup. Chapter 6 closes the thesis with some suggestions for priorities for future research work. In particular, we recommend the development of more detailed datasets that make possible analyses based on intrahousehold allocation outcomes over time. This may further encourage the development of richer bargaining models over child attributes, extended to a dynamic context and the testing of such relationships with newly developing econometric techniques that can handle the greater dimensionality, while keeping a lid on computational concerns.

Chapter 2

Review of Literature on Economics of the Family

2.1 Introduction

The modelling of fertility by economists arose with the increasing interest in the economics of the family in the late 1960's and early 1970's. These attempts described in detail the economics of fertility and have continued in more recent years to extend their theoretical formulations to address assumptions made in the initial papers and refine the econometric techniques used in order to test some of the proposed relationships more accurately.

This chapter will cover both these analytical and empirical developments, paying particular attention to those studies that improved the fit of the models applied to high fertility/high mortality populations, since the focus of the estimation work rests with lifecycle fertility behaviour in India.

We start by examining the initial static household utility framework that was adopted in an effort to incorporate the household's preferences for children and existing constraints, into the derivation of observed lifecycle fertility choices. These choices were seen to be the outcome of a unified household utility optimization problem, incorporating lifetime wealth constraints and home production technologies, in turn with preferences over children and other goods. It was recognised that children could be viewed as home-produced assets, from whom parents de-

rive a stream of benefits, in the form of child services. The motivation for desiring children was initially couched in terms of their consumptive (enjoyment) value and later, also in terms of their productive contribution.

These early models fundamentally changed the way social scientists viewed household decision-making with respect to children, yet many failed to accurately describe choice behaviour, abstracting from several important considerations that had implications for observed choice: No account was given to the dynamic setting within which fertility decisions were made, or to the uncertainties and heterogeneity inherent in the conception and survival of children that might affect future fertility choice. Fertility control was assumed perfect and costless, the biological supply of births being ignored, and all children were seen to be of equal value. Because choice was set within a unified household framework, intra-household issues were also sidelined.

We offer a schematic representation of the fertility literature in Table 4 Appendix B, showing where and how new developments were incorporated into existing models. Empirical estimates from the early models were generally biased because the models themselves were poorly specified and failed to take account of particular social, biological and behavioural processes and the role of tastes. With regard fertility, the early models were unable to explain the presence of excess or unwanted/mistimed births and the positive relation between fertility and mortality. Further, as noted in, Cain & Dooley (1976), restrictive analytical assumptions were often imposed in order to make the models more tractable mathematically but invariably left the empirical specifications underidentified with the data available. As advances in econometrics were made, some of these problems were overcome, albeit as new ones were discovered.

Before discussing extensions to the static decision framework and in light of our interest in the role of women's autonomy in conditioning fertility outcomes, we present a paper by Eswaran(2002) that is one of a handful to address the fertility consequences of low female autonomy. Further propositions in the paper are borne out by emerging evidence on the worsening position of female children vis a vis their male siblings, where the wider autonomy of women is not guaranteed. By

permiting bargaining over differing fertility preferences, such a model can also explain why the outcome will not in general reflect the optimal choice of each family member in isolation.

The single-period static framework was then gradually dropped in favour of a dynamic, multi-period approach that recognised the temporal nature of the information set upon which fertility decisions were based. Families were not seen to be making a one-time decision concerning the total number and quality of children but rather were seen to approach the decision, in light of new information concerning the realization of past stochastic fertility (gender of child), mortality and income components. A sequential framework provided a more realistic setting for the modelling of such choices.

Also at issue with the standard model of fertility is its lack of treatment of issues concerning preferences over the attributes of children, such as their gender. These preferences can contribute to an economic explanation for what the mothers describe, ex-post, as unwanted or unplanned pregnancies and births. We present the dynamic fertility model of Leung (1991) which demonstrates how such considerations can be incorporated into an analytical model and used to assess empirical tests of son preference.

We then present a selection of models that incorporate the biological supply of births and costly fertility control within a sequential framework. These models tried to realistically structure the way in which the reproduction function might depend on the efficiency (itself determined by such factors as education) with which such contraceptives were used, net of any woman-specific biological factors that might also affect conception rates. Unfortunately the availability of data rendered the empirical tests less than ideal. Heckman & Willis (1974) were among the first to address the biases inherent in past estimates of conception rates, obtained via procedures that ignored biologically-based sample selection. Some recent estimable dynamic contraception models are also discussed.

The tradeoff between child quantity and quality is then re-examined in a dynamic context, where parents optimally choose contraception, in conjunction with the further schooling of existing children. This leads to the observed joint

outcomes of births and child school attainment, as parents weigh the marginal costs and benefits of investing either in more children, or the schooling of existing children. The models can then assess how exogenous changes, say in child survival rates, or women's wages, affect these tradeoffs.

After presentation of the differing structural assumptions adopted in an effort to derive analytically the fertility choices, building in the further complexities alluded to above, we cover the implications this has for the outcome demand equations commonly estimated and follow on to a discussion of the measures of fertility developed in an effort to test some of the hypotheses. The behavioural assumptions of the structural models have implications for the appropriateness of (and difficulty in testing) various specifications of fertility, schooling and the validity of including certain variables.

The discussion will cover:

-Choices over appropriate measures of child quality and quantity; static versus dynamic specifications and assumptions on the information set.

-Simultaneity and the joint determination of fertility with mortality, labour supply choices, incomes and child quality investments such as educations and the implications for estimation.

-Discrete versus continuous specifications: One approach is to view the reproductive process as a duration problem, in a continuous fashion; time to conception. Other measures assess number of children per woman in a discrete framework, as Poisson processes.

-Treatment of Population Heterogeneity: Parametric, semiparametric and nonparametric methods in an effort to impose less structure on the data and so obtain more meaningful results.

-Simulation-assisted estimation methods.

2.2 A Static Framework for Life-Cycle Fertility

2.2.1 Child Quality and Child Quantity

The early modelling of fertility began by framing decisions concerning children as the outcome of conscious static parental choice, motivated by the value children brought to the household. That parents derived value from children was couched in terms of the intrinsic enjoyment they brought to their parents and their contribution to market, or non-market production, at varying stages of the lifecycle.

Much of the work built on foundations developed elsewhere in economics, with regard household production, life-cycle decisions concerning time allocation, labour supply and human capital theory. Schultz (1973) notes that children can be viewed as home-produced assets that entail costs, in terms of time and forgone wages, where the number of children is affected by prices, as well as by income and by the formation of human capital in children. Human capital investments in turn will depend upon the perceived returns, both monetary and otherwise, as well as the costs of these investments.

Parents are thus seen to have preferences over children, in terms of their number and quality. Conditional on present technologies and information and the uncertainties associated with conception, survival and future income opportunities, the family weighs the marginal benefits and costs in determining their demand for child quantity and quality.

A way in which to frame decisions concerning the education of children is to view these as forms of human capital investment, where-in today's sacrifices form productive stocks, able to provide services over future periods, in terms of the satisfactions (consumptive), or productive services(income) mentioned above. Children were hence deposited in the utility function of the household, consuming the time and resources of parents, in the expectation of returns.

De Tray (1973) was perhaps one of the first to link the motivations for having children, to the human capital investments made in them, by defining child services C, over both a quality Q and a quantity N dimension. In his formu-

lation (not presented here), the household's utility function is seen to comprise the stock of child services and a composite commodity Z, representing all other production-consumption activities. The model assumes all lifecycle fertility decisions over the number and quality of children are made at one point and hence the formulation is of the static-state variety.

The amount of the composite commodity produced and consumed by the household depends on the quantities of time and purchased goods X the household allocates to that production process, the state of household technology and the efficiency with which that production process is undertaken. Child services are in turn generated through home production of child quantity and child quality. All inputs to the production processes are perfectly divisible and production functions linearly homogenous. Inputs to the production of these goods are time of the husband and wife, and market goods and services. The efficiency of home production is a function of both the husband's and wife's education, with generalized indexes of efficiency.

The author allows for a special relationship to exist between child quantity and quality; although there is no joint production, there is substitutability between the two in the production of child services. The constant returns to scale assumption in C = C (N, Q) restricts the income elasticities of N and Q to be equal.

Optimization involves choosing child services and the composite commodity in an effort to maximize lifetime utility, given stable preferences, prevailing prices and initial wealth, wages and production technologies. The Marshallian demands for the number and quality of children are derived, along with choices over composite commodity, time spent in the market working and the inputs required in the production of these optimal consumption quantities. It is a constrained optimization problem under conditions of certainty. The resource and time constraints form the full wealth constraint:

$$I = \pi_Z \cdot Z + \pi_C C \tag{2.1}$$

$$= T_h \cdot W_h + T_w \cdot W_w + V \tag{2.2}$$

where π_j represents the shadow price (average cost) to the household of the jth commodity and W the lifetime wage rate, per unit of time for husbands and wives respectively. Thus the household is seen to correctly anticipate all lifetime earnings; there is no uncertainty.

Even in this static model, the assessment of responses to changes in exogenous variabels becomes complex because the signs of almost all coefficients depend on the relative importance of inputs into the household production functions, the degree to which male and female efficiency affect the production functions and the relative household expenditures on C and Z. For example, the total percentage change in N is defined as a function of the total percentage change in each of V, P_N, P_Q, P_Z, W_h, W_h, β and γ, multiplied by their corresponding weighted elasticity.

In this formulation the author restricts the income elasticities of child quantity and quality to be equal, implying that changes in full wealth should leave the ratio of quality per child unaffected. This is done as a clear refutable and testable hypothesis. The author notes the broad consensus that the true and observed income elasticity for numbers of children (quantity) is different from (and significantly less than) that for child quality.

That the two are seen as substitutes in the production of child services was recognised early on in a paper by Becker & Lewis (1973). The authors note that although child services are a normal good and we would expect demand to increase with increases in income, there is a substitution away from child quantity towards quality, that renders the demand for quantity to be empirically negatively related to income with a low elasticity.

The line of reasoning given in support of this posits that the shadow price of numbers of children is higher, the higher their quality and the shadow price of quality is higher, the greater the number of children. The authors appeal to this interdependence as the reason for the empirically divergent signs on the income elasticities of quantity and quality and notes these will both be downward-biased estimates of the true elasticities:

The authors posit static lifetime utility ;

$$U = U(N, Q, Z) \tag{2.3}$$

as a function of the number of children (N), their quality (Q), as well and other goods, (Z). In this formulation, there is no special relationship between N and Q that does not exist between N and other goods. Optimization incorporates the lifetime budget constraint;

$$I = NQ\pi + Z\pi_Z \tag{2.4}$$

where I is full income, π the price of NQ, again interpreted as child services and π_Z the price of Z.

Maximizing utility subject to the above constraint yields first order conditions of the form;

$$MU_N = \lambda Q\pi = \lambda p_N; MU_Q = \lambda N\pi = \lambda p_Q; MU_Z = \lambda \pi_Z = \lambda p_Z \tag{2.5}$$

where the MU's are the marginal utilities, the p's the shadow prices and λ, the marginal utility of wealth. The form of the budget (true) constraint gives rise to the situation where the shadow price of quantity is related to the level of quality and vice versa. The economic interpretation is that an increase in quality is more expensive, the more children there are in the family and similarly any increase in quantity costs more, where children are of higher quality.

The authors are the first to explore the implications this has for observed income effects. They demonstrate that if the true income elasticity of child quality is positive and greater than that for quantity, the above mechanism may work in such a way that observed income elasticities for quantity are found to be negative: Any increase in income, holding prices constant, will lead to an increase in quality and to only a small increase in quantity, initially. However, through the above mechanism, the relatively larger increase in child quality will render the shadow price of quantity higher and thus lead to the substitution away from quantity; an

offsetting force that may render the observed income elasticity negative. This is due to the observed over-estimation of the true change in income which fails to reflect the greater shadow cost of child quantity.

It can be seen from the original specification that the price of children, whilst dependent on a number of exogenous factors, is under the control of parents, to the extent that it depends on inputs of time and resources. Women's wages represent the opportunity cost of the mother's time in childbearing and there is ample evidence that rises in women's wages operate through the substitution effect to reduce the demand for time-intensive quantity, toward quality-enhancing investments that are less time-intensive.

Becker & Lewis (1973) demonstrate how this could come about through the differing shadow prices of quantity and quality. The budget constraint is redefined slightly, to account for this interdependence;

$$I = N\pi_N + NQ\pi + Q\pi_Q + Zp_Z \tag{2.6}$$

Thus the shadow prices are now $\mathrm{p}_N = \pi_N + \mathrm{Q}\pi$; $\mathrm{p}_Q = \pi_Q + \mathrm{N}\pi$; $\mathrm{p}_Z = \pi_Z$

The component π_N is seen to consist of costs that do not depend on quality, such as prenatal care per pregnancy. Similarly, the component π_Q depends on quality costs independent of quantity and can be likened to household "public goods" for the children, such as the "handing down" of clothes, books and other amenities. It is assumed that the fixed quantity component is more important than the fixed quality component; $\mathrm{N}\pi_N > \mathrm{Q}\pi_Q$.

Pure substitution effects, as a result of a price change, derived from the above form of the interdependent shadow prices, encourage stronger substitutions between quantity and quality, than between other goods. For example, a fall in π_Q, due to say an increase in the education of parents, causes a fall in the shadow price of quality, p_Q , which then leads to an increase in quality. This increase in quality then causes the shadow price of numbers, p_N, to rise and a corresponding fall in quantity, N.

The authors also demonstrate that an increase in women's wages, through equal percentage increases in the fixed time costs of quantity and quality, π,

π_N, and π_Q can lead to much larger substitutions away from quantity than from quality, which is less time-intensive. These costs can be reflected as a relative fall in the shadow price of other goods, p_Z but also as a relative fall in the shadow price of quality, since it is less affected by the rise in time costs than quantity. The income-compensated elasticity of quantity, with respect to equal percentage changes in time costs tends to be greater than the corresponding elasticity for quality, as a result of the greater reliance on time in the production of quantity. These additions appear to be fairly plausible and do indeed offer a theoretical explanation for the negative cross-sectional correlation between women's wages and fertility.

Although maternal education can alter the opportunity costs of a woman's time and so encourage substitution away from time-intensive quantity, it is suggested it does so also because it is seen to improve the efficiency of quality production, relative to quantity production. This may be particularly pertinent for inputs to child health, for example. In the previous model, a rise in the education of the father or mother is seen to improve the efficiency of quality production and consequently reduce the average costs of quality production, π_Q. As Schultz(1973) notes, the education of the woman "appears to be a bit of an omnibus", in as much as it likely also affects the incidence of child mortality through more informed hygiene practices, and birth control practices through better knowledge.

2.3 Which Utility Function ?

2.3.1 A Household Bargaining Framework

Although the unified household framework is frequently adopted and underlies many empirical applications, the assumption of the household as the relevant decision unit is open to criticism. In his article and lectures on The Population Problem, Partha DasGupta(1995) expresses concern over such an approach and doubts its ability to truly reflect the choices of each of the household members. There has not been great attention paid to the intra-household behavioural processes that determine fertility outcomes regarding the number, gender and

quality of children. It has been remarked that given the choice, women (particularly in Asian societies) may not be desirous of the fertility burden they possess and their utility functions may differ from those of other family members. Schultz(1973) early on expressed concern over the ability of the household to live up to social expectations, concerning the welfare of it's members.

There are several empirical papers using data sets from Asia that focus exclusively on the role of indicators of women's empowerment in explaining fertility-related behaviour. The most encompassing indicators are discussed in Schuler,Hashemi & Riley (1997) and relate maternal empowerment to an ability to move about freely out-with the family unit, to be involved in household decision making, to have some control over household income, to possess economic security and to be free to participate in a political and legal sense within the wider community and society. Murthi, Guo & Dreze (1995) relate wider female agency to improved child survival outcomes and lower fertility in their district level analysis of All-India.

Policies that impact power relationships within the family, will have knock-on effects for decision-making, some not always benign. For example, there is survey evidence that maternal education is correlated with poorer gender outcomes for girls, particularly where such education is not matched by a wider acceptance of women as contributive economic agents in both labour and credit markets. Das Gupta(1987) notes that unchanging female mortality at the higher parities has occurred among mothers of higher education: Despite the differential in child mortality in general, the mortality of girls born to mothers who already have one or more surviving daughters is similar or even greater among educated mothers as compared with uneducated mothers. Unless education changes the way parents value children, it is no panacea for female disadvantage in India.

The role of female autonomy in determining fertility and mortality is investigated in Eswaran(2002) in a simple analytical model that motivates the reasons why the mother's preferences are not represented in the utility function of the household and in general why they prefer less but higher quality children. The asymmetric costs in quantity of childbirths are modelled as an externality and it is this that generates divergence in the demand for quantity versus quality. The

model presumes that couples are motivated to have children for security in old age, such that some, if not all costs of children precede benefits.

The author proposes that "an increase in female autonomy, by bringing in its wake decision-making more in line with the preferences of women, is accompanied by a decline in fertility and there is also a reduction in child mortality due to the increased allocation of resources for children's health". A bargaining framework is offered, in which decisions regarding a couple's fertility and its allocation of resources towards the healthcare of children are determined by the relative bargaining powers of the mother and the father.

Since the mothers bear additional pregnancy-related costs that are not considered in the household decision problem, it is optimal for them to choose to have less children and invest more resources in each (health and education). Health costs associated with child birth may be as severe as maternal death but often take the form of impairments that go undiagnosed, or untreated and severely reduce the quality of life for many women.

In an environment of high infant and child mortality, quality investments can improve the probability of survival and so protect and encourage further investments in child quality, such as crucial human capital formation through schooling. Since the father does not bear the costs of high fertility, in anticipation of infant death (hoarding), he prefers to allocate less resources to their health and have more births than his partner. The maternal depletion costs therefore change the traditional child quality/child quantity trade-off.

The model does not offer a full dynamic treatment but posits a simple three period framework, wherein the first period represents uncertain childhood; the second, income earning adulthood when child-bearing may take place; and the third, the retirement period, in which parents are seen to live off the income of their children. Thus the demand for children is motivated via their old-age security contributions and the indirect utility that is derived therein, they do not enter the utility function directly.

The model focuses on intra-generational bargaining, not intergenerational behaviour and assumes that default by children represents a credible, self-enforcing

threat to the parents, when considering the possibility of defaulting on their present obligations. All parents are assumed to marry and if female, are fertile. With all children assumed born in one period, the fertility choice is static; that is, a choice over the number of children and the quality per child, the same for all offspring.

Child mortality is seen to have both exogenous and endogenous components. The child survival probability, q, is thus seen to be an increasing but strictly concave function of discretionary expenditures on health care, h such as calorific consumption, length of time breast-fed, immunization, treatment by medical staff during illnesses. n denotes the number of children and is taken to be a continuous variable. If the survival of children are independent events, known with certainty, the number of children surviving to income-earning adulthood, m will therefore be

$$m = nq(h) \tag{2.7}$$

where n.q(h) is the mean of the binomial distribution, in the discrete representation of n.

Hence there is no reliance that expected utility is a function of the expected number of surviving children, since the survival rate is known with certainty and is adjustable by the household as it sees fit.

Parents are seen to possess nonrivalrous joint consumption c each period, as well as joint income, y, assumed exogenous. It is assumed that a fraction α of income is transferred to one's parents for old age support. There are fixed costs of b per child that include the loss of household income and time during childbirth and rearing, assumed to be incurred equally by the father and mother.

Hence, the expected utility of the wife and husband, respectively, are given by:

$$U^W(n,h) = u^W[(1-2\alpha)y - n(b+h)] + u^W(\alpha ynq(h)) \tag{2.8}$$

$$U^H(n,h) = u^H[(1-2\alpha)y - n(b+h)] + u^H(\alpha y n q(h)) \tag{2.9}$$

Added to this is the further mother-specific health cost per child that is not shared by the husband and deems the utility forms as

$$u^W(c) = D(n)u^H(c) \tag{2.10}$$

where D(0 children) = 1, D(n children) >0, and D'(n) <0 for all n.

The multiplicative term, D(n) in the mother's utility function decreases with her fertility and captures this maternal depletion externality. The model assumes that in the absence of childbearing, the utility functions are indistinguishable. Importantly in the basic model, it is assumed that females contribute and benefit economically to the same extent as their male siblings and as infants, benefit equally from any health care expenditure. As noted by the author, this violates observed behaviour on son preference and is an area deserving of research attention.

Further, it is assumed that the parents share equally the old age support offered by their children. In light of these asymmetrical costs of childbirth, the optimal number of children and expenditures on them will differ for the father and the mother and hence the separate utility representations. Thus it is left to the parents to choose n and h optimally to maximize lifetime utility. In light of the above scenario, the following results are derived.[1]

(a)For a given fertility, the optimal expenditures on a child's healthcare are the same from the mother's and the father's perspectives.

Higher expenditure on a child's healthcare will curtail the couple's present consumption but increase their future utility by enhancing their children's chances of survival to adulthood. Given fertility, there is a point at which the discounted future income gain from improved survival chances is offset by the present cost of this extra health expenditure; this trade-off is the same for both parents since the mother's utility function is just an attenuated version of the father's.

[1]See Eswaran(2002) for all proofs

(b)At the optimum of either parent, fertility and health care expenditure per child are perceived as substitutes.

An increase in fertility, holding the level of healthcare expenditure per child constant, will increase the couple's future consumption by increasing the expected number of survivors and in so doing, lower the marginal utility of future consumption. Since healthcare expenditures safeguard future consumption at the expense of present consumption, fertility increases lower the marginal worth of healthcare expenditure. From this, the fertility and healthcare expenditures per child may be seen as imperfect substitutes in the provision of a more secure future.

(c)The optimal fertility (healthcare expenditure per child) from the mother's perspective is less than (greater than) that from the father's.

This proposition follows from the fact that whilst the benefits of higher fertility are equally shared by the parents, the costs are not. The preferences of the father and mother, rather than taking extreme values, are reconciled through a bargaining process, wherein the resultant fertility and healthcare expenditures maximize the following function;

$$\max_{n,h}[U^W(n,h) - \overline{U^W}]^{\gamma}[U^H(n,h) - \overline{U^H}]^{1-\gamma} \tag{2.11}$$

An asymmetric Nash bargaining solution is adopted. The γ term is interpreted as the relative bargaining power of the wife, with 1-γ that of the husband. $\overline{U}^W$ and $\overline{U}^H$ represent the threatpoint utilities of the mother and father respectively. The utility function is maximized in terms of optimal fertility n (quantity) and health care expenditures h (quality), as a function of the bargaining power and the threatpoint utility of the father and mother, both defined parametrically.

The threatpoint utilities represent the outside options in the event of a breakdown in bargaining and define the non-cooperative solution. Education of women and their independent economic status through credit and labour force participation are examples. In India, where divorce is rare, such an outcome may be defined as one where the husband and wife provide their inputs noncooperatively, see Lundberg & Pollak(1993).

The second proposition defines the comparative static effect on the couple's choices, of a change in either the threatpoint utility, or the relative bargaining power of the woman.

Proposition 1 *The couple's fertility decreases, and expenditure on the healthcare per child increases, when;*

(a) the relative bargaining power of the mother within the household increases and

(b) the threat point utility of the mother increases.

The above analysis formally establishes how the empowerment of women may hasten the decline in both fertility and mortality. There has been much discussion of the role of micro-credit programs in Bangladesh and India, in reducing fertility and mortality outcomes and improving the autonomy of women within the home and the community. As noted by Schuler et al (1997) in their study of the impact of such programs on contraceptive uptake in Bangladesh, "the prospect of obtaining access to loans induces families to let women join credit programs."

The author moves on to discuss the implications of allowing for the education of children, in a way that improves their ability to contribute economically in the future. Although there is a positive cost to educating children, in terms of foregone child earnings and school fees, an educated child is seen to be of superior quality and able to earn a higher income as an adult. In light of child mortality however, such investments are risky and make more sense where health investments can ensure higher survival probabilities. With greater female autonomy and resultant lower fertility and mortality, educational investments are therefore more likely. This complementarity is reinforcing and is seen to create a virtuous circle.

The consequences of relaxing the assumption that no son preference exists are also discussed. The parameter α could be seen to equal one for a boy and zero for a girl, implying that she is unable to repatriate returns made to her earlier in life, due to restrictions on the acceptable economic functions she can perform. Although there are fixed costs b with each birth, the further discretionary cost, h

would not be undertaken for the female child since there is no return to be had.

With such a differential return, and from Proposition 2, it is suggested that, as the bargaining power of the mother improves, relative to that of the father, ceteris paribus, she will choose to bear less children and, if they are male invest more in their health, thus improving their survival chances. The health of male children relative to females will increase, as will their survival chances, since the health and survival of female children is unaltered at [0, q(0)]. This leads directly to Proposition 3:

Proposition 2 *When the relative bargaining power or the threatpoint utility of the mother increases, relative to that of the father within the household, ceteris paribus, female disadvantage increases.*

The author proposes that this will lead to an increase in both the relative and absolute disadvantage of female children. An important distinction is made in the model between familial empowerment and empowerment at the societal level that removes the motivation to prefer male children: Unless this wider source of social gender bias is addressed, improving female decision-making autonomy within the home, without a concurrent change in attitudes to the value of them in later life at a societal level, may exacerbate female disadvantage and sex ratios.

2.4 Dynamic Treatments Incorporating Uncertainty

2.4.1 An Optimal Control Problem

A less realistic assumption of a static approach to fertility choice relates to its treatment of uncertainty; in the path of future wages/opportunities and with regard the survival of children. Moreover, such an approach lumps together first all expenditures on children and then all satisfactions from them, without recognising the temporal nature of these costs and benefits that may have important implications for the observed choices.

The nature of family formation is such that decisions concerning the number, timing and spacing of children, and their quality, are made in a sequential manner, contingent on realized fertility outcomes, such as gender and survival, and on expectations of the path of future stochastic variables, such as the income and health of parents, the survival probabilities their children may likely face and the uncertain biological conception process itself. Hence the information set upon which fertility decisions are based is necessarily dynamic in nature and not known to the family at the outset.

Early recognition of the problem as a "dynamic programming utility maximizing model, with the various risks explicitly included" came from Ben-Porath (1973). One such treatment by Wolpin (1984) offers a discrete time, discrete outcome, dynamic-stochastic fertility model, defined over a finite horizon, in which the fertile stage of a woman's life is broken up into a finite number of periods and the choice to have a child each period is considered, in light of the sequential nature of the information set.

The decision rules, which entail comparisons between expected utility levels with and without a birth are not time-invariant, given the finite decision horizon and as Wolpin(1984) admits, and are analytically complex. The author presents some results from a simplified two-period version of the model but it yields ambiguous signs and is consistent with a wide variety of behaviours. Importantly it fails to reconcile the empirical positive correlation between fertility and child mortality, since it only allows for infant death in the first year of life. Such a structured approach necessarily abstracts from a number of issues to obtain a solution and therefore sidelines issues concerning child attributes/quality and imperfect and costly fertility control.

More generally, the studies incorporating fertility within a dynamic programming framework necessarily focus in on one particularity of the family formation process and the structural and behavioural assumptions in their models reflects this. Some assess the role of infant mortality in affecting dynamic fertility choice. These were questions to which Wolpin (1984) and others turned in their focus on the endogeneity and variation in child survival. Leung(1991) and Ahn (1995)

focus on preferences over the attributes of children, such as their gender but in doing so ignore the role of infant mortality and assume incomes to be exogenously determined.

Heckman & Willis(1974) were among the first economists to focus on the role of biological reproductive factors and the implications this had for fertility and it's costly and imperfect control. Other authors, among them Rosenzweig & Schultz(1985), Montgomery (1989),(1990) and Hotz & Miller(1993) followed with papers incorporating such biological factors into the birth production technology and the contraceptive choice, assessing the dynamic consequences for fertility.

Other studies developed the links between fertility and adult labour supply, incorporating contraceptive choice within the model, see Rosenzweig & Schultz (1989), Carro & Mira (2002). More recently, authors have revisited the child quantity-child quality tradeoff within a dynamic recursive framework, sidelining issues such as infant mortality and intrahousehold issues. Only very few papers have so far incorporated intra-household bargaining into dynamic fertility models; Echevarria & Merlo(1999) offer one fairly recent analytical treatment.

An example of a simple dynamic analytical fertility model follows. It focuses on preferences over the attributes of children and the dynamic consequences for fertility but ignores child mortality and assumes contraception is perfect, such that no fertility errors occur. We shall then proceed to discuss the earlier efforts by researchers to develop suitable estimation frameworks, taking into account the imperfect and costly nature of contraception and variations in natural fecundity across women. Heckman & Willis (1974) noted the implications for estimation of such unobservable heterogeneity; Rosenzsweig & Schultz (1985) (1989) also attempted to deal with this added complexity in estimation frameworks that offered approximations to a full estimable dynamic stochastic treatment. Lastly we cover the more recent attempts at estimation of the full strucutal parameters of the dynamic fertility models.

2.4.2 Preferences over the Attributes of Children

A dynamic-stochastic treatment of fertility that accounts for the different values placed by parents on male and female children, as alluded to by Eswaran (2002) is found in Leung (1991). The model also incorporates a measure of the disutility of fertility regulation, which is further discussed in the models of the following section. The model and it's implications for empirical tests of gender preference are set out below. It incorporates son preference into a sequential model but does not deal with uncertain child survival, or issues pertaining to the role of female autonomy and intrahousehold decision processes. Nor is there a quality dimension to children. Invariably, in order to focus sufficiently on one aspect of fertility, other complexities are set aside. The author notes the dearth of theoretical models committed to describing gender preference, despite the several empirical papers focused on it's measurement.

Rather than child services defined over child quantity and quality entering the utility function of the household, the arguments are instead boys and girls, in such a way that they may provide different utilities. The specification also allows the costs of boys and girls to vary endogenously.

The model commences by assuming that the parents are married and fecund for a known number of periods, such that the woman experiences menopause in period T+1. The couple can only control the probability of birth each period. The decision problem involves choosing this probability each period in an effort to maximize lifetime utility, summed over the remaining periods and thus intertemporally separable;

$$\max_{\{ht+1, C_t\}} E_0\{\sum_{t=0}^{T} r^t[U(B_t, G_t, C_t) - W(h_{t+1})] + \rho(B_{t+1}, G_{t+1})\} \tag{2.12}$$

subject to the per period budget constraint;

$$P_t B_t + Q_t G_t + C_t \leq Y_t \tag{2.13}$$

t=0,1,. . . . . ,T

where E_0 =expectation operator in period 0

$[U(B_t,G_t, C_t) - W(h_{t+1})]$ = utility function in period t

$\rho(B_{t+1},G_{t+1})$ = post childbearing value function

B_t = number of boys in period t

G_t = number of girls in period t

C_t = composite good consumed in period t

h_{t+1} = probability of birth in period t+1, as a result of the contraceptive choice made in period t

Y_t = income in period t

P_t = cost associated with each male child in period t

Q_t = cost associated with each female child in period t

r = discount rate ($0< r <1$)

The price of the composite consumption good is the numeraire in the budget constraint. The utility function is assumed additively separable in U and W such that the marginal utility in the probability of birth, $W'(h_{t+1})$ does not directly depend on the number of children and consumption. This assumption is realistic to the extent that the disutility of avoiding pregnancy is related to the precautions taken, usually consuming time and energy to gather information and use the methods effectively. The author confirms that such an assumption could be relaxed, so along as certain restrictions are placed on the form of the cross partial derivatives in the single utility function $U(N_t,C_t,h_{t+1})$.

Both $B_0=0$ and $G_0=0$. Given the sequential nature of childbearing, $h_{t+1}(B_t, G_t)$; that is, it depends upon the number of boys and girls present in the prior period. Both infant mortality and temporary sterility are ignored in the model and income and cost are assumed random, exogenous variables.

There are a number of assumptions on the form of utility such that the marginal utility of an additional child, (which may be a boy or a girl) in period t, given that the couple has m boys and n girls, is decreasing in both m and n. It is also assumed that the disutility of avoiding a conception increases with the level

of avoidance effort but that there are no monetary costs involved. The budget constraint is assumed binding. Unlike other authors, Leung(1991) does not rely on quadratic utility to obtain a closed form solution; rather, strict concavity in U and W assures the result.

The post childbearing value function is assumed similar to the bequest value and is derived from a further optimization problem after time T, choosing optimal path of C_t. Since the probability of birth at T+1 is zero,(given sterility), W(.)=0 and the stock of sons and daughter fixed, and with the binding budget constraint, the problem degenerates to the expected value at time T+1 of the discounted sum of all future utility from sons and daughters already born and the composite good. This function is strictly concave in B_{T+1} and G_{T+1}.

The value function in terms of the state variables B and G in any period t is defined;

$$\begin{aligned} V_t(B_t, G_t) &= \max_{hk+1, k=t..T} E_t\{\sum_{k=t}^{T} r^{k-t}[U(B_k, G_k, Y_k - P_k B_k - Q_k G_k) \\ &\quad -W(h_{t+1})] + \rho(B_{T+1}, G_{T+1})\} \end{aligned} \tag{2.14}$$

and with recursion, expressed as a dynamic programming problem:

$$\begin{aligned} V_t(B_t, G_t) &= \max_{h_{t+1}}\{U(B_t, G_t, Y_t - P_t B_t - Q_t G_t) - W(h_{t+1}) \\ &\quad +r[(1-h_{t+1})V_{t+1}(B_t, G_t) \\ &\quad +h_{t+1}[\pi V_{t+1}(B_t+1, G_t) + (1-\pi)V_{t+1}(B_t, G_t+1)]]\} \end{aligned} \tag{2.15}$$

where π is the probability of a boy, given that a birth occurred. Because T is finite and ρ exists, the value function exists. The first and second order conditions

are derived;

$$W'(h_{t+1}) = r[\pi V_{t+1}(B_t + 1, G_t) + (1 - \pi)V_{t+1}(B_t, G_t + 1) - V_{t+1}(B_t, G_t)] \quad (2.16)$$

and

$$A^* = -W"(h_{t+1}) < 0 \quad (2.17)$$

It is proposed that if the marginal utility of an additional child decreases with the number of boys (girls), then the marginal value of an additional child and the probability of birth will decrease with the number of boys (girls), holding the number of girls (boys) constant.

The author notes that a useful comparative dynamic analysis would involve the study of the effect of an increase in the number of boys on the probability of birth, holding the number of children constant. This analysis is suggested in the many econometric tests of gender preference and its effects on fertility. Essentially this involves comparing how the different gender compositions of children already born affect the marginal value of an additional child and hence the probability of birth in the next period.

By differentiating the first order condition with respect to B_t, one has

$$\frac{\partial h_{t+1}}{\partial B_t} | N_t = -\frac{rK}{-W"(h_{t+1})} \quad (2.18)$$

where

$$\begin{aligned} K &= \partial[V^*_{t+1}(B_t, G_t) - V_{t+1}(B_t, G_t)]/\partial B_t \\ &\quad -\partial[V^*_{t+1}(B_t, G_t) - V_{t+1}(B_t, G_t)]/\partial G_t \end{aligned} \quad (2.19)$$

and $V^*_{t+1}(B_t,G_t) = \pi V_{t+1}\ (B_{t+1},G_t) + (1\text{-}\pi)\ V_{t+1}\ (B_t,G_{t+1})$, defined as the change in the marginal value of an additional child.

The sign of the above derivative can be determined by evaluating the sign of

K, since all other signs are known. By holding constant the number of children, an increase in B_t implies a simultaneous decrease in G_t, which in turn alters the marginal utilities; it is the analysis of these two offsetting effects on marginal utility; the first negative, the second positive, that will determine the sign of the above derivative.

In absolute value, if $|\partial[V^*_{t+1}(B_t,G_t) - V_{t+1}(B_t,G_t)]/\partial\ G_t| < |\partial[V^*_{t+1}(B_t,G_t) - V_{t+1}(B_t,G_t)]/\partial\ B_t|$, then a further birth is less likely. Thus if the decline in the marginal value of an additional child from having B+1 boys, is greater than the increase in the marginal value of an additional child from having one less girl, G-1, then a birth is less likely and it might be said that son preference exists.

In order to proceed, the author attaches a specific form to the value function, using parameters for boys and girls. If the value function has the form V $(a_tB_t + b_tG_t)$, where a and b are some constants, possibly time-varying, then a couple may be said to have son preference, no gender preference, and daughter preference if $a_t>b_t$, $a_t=b_t$, and $a_t<b_t$, respectively. As it is modelled, the gender preference may be due to differential tastes, or costs, since a and b are only net utility assignments.

With the new value function, it is shown that where $a_t > b_t$,

$$\frac{\partial h_{t+1}}{\partial B_t}|N_t \tag{2.20}$$

is indeed negative.

Rather than the number of children being the key variable, the effective number of children, $a_tB_t + b_tG_t$ becomes central to the analysis. As the marginal utility of an additional child is strictly decreasing in the number of children and children provide positive net values, the increase in the effective number of children lowers the marginal value of an additional child; this happens with a greater number of boys, holding the number of children constant. This is a testable proposition. The author likens this to the quality dimension addressed elsewhere. Certain numerical restrictions must be placed on the net values of boys and girls (in general they both need to be positive) for econometric tests to work; daughter preference, as opposed to son preference can explain higher stopping probabili-

ties associated with more living sons under some, albeit rather unlikely, scenarios. A similar dynamic programming model is presented in Ahn (1995) and results using Korean data confirm the higher values and costs placed on male children. The author highlights concern over the prevalence of technologies that are able to ascertain the gender of unborn children and the simulated implications for sex ratios at birth.

Tests of gender/sex preference have been applied to data from varying countries, focusing on parity progression ratios, (transition probability of having n + 1 children, conditional on having n) and what have been termed Differential Stopping Behaviours, (DSB) within families. Clark (2000) discusses two testable implications of DSB for the sex composition of children within completed families. The first proposes that in the absence of an ability to affect the Sex Ratio at Birth, (via use of amniocentesis/sex selective abortion), the sex ratio at the aggregate level cannot be affected by DSB : Some mothers will be lucky and achieve their son total at a low parity, giving them a high proportion of sons and some mothers will be unlucky and have their sons later in the birth order, producing a lower proportion of sons at the family level. This behaviour causes a negative correlation between completed family size and proportion of sons that is missed in national averages. A second proposition is that, within a given family size, the characteristics of couples who want a higher proportion of sons will be the same as characteristics of families who have a higher proportion of sons.

One study covering 16 of the 26 states of India, using the previous round of the NFHS India (1993), including the high fertility states in the north, examines current use of family planning by sex composition and number of living children and method use (temporary versus permanent), Mahli & Jerath(1997). The authors find unambiguously that "at each parity the acceptance of contraception was found to be higher among women who had one or more living sons." They note that in the northern states, permanent sterilisation is most likely among the women who have at least two or more surviving sons and that there is little desire for even one female child. The parity and sex composition at which permanent sterilisation is undertaken provides a clear indicator of completed target family

size and is markedly different from the patterns found in the south of the country, where there is a desire for more balances sex ratios.

2.5 Models Incorporating Imperfect and Costly Fertility Control

The early papers on the economics of fertility proceed on the assumption of perfect and costless contraceptive timing and fail to address biological issues surrounding the stochastic supply of births. There is acknowledgement that ex-ante hoarding is imperfect, due to the stochastic nature of infant mortality and that this can lead to excessive numbers of surviving children but that no significant oversupply otherwise exists.

Certainly in India, despite the early implementation of family planning that introduced modern methods of contraception, fertility control is far from an exact science and there is widespread acknowledgement that breastfeeding has been and continues to be used as a fertility regulator, particularly in the absence of modern contraceptive methods, see Rous (2001).

That fertility regulation is imperfect and entails positive costs was first proposed by the demographers Easterlin and Sheps, who took a more biological approach to fertility outcomes, discussing the supply of births, as well as the demand. The following discussion sets out the development of the analytical and estimation frameworks that developed to take account of the supply of children and the costs and errors involved in controlling this supply.

We start with a brief discussion of the estimation strategies applied to cross-sectional data and then discuss some of the attempts utilising panel datasets that were able to incorporate information on the women's full fertility and contraceptive histories. Cross-sectional applications generally only use information relating to the respondent's current use of contraception so cannot estimate a full birth production technology. These methodologies are unable to extract information relating to woman-specific biological factors that affect natural conception rates, or heterogeneity in tastes that may have implications for dynamic fertility out-

comes and subsequent behaviour. Nor can they measure variation across women in contraceptive use-effectiveness that may result from, say, improved educations, or literacy; ie the efficiency parameters in the birth production function.

Those papers based upon complete fertility and contraceptive use histories, often by month, can match contraceptive use episodes to the birth outcomes that result and, controlling for woman-specific biological heterogeneity, identify the determinants of contraceptive efficiency. The woman's use of contraception is one endogenous choice within the model, given her biological reproduction function, tastes for children and for using contraception, incomes and opportunities, as well as the costs of children and of contraception. One is able to put structure on the technical efficiency of using contraception that has dynamic implications in the presence of conception errors. Some of the panel data treatments attempt to implement the full estimable dynamic programming solution; others present instead a simplified sequential estimation framework.

2.6 Static Treatments with Contraception

While not incorporating all the complexities of a full life cycle model, the static treatments that incorporate costly and imperfect fertility control remain embedded in a household lifecycle utility framework, wherein decisions to use contraception are derived from the demand to limit/space births, in the current period/interval (year or rest of lifetime, depending on interpretation).

Rosenzweig & Seiver (1982), Bollen, Guilkey & Mroz (1995), DeGraff, Bilsborrow & Guilkey (1997) each offer simplified sequential frameworks, that permit the reformulations that would occur within a full lifecycle treatment. For example, unanticipated births are seen to impact sequential choice, as are all dynamic outcomes such as the gender of children already born.

The papers implement an estimation strategy, which we also employ, that decomposes the effects of variables, such as maternal education, into their impact on the demand for children in the period and hence the benefits of using contraception, from their impact on the costs of using contraception. Where maternal

education reduces the marginal costs of contracepting, separately from the way it affects the demand for children, the negative effect of schooling on fertility (in a reduced-form equation) will be an over-estimate of the substitution effect of increasing opportunity cost of time; educated women have less children not just because the opportunity cost of their time is greater and hence the benefits of contracepting also greater, but because they face lower marginal costs of contracepting.

Rosenzweig & Seiver (1982) note that past reduced-forms of the effects of education in increasing usage of contraceptives are biased because they don't condition on the demand for children and preferences for family size, whose variation also embodies educational differences; the technical and behavioural relationships need to be disentangled.

The authors provide a foundation for the role of schooling by proposing a certain structure to contraceptive costs that makes the fixed costs cheaper for women with more education; by defining a cardinal index of contraceptive techniques ranked in terms of fixed and variable costs and efficiency level, where in addition, the high fixed cost techniques reduce the variance of fertility. Maternal education is assumed to lower the fixed costs associated with higher efficiency techniques. Such effects have dynamic implications for family formation but raise concerns when estimating any effects with cross-sectional data.

The authors are unable to test the educational efficiency hypothesis for lack of data on the birth and contraception technologies; this is made more difficult by lack of prior information on how education may influence fertility preferences in any life cycle interval. In any given period, it is not clear how education will alter fertility intentions. It is shown that maternal education alters the choice of the interval fertility measure "additional children desired" in three ways; by changing the time price of children, by changing the accumulation of excess fertility/timing errors in prior periods and by the taste effect of schooling on numbers, timing and spacing of children.

Degraff et al (1997) stress the importance of non-monetary (psychic) contraceptive use costs and how these may relate to women's status and community

social norms. They include measures of contraceptive availability and access, that reflect time and psychic costs. Importantly, the authors acknowledge the emancipating effects of women's community organisations on contraceptive uptake.

Non-monetary contraceptive costs, in the form of familial opposition, may well be correlated with fertility preferences (for number, timing and spacing). Analysis inclusive of such non-monetary attributes must make additional assumptions in order to proceed. To the extent that the relationship between education and the non-monetary attributes of contraception are important, the fertility-conditioned effects of education on contraceptive choice cannot be interpreted as purely technical relationships. For example, as will be seen in the first empirical paper, women with more education are often better placed to overcome nonmonetary barriers relating to concern over health side-effects.

In the panel study of Rosenzweig & Schultz (1989), to be discussed shortly, the authors find that where couples perceive themselves as being of greater fecundity, (a knowledge that is gained through the life-cycle), they will use more contraception than otherwise identical couples for two reasons; first, because for their age they will likely possess the greater accumulated fertility and thus want less additional children and second, in anticipation of greater present and future fertility in the absence of contraception; they have a greater maximal supply of births to avert. Both these factors operate to increase the expected benefits of using contraception currently. Yet such biological considerations cannot be captured with cross-sectional data.

In the absence of repeated observations on the same woman, estimates are not informative about the way in which socioeconomic factors impact upon contraceptive use effectiveness : Without information on the birth technology parameters and the matching birth realizations, one cannot disentangle technological from contraceptive cost parameters. In order to interpret results one therefore needs to make assumptions about the distribution of additional unobservable factors such as couple-specific fecundity and deal with any additional endogeneity in the system arising from such dynamic behaviour and outcomes.

2.7 Dynamic Treatments Incorporating Costly and Imperfect Fertility Control

2.7.1 Approximations to the full estimable dynamic programming solution

Empirical research assessing the contraceptive choices of couples utilizing temporal information on contraceptive episodes and full fertility histories is able to estimate the parameters of the birth production function and measures of the effectiveness with which differing contraceptive methods are employed, while also controlling for permanent unobserved woman-specific biological fecundity that impacts upon conception probabilities and contraceptive behaviour.

Noted by Rosenzweig & Schultz (1985), "fertility is determined by the dynamic interaction between the supply of and demand for births, and variations in birth outcomes across households reflect exogenous intercouple variation in both the supply of births, prices(of children and of contracepting), income and preferences for children, or the demand for births."

An early dynamic treatment of the endogenous demand for contraception, incorporating stochastic reproduction and non-monetary contraceptive costs is presented in Heckman & Willis(1974). The model of Leung(1991) presented previously follows their finite approach so we do not repeat it in detail here. Instead, we present the explicit contraceptive decision that comes out of the couple's assessment of lifetime utility.

The dynamic programming analytical models vary depending on the assumptions made about the form of utility and the nature of differing costs and benefits. How do children enter the utility function ? In general the models choose a finite decision horizon, reflecting a woman's reproductive lifecycle but this makes the analytics more complex. Simplifying assumptions, such as the idea that period utility is additively separable and quadratic, or strictly concave also simplify the analysis.

The model incorporates contraceptive decisions on the basis of the utility

gained/lost from having a child each period, given the imperfect stochastic nature of conception and the efficiency of contraception. The model demonstrates how the couple's contraception strategy evolves over its life-cycle, as a function of the costs of contraception, age, parity and the time paths of income and costs of children.

As with the model of Leung(1991), the household is seen to possess an intertemporally separable utility function, over T months of marriage starting at t=0, receiving flow units of c (child services, 1 per child N_t) and s (other services) each period, with constant discounting, inclusive of a disutility cost from contracepting, f, in month t, that depends upon an intensity parameter, thus $f = f(e_t)$.

$$U = \sum_{t=0}^{T} d^t \{u(cN_t, s_t) - f_t\} \tag{2.21}$$

The monthly probability of conception, p_t^* is seen to be a function of the intensity of efforts, e_t to avoid pregnancy;

$$p_t^* = p(1 - e_t) \tag{2.22}$$

with p the woman's natural fecundity, permitted to vary across women. The intensity outcome e_t is thus an endogenous choice variable and in the empirical section, differing contraceptive methods are assumed to have differing efficiencies. Increases in efficiency are achieved at increasing cost and the indirect utility function is concave in the number of children.

The couple is seen to maximize expected lifetime utility, subject to it's lifetime resource constraints, where income is again exogenous and all contraceptive costs are non-monetary, infant mortality being ignored. There is no saving or borrowing so the budget constraint is binding each period.

The authors illustrate a couple's decision of whether or not to contracept in the first month after marriage, on the assumption that the woman is initially childless, fecund and nonpregnant. Expected lifetime utility at the beginning of month two of marriage is conditional upon the outcome of conception/non-

conception in the first month. If the woman conceives in month one , $V_2(b_1)$ is defined as the couple's expected lifetime utility at the beginning of month two, on the assumption that the couple follows an optimal expected utility maximizing contraception strategy in all subsequent time periods, conditional on beginning month two in a pregnant state. Similarly $V_2(\tilde{}b_1)$ is defined as the expected lifetime utility at the beginning of month two, conditional on entering that month in a nonpregnant state. Thus the couple's expected lifetime utility at the beginning of marriage is written as a discounted weighted sum of the two lifetime utilities during the first month;

$$V_{01} = p_1^*\{V_2(b_1) - f(e_1)\} + (1 - p_1^*)\{V_2(\tilde{}b_1) - f(e_1)\} \tag{2.23}$$

One then examines the conditions under which a couple will contracept and if so how efficiently. Leaving aside contraception, its expected lifetime utility at the beginning of marriage, is given as

$$V_{01} = pV_2(b_1) + (1 - p)V_2(\tilde{}b_1) = V_2(\tilde{}b_1) - p\Delta V_2(\tilde{}b_1) \tag{2.24}$$

The term $\Delta V_2(\tilde{}b_1)$ is the expected lifetime utility of preventing a conception in month one. If it is positive and there is some gain to averting a birth, the couple may choose to contracept; if it is negative, the couple will not choose to contracept. As with Leung(1991), the assumption of concavity in V ensures that the marginal utility of an additional child is diminishing.

Assuming it to be positive, the couple selects the value of contraceptive efficiency e_1 that maximizes expected lifetime utility above. The first order condition for a maximum states that the optimal value of e_1 is such that the marginal cost of efficiency, f' is equal to the expected marginal benefit of efficiency, $p\Delta V_2(\tilde{}b_1)$.

The second order condition implies that the marginal cost of efficiency must be rising if values of e_1 strictly greater than zero, or less than one, can be optimal. This analysis is extended to the contraception decision of a couple with n children at the beginning of month t. Generalizing the equation above, the couple's expected utility over the remaining portion of life is given.

$$V_{nt} = V_{t+1}(\tilde{b}_{n+1}) - p_t^* \Delta V_{t+1}(\tilde{b}_{n+1}) - f(e_t) \tag{2.25}$$

The sequence of contraceptive use decisions made by the couple depends on how the sign and magnitude of $\Delta V_{t+1}(\tilde{b}_{n+1})$, the lifetime utility of an averted birth in that period, varies with time and parity and with the probabilistic outcome of these decisions, in terms of the actual timing and number of pregnancies and births the couple experiences. The authors acknowledge the intractability of a full dynamic-stochastic analytical model but use it for illustrative purposes and to guide the empirical formulation.

A discussion of alternative paths of contraceptive choices is presented, allowing for the possibility of an oversupply of births; "accidental" pregnancies that may motivate precautionary contraceptive behaviour. Such errors and behavioural responses were not accommodated in the model of Leung(1991).

The theory is extended to address contraceptive methods with differing fixed and variable costs. Such a framework can help formalize the way in which women make contraceptive use decisions and can partly explain why women choose the one-off cost of irreversible sterilisation, particularly in an environment of child hoarding and rules-of-thumb behaviours. The theory also assesses the fertility implications of different time paths of the costs of children (as wages rise) and of full income and the implications this has for optimal completed family sizes, when coupled with random times to conception.

The authors use data on the full reproductive and contraceptive use histories of sampled women to estimate the effect of economic variables and prior experience with the fertility process on contraceptive decisions. They stress the importance of the unmeasured components of persistent variation in natural fecundity and contraceptive effectiveness that raise serious statistical problems in obtaining unbiased estimates of the effect of economic variables on the monthly probability of conception of a representative couple. Selection occurs because the sample of women becomes less fecund as the months of non-conception grow; the most fecund women will always conceive sooner and leave the sample. The authors demonstrate the biases inherent in coefficient estimates based on procedures

that ignore the serial correlation.

Estimation centres on the monthly probability of conception (reproduction function) in the woman's first pregnancy interval up to a maximum 120 months. Thus there is no response by women to their unobserved (to the researcher) fecundity. The woman has her first pregnancy in month j if and only if she has not already conceived in prior months. These continuous latent conception probabilities, S_i are observed as pregnant/nonpregnant indices each month. The likelihood function is formed for each woman as this sequence and then summed over the distribution of all women. The correlation structure between S_i in any two periods is defined and the integral is formed assuming S to be normally distributed. For each group separately (contraceptors and noncontraceptors), parameters are estimated that maximize the likelihood of observing the sequence of conception/no conception for months (j=1, ...,120), or the event that the woman went for the maximum 120 months without conceiving. The serial correlation ρ is found to be positive and statistically significant in both groups.

2.7.2 Estimates of the Birth Production Technology

Rosenzweig & Schultz (1985) develop and implement a methodology for identifying empirically the supply function for births, in order to assess the consequences of exogenous variation in the supply of births for the couple's choice of contraceptive techniques and resultant fertility and for the life cycle labour supply choices of married women in the US.

A dynamic optimization model of contraceptive choice and labour supply, incorporating uncertain conception and persistent heterogeneity in preferences and biological fecundity is presented. An estimation strategy is proposed for obtaining estimates of the biological components of fecundity and the efficacy of contraceptive techniques, given household optimising behaviour and heterogeneity in natural fecundity and in preferences. The methodology is then applied to monthly longitudinal data from the US on contraceptive use, birth outcomes and female labour supply decisions.

The compensatory behaviour (in response to known woman-specific fecun-

dity) leads to significant under-estimation of the efficacy of contraceptive methods, where such biological heterogeneity is ignored, ie women who know they possess greater fecundity will use more contraception than similar women with lower fecundity. The authors note the presence of biases in other past estimated responses of labour supply and of adjustments in contraceptive choices, in response to variation in exogenous supply of births, when these are proxied using naive fertility outcomes.

A periodic birth production function is proposed in which the number of births to a woman depends upon her permanent biological fecundity, her age and a contraceptive technology parameter, as well as an iid serially uncorrelated error.

The lifetime problem follows, with the usual assumptions on the form of lifetime utility, subject to a per period income constraint, endogenising the mother's labour choice, given an exogenous wage. This maximisation is also subject to a permanent random taste parameter. The two choices each period are whether to contracept and whether the woman should go to work, based on the information set at the beginning of the period: Parents are aware of the persistent component of their fertility, μ_j, but not how many births they will have that period.

The authors acknowledge the analytical intractability of decision rules for L_i and Z_i in any period and instead offer comparative statics for the final period decision in which the parents can ignore the future ramifications of their present decisions. The utility function each period is given as linear quadratic in its arguments, wherein leisure and fertility are allowed to interact in a complementary manner. It is debatable if such a case can be made in India, where child-rearing and work can often be complementary. Preference parameters are constant across all periods but preferences for the consumption good X vary across households for all periods.

For the final period, t, the difference in discounted lifetime utility from contracepting is derived and some responses modelled; responses to both random increases in the stock of children and to changes in known peristent fecundity. The relationship between variations in prior fertility and the benefits of using birth control presently, depends on the information held by parents about whether the

variation is due to preferences(planned) or technology, (unplanned). An unanticipated random birth increases the likelihood of using birth control in period t.

An increase in known fecundity will have affected past birth outcomes and therefore accumulated unplanned births. It will also lead the family to expect more children in the future and in the present period. The authors also note that where there is heterogeneity in preferences for family size, τ,the direction and magnitude of the bias in past studies that use only fertility outcomes when assessing the effectiveness of contraception, is difficult to sign.

The effect of cumulative fertility on the current values of the utility differential associated with contraceptive choice, in a population heterogeneous in fecundity and preferences for the timing, spacing and number of births, is not clear, since women with higher cumulative fertility for their age are likely to be more fecund and for given preferences, the more likely to use contraception. However, women with greater accumulated fertility, for given fecundity may just have a taste for large families and hence "will derive less utility from the savings generated by contraception".

Similar concerns affect the start-of-period labour supply decision to work or not to work, given cumulative fertility. In period t, it is shown that the sign of the effect of an unanticipated(excess) increase in past fertility is ambiguous, given heterogeneity in preferences and fecundity, assuming that leisure and children are complementary: While greater excess fertility increases the returns to working, leisure time and children are complementary and thus the returns to staying at home increase also.

The dynamic response of the woman's leisure to exogenous variation in fertility due to persistent and random fecundity is also confounded by preferences for the timing, spacing and number of births. The authors confirm that a positive supply shock to cumulative fertility is likely to reduce fertility demand and increase contraceptive demand but to reduce labour supply (where leisure and children are assumed complementary) and that if the source of the shock lies with persistent biological fecundity, rather than in random elements, these effects

are strengthened.

This was the first analytical paper that built heterogeneity in preferences into a fertility model already heterogeneous in biological fecundity where couples could learn of and respond to their own fecundity and spelt out the implications this would have for prior estimates. Under these conditions, tests of the propositions require the isolation of the persistent and random supply components of fertility, from their demand components. Knowledge of β, combined with information on contraceptive use and birth outcomes enables estimation of μ and ε_{ij}.

To obtain consistent estimates of the $\beta's$, the authors use information on conceptions, pregnancies and contraceptive use, in a reduced-form procedure, rather than a full parameterised structural estimation method. Data consists of monthly contraception, conception, births and labour force participation from 1970 to the re-interview in 1975 for white, married women. Information was also collected relating to region of residence, local prices, labour market characteristics, and availability of public health and family planning services.

The authors suggest their Instrumental Variables strategy allows them to focus on estimating a "more complex" technology. The dependent variable is defined as the number of conceptions ocurring between the interview dates divided by the months of exposure to the risk of conception, as a function of the fractions of the time period that the couple used one of four methods of contraception. Aggregating over S periods where fertility control Z is used in f of these periods, the time-aggregated version is given as;

$$n_j = \mu_j + \sum_{i=1}^{S} \varepsilon_{ij} + \gamma A_j - \beta F_j \tag{2.26}$$

where $\mathrm{F}_j = f_j/S$ and endogenously chosen and A is the average age in the period. Fertility demand factors are used to identify F; preferences, prices and income, in order to get at consistent estimates of both β and μ_j. The reproduction function uses information on past fertility to 1970 and other biological determinants of conception, along with the usual set of exogenous factors to explain tastes, opportunities and constraints; educations, occupation and income of

husband, religious affiliation and age, information on local area and relative costs of children and other goods.

The monthly conception rate is estimated using OLS, 2SLS and in order to account for the right-censoring, single and 2-stage Tobit models are also estimated. Significant biases are found in the simple OLS of monthly conception rate as compared to the amended estimates.

These birth production estimates are then used to estimate the random and persistent components of fertility supply, by calculating the difference between the consistently estimated (2-stage Tobit) predicted conception rate, given their actual contraception choices and the couple's actual conception rate experienced, assuming away other sources of unexplained variation in birth rates from omitted variables, or measurement error.

The authors then estimate reduced-form effects of persistent and random fertility supply shocks, on accumulated fertility, resource allocations over the life cycle, on fertility intentions by the end of the survey and on female labour supply decisions. In all regressions, the fertility supply variables are significant and add to the tobit likelihoods.

2.7.3 Estimation of Determinants of Contraceptive Knowledge, Λ_j and effectiveness, β_j

Using the same dataset, the authors, Rosenzweig & Schultz (1989) followed with a further empirical paper assessing the effectiveness of education in improving knowledge and use of contraception, so as to allow the women to better achieve any given stated fertility goal (total fertility intention). They assess fertility outcomes from contraceptive use episodes and relate this to socioeconomic factors such as maternal education.

The authors note that the preferences of decision-makers are relevant to production decisions in this home-production instance and such preferences may not be exogenous to schooling; "holding constant prices, incomes and technology, ed-

ucation may change fertility and child health investments because it induces a systematic change in tastes".

Their paper also aims to assess if education helps couples gauge a better idea of their inherent biological fecundity, μ , based on their own fertility experience and thus exert better control over fertility outcomes. One has to disentangle the efficiency, input allocation and taste effects of education, on household production. The authors propose that the way in which education is thought to impact contraceptive use efficiency is through improved information acquisition, for those contraceptive methods that are not prescribed or installed by health professionals. Their results indicate that couples with higher biological propensity to conceive, net of their efforts to reduce conceptions, report a higher proportion of unplanned pregnancies and increasingly so later on in the woman's life cycle. Women with more education were able to counteract this with less unplanned pregnancies than women of similar inherent fecundity.

2.7.4 Estimable Dynamic-Stochastic Treatments of Contraception

The above papers established a sound methodology for estimating the biological supply function for births and the effectiveness of endogenous contraception on the path of fertility, accounting for permanent unobserved couple-specific fecundity and heterogeneity in tastes for children, yet they offer only approximations to true structural parameters and apply fairly basic econometric techniques.

Examples of structural estimation of dynamic discrete choice models of fertility are given in Wolpin (1984) and Ahn (1995), who also addresses the preference for sons, while Montgomery (1988) and Hotz & Miller (1989), (1993) and more recently Carro & Mira (2002) offer the only attempts at estimable dynamic contraceptive-fertility models.

These efforts have been few, in part, due to the computational burdens involved, even where uncertainty over future choices is removed. The need to simplify overly in order to obtain a solution becomes apparent when fitting the

results to the data. Wolpin's (1984) model did not fit the data and was unable to generate the observed positive empirical link between fertility and mortality. Carro & Mira (2002) note the failure of the model of Hotz & Miller (1993) also to generate "plausible" results, although it did exhibit application of the Conditional Choice Probability (CCP) estimator.

As noted in Train(2003), it is unlikely that a "general purpose breakthrough will arise that makes estimation simple for all forms of dynamic optimization models." Rather, the particulars of the research objective and decision setting will guide choice of the most appropriate specification and estimation method, each with it's inevitable strengths and weaknesses.

Eckstein & Wolpin (1989) provide a survey of the literature confirming the similarities and differences of utility specifications even among the fertility models. Estimable dynamic models are able to make explicit the information sets available and impose discipline on the researcher to keep things simple but may abstract from important behavioural concepts and for this reason are population-specific.

A more general dynamic programming problem, which nests the dynamic discrete choice models, comes from Bellman(1957). The solution to what is a multidimensional problem is pared down to a sequence of pair-wise comparisons, in a recursive manner. A general model set out in Eckstein & Wolpin(1989) is reproduced below. Essentially a sequence of I discrete choices are made over T discrete periods of time, where T may be finite or infinite. The individual chooses one of I alternatives where the indicator, $d_i(t) = 1$ if alternative i is chosen at time t and $d_i(t) = 0$ otherwise. Alternatives are mutually exclusive, or can be made so. $\sum d_i(t) = 1$. The objective function at any time can be defined as a maximization of

$$E\left[\sum_{j=t}^{T} \beta^{j-t} \sum_{i \in I} R_i(j) d_i(j) | \Omega(t)\right] \tag{2.27}$$

where $0 < \beta < 1$ is the individual's discount rate, E(.) the expectations operator, $\Omega(t)$, the individual's information set at time t, which includes all past and current realizations of the variables that directly, or indirectly affect the value

of the above equation and $R_i(t)$ is a random variable representing the individual's reward if alternative i is chosen at time t. $R_i(s)$ for $s \leq t$ belong to the individual's information set at time t. Maximisation involves choice of the optimal sequence of control variables $\{d_i(t)\}_{i \in I}$ for t=0,1,2,...,T which are functions of information that is available when the decision is made.

Defining the maximal expected value of the reward at time t

$$V(\Omega(t)) = \sup_{\{d_i(t)\}_{i \in I}} E\left[\sum_{j=t}^{T} \beta^{j-t} R(j)\Omega(t)\right] \tag{2.28}$$

where $R(j) = \sum_{i \in I} R_i(j) d_i(j)$ is the reward at time j. This value function depends only on information at time t. The dynamics are due to the dependence of the value function at time $t+1$ on the choice of d_i at time t and possibly before. Without building in any variation in observed behaviour, the model would predict that homogenous individuals will all make the same decision. One can build in such heterogeneity by assuming that the reward function is stochastic and given by, for example, $R(j) + \varepsilon(j)$ and to assume that individuals draw at each j from the density function for $\varepsilon(j)$.

This gives the value function now to be $V(j) = \max(R(j) + \varepsilon(j), E(V(j+1)|\Omega(j))$ where E() is the conditional expectation of V(t+1) taken over all future $\varepsilon' s$.One then makes specific assumptions about the distribution of these ε's, for example that they are iid over time. Since they are unobserved by the researcher, the decision appears random. A comparison of the resultant predicted probabilities over time, with the observed choices forms the basis for the estimation of the reward function.

What separates specific applications of the models more fundamentally lies in the assumptions underlying the models' stochastic structure. For example, Wolpin(1984) assumes the $\varepsilon_i(t)$ to be normal and independently distributed through time but adds a further individual-specific permanent unobservable, whereas Ahn(1995) follows Rust(1987) by assuming the $\varepsilon' s$ to be iid extreme value. Montgomery(1988) also follows the framework in Rust(1987). The fertility models of Wolpin, Ahn, Hotz & Miller, Montogmery all allow for forms of permanent un-

observed biological fecundity in women, as was originally set out by Heckman & Willis(1974).

Carro & Mira (2002) also follow the framework of Rust(1987), where the errors are assumed conditionally independent across choices, periods and couples and distributed extreme value and build in a form of permanent unobserved heterogeneity. They use 1995 Spanish Family and Fertility Survey data and propose a dynamic-stochastic model of sterilisation and contraceptive use. They permit simple forms of permanent unobserved biological heterogeneity in fecundity that has implications for estimates of utility and cost parameters. They suggest most Spanish couples would have two children but significant deviations from this goal occur as the result of costly and imperfect fertility control.

In order to estimate the parameters of any of the models, a closed-form (not necessarily analytical) solution must be obtained for the optimization problem. In the finite horizon case the solution is obtained using backwards recursion of the decision problem. The computations required depend upon the form of the model and assumptions made. Rust(1987) introduced certain assumptions on the form of the errors (that they came from a closed-form distribution) that simplified greatly the calculations required.

2.8 Child Schooling and Child Labour

As with optimal family size decisions, those concerning investments in the quality (human capital) of children, such as their education, are also made in a dynamic setting, simultaneously with those over child quantity. The explicit costs, opportunity costs and returns to both schooling and child labour are assessed by parents in arriving at their optimal family formation strategy, in light of prices, natural fecundity, wages, borrowing/lending constraints and expected survival probabilities. The costs of controlling fertility have implications not only for the number of children born but also for their quality.

The more recent treatments have stepped away from the static frameworks of DeTray (1973) and Becker & Lewis (1973), in an effort to build in the temporal

dimension to decision-making that has implications for the number of children born and their quality. With costly schooling and imperfect capital markets, an inability to control fertility renders parents unable to send existing children to school. In a multi-period context, the parents repeatedly face a trade-off between childbearing(quantity investment) and providing education(quality investment) to existing school-age children, in an environment of costly and imperfect fertility control: Reducing the costs of contraception alters this trade-off.

Foster & Roy (1997) look at the effects of randomized current Family Planning programs on contraceptive use and child schooling decisions, via short-run family composition effects, using Bangladeshi longitudinal survey data. The authors mention faults with previous studies addressing cross-sectional associations between family sex composition and the differential schooling of boys and girls where such simultaneity is ignored. Heterogeneity in preferences will be confounded with the schooling effects of Differential Stopping Behaviour (DSB), in the presence of son preference: Preferences may cause a taste for more schooling (quality) to be associated with smaller families, but in addition, the preference for sons will result in smaller families being son-heavy, more so than larger families, thus causing a correlation between family size and proportion female. The regression of schooling on the number of children and proportion female will yield biased estimates of both effects.

The sequential estimation employed in Foster & Roy (1997) builds in a first-order serial correlation in the contraceptive cost series, accounting for persistent woman-level fecundity heterogeneity. Estimation offers linear approximations to the decision rules for fertility and for schooling and makes use of Instrumental Variable procedures.

The effects of family planning are not found to be entirely favourable, with results confirming the significant sex composition effects on schooling that arise because couples with daughters are less likely than those with sons to limit further fertility. A-priori, one might expect that where older daughters are needed to fulfil the childcare role (of younger siblings), such childcare time may preclude their attendance at school and that the use of contraception, by curtailing these

higher-order births, renders the girl free to attend school. Yet this is not found to be the case; sex differentials in schooling are seen to increase with the use of contraception because families with older daughters in general choose not to use contraception and go on to have larger families.

These family composition effects are assessed empirically in Jensen (2003) who confirms the existence of a positive correlation of proportion female with family size, that has implications for gender differences in schooling. The author illustrates the impact for family sex composition of (DSB), with a simple fertility rule and shows that even mild DSB can generate quite large family size differences for boys and girls. Estimates suggest that between 1/10 to 1/4 of the differential in educational outcomes among sons and daughters can be attributed to this DSB, that causes female children to reside in larger families.

Gandhi-Kingdon (1997) finds evidence of a significant differential in labour market returns for men and women in India and points to these lower expected gains from educating girls as the root cause of much of the gender gap in schooling in India. The author estimates labour force participation functions and selectivity-corrected earnings functions for both men and women and performs a Blinder-Oaxaca decomposition of the explained and unexplained components of this gender-based earnings differential.

Marriage practices in India also have implications for the returns to schooling of girls, particularly among populations practising exogamic marriage, where the female child leaves her natal home permanently to reside in a different village. Returns to her schooling are only realised by her in-laws. Factors such as the quality and relevance of education also affect perceptions of it's future and present worth.

Angeles, Guilkey & Mroz (2004) address the issue of how to obtain consistent estimates of the effects of maternal education on fertility, in light of concern that such maternal education may itself be endogenous. The authors suggest the presence of family planning programs may influence young women's decisions about their own education and age at marriage. If the costs of using contraception are perceived to be too great, young women will acknowledge their inability to

control future fertility and therefore won't bother to remain in school.

The premise of their paper is that female schooling decisions are made taking into account knowledge of contraception at the time the girl is young. This knowledge of contraception, that is improved through the presence of community level family planning (FP) facilities will reduce the probability that she overshoots her family size later in life, leaving her free to work in the labour market, thereby realizing any returns to her education.

This is a compelling economic reason why parents differentially educate sons rather than daughters, since sons will not be responsible for the time care of their own children to the same extent that girls will. In such an instance, the parents do not expect to realize any returns to educational investments and on that basis choose not to educate their daughter.

Thus, current availability of community-level family planning facilities will have separate effects on the education of girls because of the way it increases the expected returns to investments in female schooling. Such an effect of community-level indicators of FP facilities will not be found for boys because they will always be free to realize returns to schooling.

Gandhi Kingdon (2002) offers an analysis of the gender gap in educational attainment of male and female adults of completed schooling between the ages of 23-45, in the urban capital city of Uttar Pradesh, Lucknow. The author initially estimates a binary enrolment equation and finds the effect of being female to be significant and strongly negative on the probability of enrolment.

Negative effects of coming from a Scheduled Caste, or Muslim household are found and point to discrimination in the returns to schooling for these disadvantaged groups. Family wealth when respondent was a child is positively related to enrolment rates for both males and females, though the effect becomes progressively weaker at higher levels of wealth. Even fee-free schooling seems to discourage enrolment due to high opportunity costs and other non-fee expenses such as transport and books.

Parental schooling is seen to be differentially important for enrolment of females but not for males. Poor child health when aged 14 years is seen to reduce

the probability of enrolment for males only. Having a working mother exerts a significant, negative influence on the enrolment probability for females and this is thought to reflect the need of daughters to fulfill household chores and child-care duties. This indicator also possibly acts as a wealth proxy, indicating a poorer household. Selectivity-corrected education attainment (in years) functions, conditional on enrolment, are also estimated.

While the study uses comprehensive data that also contains information on individual ability, it did not contain the rich description of child labour opportunities, or data on adult and child wages that may have strongly influenced the parents decision to send the child to school and therefore is left with a fairly sizeable unexplained component for the gender differential in schooling.

Dancer & Rammohan (2004), Dreze & Kingdon(1999) and Morduch (2000) all focus on the differing roles of gender, school quality and birth order in explaining schooling outcomes for children. Afridi(2005) discusses the role of female autonomy and intrahousehold bargaining in explaining the gender gap in schooling, picking up on the themes discussed in Eswaran (2002), relating to divergent preferences of the husband and wife and the way in which these are reconciled.

However, few of these papers provide sufficient account of the role of productive child labour opportunities in identifying the true costs of sending children to school. A more rigorous treatment of schooling outcomes must appreciate the way in which parents make schooling decisions, in light of incomes, capital market imperfections and the tradeoff between present and future consumption.

Inclusion of these implicit schooling costs will also contribute to explaining the gender gap in school attainment, left unexplained in Gandhi-Kingdon (2002b). This is because opportunities to contribute economically often differ with the child's gender. In several developing countries, gender norms dictate the type of work performed by men and women and their sons and daughters, particularly in south-east Asia.

Much of the work performed by sons relates to family enterprise outside the home, or within the unskilled labour market, whereas female children are expected to contribute mainly to household chores and to the care of sick or younger

family members. These socially-prescribed gender roles lead to differences in the opportunity costs of schooling by gender. In addition these opportunity costs have also been found to vary by birth order, wherein older siblings are expected to care for sick family members, or younger brothers and sisters.

One can also address the question of why some children may appear "idle". Such idleness is either a misclassification (where children are actually working within the home), or a result of the combination of poor quality schooling with few productive child labour opportunities. Moreover, child-specific ability plays an important role in parental schooling allocations for the way it affects the perceived returns and contributes to the explanation for child idleness.

The literature focusing on an explanation of child labour looks to the theory on Permanent Income and the role children's earnings play in smoothing and contributing to household consumption, in the absence of other mechanisms. This approach is embraced by Beegle, Dehejia & Gatti (2005), who investigate the extent to which transitory income shocks lead to increases in child labour and whether household access to credit mitigates the effects of these shocks and hence the need for child labour. They point to the inefficiency of child labour, where it results from imperfect capital markets that constrain the household's ability to borrow in, or insure against times of need. The authors find evidence in support of their hypotheses among rural Tanzanian households.

Along similar lines, Edmonds (2004) finds evidence that liquidity constraints drive children out of school and into labour, by assessing the response of Tanzanian households to anticipated cash transfers, in the form of age-tested social pension benefits. As households become eligible for the pension, the increase in non-labour income is found to reduce household child labour supply and increase schooling. The effects were larger where male pensioners became eligible.

The two-period model of Edmonds (2004) is based on that of Baland & Robinson (2000), where some child labour is privately efficient. Although parents do not expect to receive income from their adult children, they do care about the utility of their children, which in turn depends upon the bequests parents bestow upon them in the second period, in an effort to return to the adult child, the

earnings from their labours when younger.

Cigno, Rosati & Tzannatos (2001) apply a simplified two-period model of parental decision-making over fertility, schooling and child labour under uncertainty over child survival. This survival can be affected by parental spending on the child. The authors propose one version in which parents behave altruistically, where both the consumption of children and their human capital enter the utility function of the parents and another in which parents raise children only as a form of old-age pension (non-altruistic model), where such pension benefits are linked to the earnings capacity of the adult child. These earnings are improved with costly investments in the child's schooling and health.

Using data from the Human Development of India Surey 1994, the authors derive a test to determine if parental behaviour more closely fits the altruistic model or the one lacking such concern. This is achieved by assessing how parents react to an increase in the survival probability of a school-age child through inclusion of a local level survival rate; because non-altruistic parents will perceive a greater expected return, the greater the child survival probability, they will invest more in the child's schooling: Altruistic parents should not alter their schooling decisions. Parents were found to alter their schooling decisions, thus providing support for the "non-altruistic" model, as defined.

Basu (1999) offers a comprehensive review of the theoretical literature on child labour, distinguishing between non-altruistic models of intrahousehold bargaining that point to the victimisation of children and those that assume a unified household framework, where credit constraints lead to socially inefficient levels of child labour, as in the above papers that assume parental altruism.

Cigno (2004) presents a three-period model in which the decision is again over child labour or schooling, taking fertility as given. The model combines both the altruistic qualities of parents, with a pension motivation, typical of non-altruistic parent models. He offers competing realities that show that child labour exists optimally, not only without capital markets but also with such extensions to borrowing and lending. The model does not assess any supply issues that affect the child wage.

In an effort to focus on the tradeoffs between labour and schooling, the number of children is often taken as given, or chosen exogenously before the choice to allocate child time is made. The models are thus unrealistic in their treatment of parental decision-making in ways that are important. For example, an extra birth, accidental or otherwise, may lead to older children being pulled from school to contribute to household income.

If insufficient account is taken of the role of such fertility, the hazard of a child being pulled from school in order to work at the going child wage may be underestimated. A handful of papers have applied multinomial discrete choice frameworks to estimate a child's time allocation, taking into account the possible endogeneity of current number of children and the existence of idle children, classed as not working or attending school.

Bacolod & Ranjan (2004) present a theoretical model that shows idleness may be chosen optimally by borrowing-constrained households whose child is of low ability. Using longitudinal data from the Philippines that contains information on the child's non-verbal IQ test as a measure of ability, in conjunction with child and household-level information, the authors find that while other factors including maternal labour supply, the presence of a family business and access to good school quality contribute to such time allocation decisions, the child's ability and household wealth are the most important determinants of child idleness and the use of child labour.

Deb & Rosati (2003) implement a similar multinomial model but take account of the effect of endogenous fertility (number of other siblings) on the current child's education/labour/"idle" decision. They estimate a multinomial logit model of each child's activity, choosing only one child per household, with heterogeneity component and i.i.d errors following an extreme value distribution, jointly with a Count of the number of other siblings, assumed to follow Poisson process. The authors apply Maximum Simulated Likelihood techniques.

The NCAER 1994 data used does not contain information on wages for adults or children so leaves unexplained any variation relating to schooling returns and the opportunity costs of schooling. Three cost of education variables are devel-

oped; the presence of a primary school in the village; the presence of a secondary school in the village and the village-average monthly cost of schooling. The authors suggest that significant child mortality means that parents wait until the survival uncertainty is largely resolved before they make the schooling/labour decision for each child.

Pal (2004) implements a bivariate probit framework to jointly determine a child's participation in school and in the labour market using data from the World Institute of Development Economics Research (WIDER) for rural villages in West Bengal, India, focusing on children in the age group 5 - 15 years of age and currently therefore in school.

The authors take account of both implicit and explicit opportunity costs of schooling through the inclusion of data on labour force participation rates of men and women at village-level and daily village-level wage rates, to proxy for the expected returns to schooling. Results suggest that indicators of household resources, parental preferences, returns to and opportunity costs of domestic work significantly affect child school enrolment.

Deb & Rosati (2004) assess the determinants of child labour and school attendance paying particular attention to the role of household-specific factors not observable to the researcher through estimation of a semi-parametric latent class multinomial logit. In this vein they test for differing numbers of unobservable latent types, assuming the distribution to be discrete; five types of households are identified using Bayesian methods. Unobserved household heterogeneity is found to be substantial.

2.9 Observable Fertility Demands and Appropriate Estimation Techniques

2.9.1 Static Measures of Child Quantity and Quality

The field of empirical fertility research developed with the efforts of social scientists to map the geographical dimensions of fertility and life expectancy across

cultures in order to provide some short-term projections of population growth. These projections were broad estimates, based on an intrinsic understanding of the differences across families. The demographic models were descriptive in nature, explaining the existence of observed fertility patterns, particularly with regard the demographic transition from high to low birth and death rates, both between and within countries across time.

A deeper knowledge of the factors that caused these demographic patterns and changes over time came into focus and the modelling by economists helped clarify what had been proposed by other social scientists. Necessarily, concern pointed toward the family and the opportunities they perceived for education, employment and migration and the exogenous expected living conditions (such as access to credit and water) that impact on health and determine optimal human capital investments, notwithstanding the sociocultural context.

The applied work by economists aimed to test some of the predictions of the early theoretical models, with regard this life-cycle behaviour. These models were a first attempt to understand the motivations for family formation, viewed in the framework of household choice. They are static formulations of the life-cycle decision problem: The prospective parents are seen to make a one-time decision concerning the total number and quality of children to bear, based upon an information set available at the beginning of their matrimony.

The empirical work commences with tests of the predictions of the early static formulations of fertility, with regard parental response to changes in exogenous circumstances. The relevant dependent variables are measured at the level of the woman ; number of children per woman, for all women of completed fertility, and quality per child for these women. De Tray (1973) uses 1960 US Census of Population data and the above fertility definitions to test some theoretical predictions.

Early empirical formulations relied on Ordinary Least Squares procedures and supplemented these with Two-Stage Least Squares to account for the endogenous nature of particular explanatory variables, such as income and child mortality. Instrumental Variables procedures are used to identify the exogenous compo-

nents of these variables. This approach is favoured by Benefo & Schultz(1996) in their study of fertility determinants in two African countries, Ghana and Cote I'voire. They note that children and market labour place competing demands on a woman's time and thus render any labour supply decisions endogenous to the decision on fertility. However, decisions that were made in the past before a woman's fertility cycle began may be considered exogenous. So for example any information pertaining to the family's inherited wealth or capital assets as well as human capital in the form of education may help independently identify its lifetime demand for births.

The nature of fertility and infant and child mortality experience, at the level of the woman, renders many women with no experience of birth, or child death and others with discrete numbers of each. Thus the values the dependent variable can assume are limited, often with a mass at zero. Poisson regression techniques record the number of events in an interval as a stochastic process and certain less restrictive forms of this process can validly represent the outcomes of fertility and mortality at the level of the woman and have been applied in this manner.

Atella & Rosati (2000) choose a sequential Hurdle-Poisson model to handle under-dispersion in their count data fertility model, though Poisson specifications are also tested as a benchmark. The specification, number of births per woman, is able to determine the effects of changes in the mean and variance of exogenous village-level survival rates on decisions regarding children, net of the direct effects of child loss.

Gangadharan & Maitra (1999) make use of a Poisson regression model to determine fertility-mortality interactions in South Africa. The dependent variable is defined as the number of times a woman has been pregnant. Infant deaths are recorded as well as information on stillbirths. Estimation utilizes instrumental variable techniques, in order to address concern over endogeneity.

Windmeijer & Santos Silva (1997) discuss further the use of GMM procedures in estimating count data models with endogenous regressors and compare this to a Two-Stage quasi-MLE. They note the importance of the way in which heterogeneity enters the model ; multiplicatively, or additively.

Mullahy (1997) also addresses concern with unobservable heterogeneity when it is correlated with regressors and proposes a GMM procedure, assuming heterogeneity enters additively. Miranda (2004) provides FIML estimation of count data model with endogenous regressor.

Perhaps the reason such techniques have not been used so extensively in empirical family formation work is that the woman-level analysis of births or deaths does not allow for estimation of dynamic temporal behaviours that typify the family formation process. Such measures are useful in assessing the determinants of completed child quantity and quality.

2.9.2 Dynamic Behaviour and Estimation of Replacement Responses

An empirical counterpart to the dynamic theoretical models of the 1970's and 80's needed to be able to represent sequential behavioural response that was at the heart of new hypotheses, while accounting for certain permanent unobserved processes. New sequential fertility measures were formulated as the outcome of a period-by-period decision problem, in light of uncertainty over future child survival and income-earning opportunities.

This latent decision (since we cannot observe the marginal change) leading to the discrete choice, is interpreted as the conception probability each period. It is recognised that the natural biological fecundity of women leads to a positive probability of birth even where there is no intention to conceive and as such, methods to avoid pregnancy are included that entail positive costs, in the form of disutility. Heckman & Willis (1974) give an early indication of the complexity of the estimation problem, in their calculation of the monthly probability of conception, in an environment of imperfect contraceptive control.

Sequential replacement behaviours, in the form of responses to regimes of high infant mortality, expected or experienced have been estimated in numerous papers. In the earlier papers, infant and child mortality are assumed exogenous and an ex-post replacement response is estimated. An early empirical paper by

Ben Porath et al (1976) assesses the direct, ex-post replacement response to child death. The dependent variable is defined as the probability that each birth for a woman is the last, hence is a stopping probability in the form of a discrete Logit. For a given birth order, the stopping probability was found to be lower where one of the preceding births ended in death.

Olsen (1983) and Olsen & Wolpin (1983) present lifetime decision models and a more refined methodology to separate the ex-post replacement response, from the ex-ante hoarding response, from the ex-post biological replacement, utilizing both woman-level fertility and mortality measures, as well as parametric waiting time regression techniques. The authors develop a WLS estimator of length of infant life in months, including a within-group Fixed Effect estimator, interpreted as the exogenous component of infant mortality, (biological mother-specific frailty) and assumed known to the family before the first birth; this is assumed to determine the ex-ante replacement (hoarding) response to anticipated child deaths. The authors also use actual experience of death to estimate direct replacement but acknowledge its endogenous nature. They find it to have a much greater impact on replacement, in this case ex-post.

Waiting time regression models were also used to estimate the hazard/probability of conception at a particular point in time, t+1, conditional on not having conceived up to time t. Assumptions about the form of the hazard must correspond to observed behaviour. For example, if it is the case that there is some uniform probability of conception each period, the exponential model is an option. Both semi-parametric and non-parametric hazard functions have been used to assess birth interval correlates, accounting for woman-specific biological effects. Hazard models deal with the right censoring of observations that occurs where respondents fail to re-conceive and the birth interval is left open. All information is used efficiently up until the point of censoring.

Panis (1992) attempts a joint determination of fertility and mortality, interpreting the conception intervals between births as the measure of fertility and using continuous survival technique (hazard functions) for both processes. The proportional hazard specifications adopted by the author allows for a non-parametric

baseline hazard, following Cox (1972), with several multiplicative duration dependencies. Mother-specific heterogeneity components are incorporated across the two equations, in the form of random effects, assumed normally distributed; thus it is a semi-parametric class of model.

2.9.3 Simultaneous Estimation Methods

The health outcome research, estimating the determinants of infant and child mortality and other measures, noted the role of high fertility in exacerbating mortality, via resource-constrained households, higher disease transmission associated with greater numbers of young children and via depletion of the mother from rapid child bearing. This gave support to the idea of dual causality between fertility and mortality, as well as the presence of underlying exogenous preferences and conditions, giving rise to a joint determination of the two. Certainly it was acknowledged that mortality was at least to some degree under the control of households through the resource inputs parents spent on their children.

With the acknowledgement of an endogenous component of child mortality and fertility, in conjunction with the failure of 2SLS to provide stable estimates, economists attempted simultaneous estimation using ML procedures. They began imposing a-priori structure on the equations and disturbances, based on behavioural and temporal assumptions that help identify the effect of an endogenous explanatory variable on fertility, conditional on the hypothesized error structure.

Simultaneous discrete choice methods became popular with fertility in each period framed as binary choice and with mortality as the event of interest, occurring, (or not) in some specified interval. The specifications accounted for selectivity in births and survival, modelling the heterogeneity components with less structure than previously. Pitt (1997), Pitt & Sigle (1997), Bhargava (2003) all make use of Random Effects Bivariate Probits, using Maximum Likelihood procedures.

Pitt (1997) attempts to estimate the determinants of child mortality and health, accounting for selectivity in children born, finding significant but small effects. A normally distributed Random Effects structure is assumed for the

family-specific heterogeneity component in the bivariate probit, however, the author found the model difficult to identify without further restrictions. The dynamic nature of fertility and mortality means modelling the birth decision, in an effort to deal with the selectivity is inherently difficult, since there are few variables that identify the endogenous fertility decision but not subsequent child mortality. In order to consistently estimate the model, structure is imposed on the intertemporal error correlation matrix.

As the author notes, associating all correlation with a single woman-specific factor is sufficient to yield an error correlation matrix with equicorrelation, a special case of the exchangeability property. As an extension to the paper, the author then permits a relaxation of this error structure (woman-specific time-invariant factor), replacing it with an expression that permits the woman-specific effect to vary across time, or with the woman's age; thus effects can be made non-parametric, or parametric functions of these time-varying exogenous factors.

The exchangeability property between the uncorrelated portion of the errors is also relaxed to allow for cohort-specific shocks that may induce lower fertility when the expected chances of survival are lower. This renders the children who are born at risk of greater mortality.

Using complete birth and mortality history data, Pitt & Sigle (1997), provide for joint estimation of the probability of giving birth in each month, along with the monthly probability of child death, for each woman to determine dynamic household behaviour in response to rainfall shocks. Estimation utilizes ML methods, for both a reduced form simultaneous model and a further set of equations incorporating structural state dependence, inclusive of serially correlated heterogeneity, using Demographic Health Survey birth history data and merged rainfall data for Senegal. All mother-specific random effects are assumed normally distributed, the stochastic component logistically distributed. Again, with the woman level factors integrated out, the only source of correlation is removed and thus consistent parameters are therefore estimated.

Data Considerations

Data, to test what may appear an interesting theoretical phenomenon, are often not available. For example, it has been proposed that the wages of husbands represent an income effect, increasing the demand for children, and those of women represent substitution effects, since they reflect the opportunity cost of her time and hence the price of children. But data on women's wages are not collected at low enough levels of aggregation, particularly in developing countries. And where they are, they often represent wages of a select group of women, (often less than 5% of those in gainful activity) who actually receive a formal wage; a biased measure.

Depending on the country in question, there are data limitations of varying degrees. Fertility surveys of the type generally collected to assess lifecycle fertility behaviour are ordinarily cross-sectional and retrospective in nature, containing varying degrees of birth history information and vital event histories. These surveys generally do not collect detailed information on local wage rates, earnings levels of men, women or children, or contain much price data. In developed countries, vital event history data can be merged with data from income and household economic surveys but in developing countries, this is often not available. Thus much of what economists wish to assess in terms of substitution and income effects is either unavailable, measured with error, or even immeasurable.

So too, evidence of the behavioural response of parents to child-specific factors (such as endowment heterogeneity), observable or not, in the form of intra-household resource allocations, has been scant because of the lack of data on these family processes. This is now a growing area in the literature. Intra-family information is becoming more widely available, as are repeated and matched samples and more accurate reporting of the household conditions that cannot always be assumed unchanging over the lifecycle.

2.9.4 Relaxing Distributional Assumptions

The probit, logit and other extensions are parametric models wherein the probability of interest depends on a finite number of parameters. With regard the Probit model, departures from normality can be costly, in terms of consistency. This conditional probability may be written;

$$P(y = 1|x) = G(x\beta) \equiv p(x) \tag{2.29}$$

where x is 1 x K, β is K x 1, and the first element of x is taken to be 1. For the linear probability model, G(z)=z is the identity function, which results in response probabilities falling outside the unit interval. The function G maps the index into the response probability and in most applications, is a cumulative distribution function (cdf), whose specific form can be derived from underlying assumptions on economic behaviour and unobservable preferences. This same result derives from the latent variable model:

$$y^* = x\beta + e, \quad y = 1[y^* > 0] \tag{2.30}$$

where e is a continuously distributed variable independent of x and the distribution of e is symmetric about zero. Thus, where G is the cdf of e, 1 - G(-z) = G(z) and hence

$$P(y = 1|x) = 1 - G(-x\beta) = G(x\beta) \tag{2.31}$$

Recently there have been relaxations of the parametric assumptions on P (y|x). Wooldridge (2002) notes that if it is acceptable to restrict attention to the direction and relative sizes of the partial effects, and not the response probabilities per se, several approaches are possible which do not rely on strict distributional assumptions. Ruud (1983) obtains conditions under which the slope parameters can be estimated, up to scale, even though there is a misspecification of G(.).

Another approach recognizes that the function G(.) may not be known but the response probability has the form such that the error is independent of re-

gressors; semiparametric estimators of the slope parameters up to scale do not require knowledge of the distribution of the errors and hence the functional form of G. Under certain restrictions on the function G and distribution of x, the semiparametric estimators are consistent and $\sqrt{N}$-asymptotically normal.

Lee et al (1997) make use of the Klein & Spady (1993) semiparametric estimator in assessing health and mortality with selectivity in birth and survival. Further semi-parametric estimators of the slope parameters up to scale, that do not rely on information regarding the function G(.) are provided in Stoker (1986), Powell, Stock & Stoker (1989).

Wooldridge (2002) notes that even where the error and regressors are not independent, it is possible to estimate β up to scale, with some restrictions on the error (ie that the median, not the mean of e|x = 0) and distribution of x. Manski's (1988) Maximum Score Estimator is one example of this. Other semiparametric and nonparametric approaches to discrete estimation are emerging, however their ability to deal with endogenous explanatory variables is only just developing.

Lewbel (1998) proposes a semiparametric estimator for a latent variable model with endogenous regressor and Newey, Powell & Vella (1999), Imbens & Newey (2002) propose nonparametric estimation of a triangular simultaneous equations models. Das, Newey & Vella (2003) cover non-parametric estimation of sample selection models. Blundell & Powell (2004) cover endogeneity in semiparametric binary response models.

Ruud (2000) provides an overview of semi-parametric estimation techniques for discrete choice models where the unobserved portion of utility is not assumed to follow a particular functional form but instead is treated non-parametrically. Differing estimators are proposed, depending on assumptions of independence of vector of explanatory variables and error.

2.9.5 Estimation with Simulation for Discrete Outcomes

In recent years advances in simulation have permitted the estimation of more flexible models in numerous settings. The ability to approximate integrals frees the researcher from imposing estimation constraints based not on the data but

numerical expediency. This allows for a more accurate depiction of the choice siutation at hand, makes fuller use of the data and permits further concerns to be dealt with.

Where the behavioural process entails variables not observable to the researcher, the problem appears not to be deterministic and so the probability of each outcome is derived. In it's basic form, this probability appears as an integral of an indicator over all possible values of the unobservables. Where the specification for the distribution of the unobservable variables take particular forms, the probability can be calulated exactly, as in the logit. For others, where the integral does not take a closed form, methods of simulation come into play. Since integration over a density is a form of averaging, the procedure can be approximated through simulation methods.

Train(2003) offers the basic intuition involving drawing from the distribution of the unobservables and using these draws, along with observed outcomes, to calculate the simulated probability. Partial simulation is used where the unobservable components fall into different elements, with differing densities; some of the integrals can be calculated exactly, others are simulated. This procedure is labelled "convenient error partitioning", in the sense that it is useful to simplify estimation where possible and use closed-form integrals that can be exactly calculated analytically. One example of this is the Mixed Logit model, where the standard logistic error is combined with further error elements that can take one of a number of distributions.

As Train (2003) notes, the properties of an estimator can change where simulated probabilities replace actual probabilities and can introduce additional concerns that must be understood. Various methods of estimation involve simulation and depending on the properties desired of the simulated estimator, differing procedures are advised. Train (2003) discusses three methods of estimation that make use of simulation methods: Maximum Simulated Likelihood, Method of Simulated Moments and the Method of Simulated Scores. Each of these is discussed with reference to it's non-simulated analog; the properties of the traditional estimator are compared to those of the simulated estimator. The simulation is shown to

add extra elements to the sampling distribution of the estimator. The conditions under which these elements disappear asymptotically are identified so that the simulated estimator is asymptotically equivalent to it's non-simulated counterpart. Even where this equivalence does not hold, conditions are identified under which the estimator is at least consistent. Bayesian estimation procedures have also been developed that use simulation methods.

Chapter 3

Background to Contraceptive Behaviour in Uttar Pradesh

3.1 Drivers of High Fertility

The reasons for the slowing decline of fertility in the north of India are varied and of diverse origin and in large part relate to the lack of economic, environmental and governmental changes that have occurred elsewhere in the country, that affect the costs and benefits of raising children and controlling their number. Opportunities, as perceived by families form a crucial part of this assessment and all work together to shape preferences for family size, timing, spacing and optimal quality investments. This is notwithstanding the role of deep-rooted cultural practices that impact upon economic incentives and household decision making in important ways.

In recent years, a number of measures have been taken elsewhere in India, to improve the lives of women and encourage their participation in economic and community spheres, as well as to improve the quality and coverage of health services that in turn help women gain control over their fertility. The state of Uttar Pradesh scores consistently poorly (followed only by Orissa and Bihar) in terms of all social development indicators such as mortality rates, birth rates, literacy levels, teacher/pupil ratios, provision of community health services, local infrastructure in terms of per capita power consumption, as well as measures of

political accountability.[1]

Some parts of the state have benefited from productivity growth in agriculture but the five regions have not faired equally from public investments. Of all concerns expressed by the people of Uttar Pradesh, corruption and the inability to trust public institutions came out ahead of a desire for more funding, or even improved education, see Lieten (2003). With regard population policy, many families are deservedly sceptical of family planning practices as a means to control population given the coercive nature of governmental efforts in the 1970's.

Continuing high fertility in the north of India needs to be seen as the outcome of both demand and supply factors; each will be assessed in the empirical sections of this thesis. The former relate to the conditions determining the demand for children; the second, to the lack of ability of households/respondents to adequately control the supply of births. In doing so, this work provides an economic footing for what has been termed "greater than ideal" fertility; a situation where the women respond that they have more than their ideal number of surviving children. Such analysis can also help explain the existence of births described by the mothers as mistimed, or even unwanted.

Regimes of high and uncertain infant and child mortality can cause the number of survivors to be greater than expected, from any optimally chosen number of births, ses Sah (1991) for exposition; this can partly explain greater than ideal fertility. In addition, where the sex of the child cannot be chosen at conception, and in the absence of sex-selective abortion, a preference for sons often leads families to give birth to greater than ideal numbers of girls.

The preference for a child/ren of a particular gender (which is not under the control of parents, in the absence of sex-selective abortion) can drive further conceptions than would not otherwise be necessary in its absence, since for any given number of births, only a proportion will be of the preferred type, (approximately 1.05 boys for each female birth). Although the chances of a boy/girl are known with some precision, this outcome is not revealed until the child is born, by which time the choice to have the child has already been made. Son preference thus

[1] see UP gov't website;http://upgov.nic.in/

adds a further stochastic dimension to birth outcomes.

The costs involved in controlling the supply of births are non-trivial and need to be thoroughly examined. Where these costs outweigh the benefits of avoiding an unwanted or mistimed birth/s, the women may well remain at risk of pregnancy. By recognising the stochastic biological nature of reproduction, in conjunction with the costs of fertility control, along the lines of Easterlin et al (1988) and others, one can appreciate the existence of a large group of women who, despite an expressed desire to delay, or to limit their fertility, are not using any form of contraception to avoid pregnancy. This situation has been identified as the "unmet need" for contraception, in contrast to the "met need" for contraception.

We present below some tabulations of fertility preferences, intentions, contraceptive use and product knowledge in UP, from the perspective of the respondent woman. The data highlight a disparity between current fertility intentions and contraceptive behaviour that needs careful explanation and motivates the subsequent empirical paper. We present measures of unmet need, as compiled by NFHS, for the state of Uttar Pradesh, that help in understanding its root cause.

3.1.1 Monetary and Non-monetary Contraceptive Costs

Classical economists studying fertility for a long time assumed the costs of controlling the supply of births to be trivially zero, such that no barriers existed to the uptake of contraception, where there was demand. In addition such fertility control was assumed perfect so that births could not occur by accident. A possible reason for the existence of greater than ideal fertility is the presence of prohibitive costs associated with controlling the supply of births and the possibility that births may occur accidentally, even when birth control products are used.

Costs of contracepting cover all the monetary and non-monetary time, informational and psychic costs of sourcing and using the products. They include the lack of knowledge of such products, as well as significant non-monetary costs in the form of concern over health side-effects and both social and familial opposi-

tion.

The stated role of trained medical personnel, in the form of home-visitors and public health centre attendants, is to provide vital information, support and counselling in an effort to overcome these non-monetary barriers. Yet the availability of the necessary public clinics and support is acknowledged to be grossly inadequate in rural India.

Studies in the sociological literature confirm the significance of health side-effect concerns among women and the existence of formidable oppositional costs. Westoff & Bankole (1998), in their study of the determinants of the unmet need for contraception in Morocco calculate the percent of women from their original survey who did not intend to practice contraception but who subsequently went on to use a method between the two surveys, classified by their stated reason for not intending to do so. Of all the reasons initially given by these subsequent users, for not intending to use a method, the fear of side effects was most frequently overcome and familial opposition the least.

Contact with modern maternal and child health facilities offered in urban centres may not only reduce costs related to concerns with health side-effects but also work to change preferences for family size and preferences over acceptable forms of family planning, thus stimulating demand in different ways. Where there is religious or social opposition to the use of particular forms of contraception, contact with the modern influences may help change beliefs/attitudes.

3.1.2 The Role of Women's Autonomy

Several papers have looked to social indicators of women's autonomy to help explain contraceptive behaviour. Where there exists opposition, this is more likely to be overcome where the woman has greater bargaining power and control over family resources. One such study in Pakistan by Casterline et al (2001) assesses the relative importance of different costs of contraceptive uptake, among women perceived as having an unmet need. The authors point to both spousal and social opposition as the two principle obstacles to contraceptive use in the Punjab province under study, followed by the woman's lack of awareness and

knowledge of alternative methods. As mentioned, familial opposition may derive from divergent preferences over acceptable forms of family planning, or from divergent fertility preferences.

The empirical paper in the following chapter will attempt to test if lower female bargaining power within the home and poorer outside options in the wider community are associated with a decrease in the woman's propensity to use family planning, by increasing the perceived oppositional costs of use. In India, where divorce and re-marriage practices often result in a worsening of the woman's position, her incentive to stand up to opposition may be very weak; this is known by relevant parties within the family. In such an instance, the penalty of going against the wishes of the family is too great and it becomes optimal to defer to their preferences instead.

Where the woman has greater bargaining power, in the form of control over family resources, or economic opportunities outside the home, she is more likely to overcome such opposition and institute her own preferences; to discontinue child-bearing and to make use of any contraceptive method she chooses in order to achieve this. Actions that work to improve women's independent economic standing and bargaining power within the marriage and wider society, regardless of the preferences of other family members, will work to increase contraceptive uptake and reduce fertility. Such an approach also tackles the deeper goal of gender equality, not just population control. In espousing the cooperative approach to population policy, Amartya Sen(1997), in his address to the Indian International Lecture Series on Population Issues, points out that "the mother-in-law can be much more keen on a larger number of grand-children than the daughter-in-law, who has to bear much of the burden of this achievement."

The participation of women in wider economic and social spheres, as well as greater female empowerment and decision-making within the home have been found to improve fertility control elsewhere; see Murthi et al (1995) for an assessment across the districts of India. Indirect evidence of this can also be seen among the Moroccan sample in Westoff & Bankole (1998), in which the most significant cost in the use of contraception cited by the surveyed women was opposition by

other family members.

Lundberg & Pollack (1993) in their discussion of the household utility framework refer to Samuelson's (1956) Consensus Model as providing the first formal justification for sidelining intra-household processes by "identifying the conditions under which consumer demand analysis can proceed, without being concerned with explaining distribution within the family." In Samuelson's model, each family member behaves as though they were optimising a family utility function and thus they can be analysed as a single entity. The author admits it is in no way a theory of distribution within the family, even at the time of writing.

Degraff (1997) conduct their analysis specifically to understand the channels through which contraceptive use is increased in the Philippines: By changing the costs of fertility regulation directly, through better provision of community health services and support, or by working to change preferences for large family sizes, through informational campaigns and through promotion of the acceptability of modern contraceptive methods. Their paper implicitly addresses the role of women's autonomy but does not explicitly discuss the possibility of divergent fertility or contraceptive preferences within the family.

This raises the question of why a woman would stay in a union that clearly does not optimise her preferences. Against this necessarily must be balanced the enormous non-monetary costs of divorce, particularly in a society such as India. Hindu women in India do not receive any legal right to maintenance after marital breakdown, despite the unpaid nature of their contributions to society and their inability to live independently. Muslim law does allow for a sum to be paid to the wife, in divorce, called the *mehr* but is rarely demanded by the woman and more often that not is "forgiven." For an in-depth discussion of the position of divorced women in India and their re-marriage practices, see chapter by Jeffery (2003), A Uniform Customary Code ? Marital Breakdown and Women's Economic Entitlements in Rural Bijnor, India.

These changes do not occur in isolation and it is likely that as women's ability to contribute economically improves, with better legislation and they attain greater independence, the way in which they are valued by others will change and

in turn affect family formation preferences and practices.

3.2 Fertility Intentions & Measurement

3.2.1 The Unmet Need for Contraception

Those respondents who reply that they do not desire further children at any future time but are not making use of any contraceptive methods, traditional or modern to avoid further pregnancy, after controlling for their fecundity and sexual practice, are classed as having an unmet need for limiting fertility. Non-sterilised women who noted a desire for additional children were then asked if they desired the child at the present time (of survey), or after a two year delay. Those who responded that they desired a further child only after the two-year delay, yet were not using any form of contraception at the time of the survey, were classed as having an unmet need for spacing. Account is taken of their fecund status at the time of the survey, since women experience post-partum amenorrhea, a form of post-birth temporary sterility that is prolonged (often knowingly) through breast-feeding (thus a traditional form of contraception).

According to the DHS definitions, just over one quarter of all married women in Uttar Pradesh are not making use of any methods of family planning, either modern, or traditional, to avoid further pregnancy, despite expressing a desire for no more children either at present (within 2 years), or at any time in the future, after accounting for their present fecundity. Unmet need for both spacing and limiting are seen to be highest in rural areas and among Muslim women and lowest for women who do not come from one of the designated disadvantaged scheduled castes or tribes, or other backward classes. The percent of total demand satisfied, by category, is lowest for very young women and those without children, for Muslim and rural women, for those who are illiterate and for those with a low standard of living, or coming from one of the scheduled tribes.

The unmet need for limiting peaks for women aged 30-34 years, then declines, possibly as some women become menopausal and drop from the calculations. It increases with parity (number of living children) and is highest among illiterate

women and those with less than middle school complete. The unmet need for limiting also declines as the household's standard of living improves. The unmet need for spacing, as a percent of each age category, is highest for the youngest age group and declines with each successive age category. It is high for women with no living children (young women wanting to postpone the onset of childrearing) and highest for women with one living child, declining with each successive birth.

Interestingly, women with the greatest unmet need to space their births are those with at least middle school complete. Education is possibly operating to change fertility spacing preferences, such that those with the highest education have the greatest desire to space their births. Education stimulates the demand for spacing devices, indirectly via preferences and reveals the supply shortage of these modern temporary methods. It is not that uneducated women have a need for spacing that is being met; they do not wish to space their births at all and thus have no need. As education begins to change preferences for spacing, it is revealing existing weaknesses in availability, the lack of supply of temporary methods, that was not previously evident simply because there was no demand.

While the concept of unmet need is purely definitional and indeed one does not normally approach consumer demand analysis relying on such self-reported intention data, it is one method of gauging the level of control women exert over their fertility. As noted there is evidence that women under-report unwanted and mistimed births retrospectively. The key is in revealing the fertility preferences of the women, in circumstances where there is often a lack of incentive to do so, yet not in a way that reads into the hands of population policy proponents.

3.2.2 Desires for Additional Children

Currently married, non-sterilised women between the ages of 15 and 49 years were asked if they desired additional children and if so, whether in the immediate future, or after a delay of at least two years. Tables 3.1 and 3.2 provide a breakdown of their responses by number of living children. The latter table also reports the preferred gender of an additional child, where one is desired. Sterilised women were appreciably not asked this question and are assumed to have

Desire for additional child	Number of Living Children					
	0	1	2	3	4+	Total
Wants another soon	71.7	28.4	16.5	7.4	2.5	17.0
Wants another later	16.5	52.3	26.3	13.5	3.8	17.8
Wants another, undecided when	4.5	4.4	2.6	0.9	0.6	2.0
Undecided/Up to God	1.6	3.3	5.2	5.5	5.5	4.8
Wants no more	1.2	8.5	35.4	43.9	57.7	38.1
Sterilised	0.0	1.0	10.4	25.1	23.0	15.6
Declared medically infecund	4.5	1.8	3.3	3.5	6.6	4.5
Missing	0.1	0.3	0.2	0.2	0.3	0.2
Total Percent	100.00	100.00	100.00	100.00	100.00	100.00
Note: Includes current pregnancy, if any.						
Source: NFHS State Level Final Report, UP. Chapter 4, p79						

Table 3.1: Desires for Additional Children

Preferred sex of additional child	Number of Living Children					
(where one desired)	0	1	2	3	4+	Total
Boy	46.5	48.8	65.6	74.9	73.5	56.3
Girl	1.1	11.4	11.1	7.3	3.7	7.1
Doesn't matter	24.3	13.5	7.9	6.2	7.4	14.4
Up to God	28.1	26.4	15.4	11.7	15.4	22.1
Total percent	100.00	100.00	100.00	100.00	100.00	100.00
Note; question was not asked of currently pregnant women.						
Source: NFHS State Level Final Report, UP. Chapter 4, p79						

Table 3.2: Preferred sex of additional child

chosen to limit any further fertility. Women who had been declared medically infecund were similarly not asked their future fertility intentions.

From the above table, just over ten percent of respondents with two children are sterilised and an additional thirty five percent responded that they did not desire a further child. Almost half of all women with two children had a need to limit fertility. Yet the level of contraceptive use among women with two children is much lower than this. Among women with four or more children, 23 percent were sterilised and an additional 57 percent did not desire further children. These figures on the fertility intentions of the non-sterilised women do not match figures for use of temporary contraceptive methods, which are much lower, even after accounting for pregnancy, fecundity and sexual practice. Despite their stated intention not to have further births, many of these women will reconceive.

In an effort to assess the level of congruency of stated fertility intentions with actual contraceptive behaviour, Westoff & Bankole (1998) merge data from the two most recent DHS surveys for Morocco, 1992 and 1995 and find that among the women originally identified as having an unmet need for limiting, almost 60 percent went on to have a further birth between the two surveys, or were pregnant at the time of the second interview. When these same women were then asked if the birth was considered unwanted, only one third said it was.

From the second table, it is also clear that at all birth orders, the desire for a son is far greater than for a girl. As the number of living children increases, the desire for a son appears stronger, possibly because lower parity births were female and this has compounded and revealed existing son preference. At the same time, it is possible the respondents feel pressured into aligning their preferences for fertility with those of the interviewer: Because large families are perceived (by some) as irresponsible for such poor households, the respondents may feel they should agree that their existing family size is greater than ideal, or that they do not desire further children. Perhaps this form of cognitive response masks the true satisfaction with such fertility outcomes and this explains why the women remain unprotected from conception.

However, there is broad evidence that the bias, if anything, works the other way. Women tend to under-report unwanted births by attempting to justify their large family sizes as perfectly planned. It is extremely difficult for a mother to retrospectively report one of her offspring as unwanted, particularly where there is familial pressure for larger families. It is widely believed that in cultures where women's agency is low, the mothers do not report their true preferences for smaller families, for fear of the repercussions.

3.2.3 Unwanted Fertility

The woman's questionnaire that constitutes part of the NFHS also asked women to note the status of all current pregnancies and births within the past three years, according to whether the pregnancy or birth was wanted at that time, wanted at a later time (mistimed), or not wanted at all.

This planning status is presented, according to selected characteristics in Table 3.3. Almost 14 percent of all live births and current pregnancies were described as not wanted at all and a further 10 percent were wanted at a later time. The percent of births wanted falls dramatically with the mother's age at birth and with birth order. The percent not wanted at all also increases sharply with the same two explanatory variables. These results need to be interpreted with great caution and the figures are likely underestimates for three reasons: First, they do not include the number of pregnancies that did not result in a live birth due to abortion; second, they exclude female infanticide after birth and third such questions have been shown to lead to a systematic under-reporting by retrospectively justifying as wanted, previously unplanned births.

3.2.4 Ideal versus Actual Family Sizes

All eligible women, regardless of their present fecundity were asked how many surviving boys and girls they had at the time of interview and how many boys and girls they would choose to have if they were able to go back to the beginning of their fertility cycle and start again. Many of the younger women in the sample had only recently commenced childbearing and so had less than their ideal number of children. Other mothers responded they were happy with their existing family size, such that their actual family size corresponded with their ideal.

A number of women in the sample, nearing the end of their fertility cycle responded that they would have had less children and in particular less girls. Because the question does not refer to any one of a woman's children specifically, it can only serve as a guide to the woman's likely need for limiting fertility. It does not tell us if the woman wishes to delay a pregnancy; the need to space births: There may be many young women with what they deem to be excess fertility for their age, despite not having reached their target family size, yet this is not captured by the present measure. It is also clear that even where the women indicate they have achieved their ideal family size, they may well proceed to still higher parities if not sterilised.

For this reason, we assess the divergence of ideal from actual family size for

Characteristic	Planning Status of Pregnancy				
Mother's age at birth	Wanted Then	Wanted Later	Not Wanted	Missing	Total %
15-19	87.3	11.1	1.4	0.2	100.00
20-24	80.5	13.1	6.2	0.2	100.00
25-29	71.8	10.5	17.3	0.4	100.00
30-34	59.7	6.4	33.8	0.1	100.00
35-39	50.5	5.7	43.4	0.4	100.00
40-44	40.9	4.4	53.9	0.8	100.00
Residence					
Urban	73.8	10.6	15.3	0.3	100.00
Rural	75.4	10.7	13.6	0.3	100.00
Mother's education					
Illiterate	75.4	9.4	14.9	0.2	100.00
Literate,<mid school	71.1	15.0	13.4	0.6	100.00
Middle school	73.5	14.6	11.9	0.0	100.00
High school or +	79.1	12.3	8.5	0.2	100.00
Religion					
Hindu	76.8	10.3	12.7	0.2	100.00
Muslim	68.9	12.1	18.7	0.3	100.00
Sikh	73.3	17.0	5.0	4.7	100.00
Standard of living					
Low	74.5	9.8	15.5	0.2	100.00
Medium	75.2	10.6	13.9	0.3	100.00
High	75.9	12.9	10.9	0.3	100.00
Birth Order					
1	89.2	9.1	1.5	0.3	100.00
2	82.1	14.5	3.2	0.3	100.00
3	78.2	12.2	9.4	0.2	100.00
4+	60.9	9.1	29.7	0.3	100.00
Total	75.2	10.7	13.9	0.3	100.00

Table 3.3: Percent distribution of births during the three years preceding the survey and current pregnancies, by fertility planning status, according to selected background characteristics

Greater Than Ideal Fertility	Frequency	Percent
-8	2	0.07
-6	4	0.13
-5	7	0.23
-4	46	1.52
-3	91	3.01
-2	214	7.09
-1	354	11.73
0	1016	33.65
1	515	17.06
2	397	13.15
3	188	6.23
4	123	4.07
5	33	1.09
6	16	0.53
7	8	0.26
8	2	0.07
9	2	0.07
10	1	0.03
Total	**3019**	**100.00**

Table 3.4: Greater than Ideal Fertility (for women of completed fertility >40yrs, sterilised or menopausal)

women of completed fertility, that is, sterilised, menopausal and 40+ yrs of age. This is done for both rural and urban women in Table 3.4 and the results suggest many women undershoot their target, as well as overshoot. Where the measure is negative, women have undershot their target Ideal family size.

One of the aims of this research is to understand more thoroughly the reasons behind the continuing high fertility in the north of India, particularly in rural areas, as compared to the southern states that have largely achieved replacement levels of births and relate this to the mechanisms described above. Such family sizes represent the outcome of many factors, economic and cultural, as well as intentional and not, that have existed in India for many hundreds of years. It has not been part of the Indian social makeup to practice birth control beyond minimal folkloric, or abstinential methods.

As we shall present below, knowledge of traditional fertility moderators in India is extremely low, much lower than knowledge of the modern methods of

sterilisation, or the IUD, Pill, or condom. So while the approach is to investigate the reasons for continuing high fertility and the determinants of contraceptive use, there has to be acknowledgement that recent fertility reductions steer families away from formation patterns that have existed throughout a very long history.

3.3 Contraceptive Use and Knowledge

Table 3.5 and 3.6 shows the prevalence of contraceptive use in Uttar Pradesh, by method type, according to selected background characteristics. It highlights the very low contraceptive prevalence rates particularly in use of the temporary modern methods. Only 28 percent of currently married women were making use of any method of contraception at the time of the survey, compared with an All-India average of 48 percent. Current use varies quite markedly by residence, with 45 percent of urban women using, compared with only 24 percent in rural areas.

Current use is higher in both the Hill and Bundelkhand regions. It is higher for Sikh women and for those with more education, with each ordered education category and increases consistently with the respondent's standard of living. The scheduled tribes, scheduled castes and other backward classes are all less likely to make use of any method than the base category "other" higher-class castes. Interestingly, within any parity, the percent of respondents sterilised rises consistently with the number of sons.

One can see there exist different subgroups of women within the state: A large part of the population in Uttar Pradesh is not using any method; 71.9 percent of all women. Of those that do, the largest proportion compose the women who are sterilised (about 75 percent of total users); this is followed by a very small fraction of women using temporary methods and these are disproportionately concentrated in urban areas. As we will see shortly, most of this temporary method use occurs among women wanting to limit, not to delay further births.

In a discussion on the relative importance of unmet need as an organising concept, Casterline & Sinding (2000) note that even in the absence of further change in fertility preferences, a country such as India could move halfway toward its

replacement level of fertility alone by addressing both forms of unmet need, as presently defined. The authors emphasize the importance of factors strongly related to a lack of knowledge, familial and social opposition, along with significant health concerns, although they do not dismiss other supply side quality issues, that in turn affect these perceptions.

Table 3.7 provides a breakdown of knowledge of modern and traditional methods of contraception, by residence. Knowledge of female sterilisation is almost universal in India and in the state of Uttar Pradesh almost 98 percent of currently married women knew of this method. The data on knowledge of temporary methods provides for much lower rates, particularly in rural areas. Reproductive health problems occupy a non-trivial role in the lives of many of the women; in just the last 3 months prior to the survey, 38 percent of currently married women had experienced some reproductive health problem. Such health concerns, coupled with a poor quality of service may discourage women from uptake.

Table 3.8 provides a breakdown of the exposure status of women with different fertility intentions. In accordance with the results on unmet need presented earlier, the table shows that of all temporary method users, more than 75 percent of them are using in order to limit further births and only 21 percent of the mothers are using in order to space their births: Almost all the contraceptive demand in Uttar Pradesh can be attributed to the group of mothers who are using either temporary or permanent methods in order to limit further births and not to space them. There is much to be done to encourage younger women to uptake temporary methods and postpone the onset and pace of childbearing as indicated by their demand. Both births to young mothers and those with short intervals between have been linked to heightened infant mortality in numerous studies.

3.3.1 Policy Perspective

The International Institute for Population Sciences in Mumbai (IIPS) produces a range of Subject Reports, covering topics addressed by the DHS surveys. Both the core household and woman's questionnaires are highly comparable across

Background characteristic	Not using any method	Sterilised	Using modern temp. method	Using trad. method	Total
Age					
15-19	94.6	0.0	2.5	2.9	100.00
20-24	87.6	3.2	4.9	4.3	100.00
25-29	74.1	10.8	8.5	6.6	100.00
30-34	60.8	20.5	9.5	9.2	100.00
35-39	54.4	27.3	9.8	8.5	100.00
40-44	58.9	30.3	3.8	7.0	100.00
45-49	62.0	33.4	1.7	2.9	100.00
Residence					
Urban	55.2	19.0	17.5	8.3	100.00
Rural	76.1	14.7	3.7	5.5	100.00
Region					
Hill	55.7	31.8	9.6	2.9	100.00
Western	72.8	14.2	8.2	4.8	100.00
Central	72.1	12.3	8.9	6.7	100.00
Eastern	73.7	15.0	3.6	7.7	100.00
Bundelkhand	65.7	27.5	3.0	3.8	100.00
Education					
Illiterate	76.0	15.0	3.3	5.7	100.00
Literate,<mid school	68.6	18.7	7.4	5.3	100.00
Middle school	65.3	16.4	11.4	6.9	100.00
High school or +	54.3	15.7	21.0	9.0	100.00
Religion					
Hindu	70.8	17.6	5.3	6.3	100.00
Muslim	79.0	4.3	11.5	5.2	100.00
Sikh	45.4	37.3	9.6	7.7	100.00

Table 3.5: Current Contraceptive Use by Background Characteristics

Background characteristic	Not using	Sterilised	Using modern	Using trad.	Total
Caste/Tribe					
Scheduled caste	75.2	15.3	3.5	6.0	100.00
Scheduled tribe	84.9	11.1	2.2	1.8	100.00
Other disadvantaged class	75.8	13.6	4.3	6.3	100.00
Other	67.3	17.1	9.3	6.3	100.00
Standard of living index					
Low	80.3	11.4	2.7	5.6	100.00
Medium	73.5	15.3	5.4	5.8	100.00
High	54.7	21.7	15.4	8.2	100.00
No. & sex of living children					
No children	97.7	0.0	0.9	1.4	100.00
1 child	87.7	1.0	5.8	5.5	100.00
1 son	85.3	1.9	7.3	5.5	100.00
No sons	90.8	0.1	3.9	5.2	100.00
2 children	72.8	10.6	11.1	5.5	100.00
2 sons	60.4	23.1	12.4	4.1	100.00
1 son	75.6	6.2	11.6	6.6	100.00
No sons	85.8	1.8	7.1	5.3	100.00
3 children	60.7	25.5	7.1	6.7	100.00
3 sons	53.3	36.8	4.3	5.6	100.00
2 sons	52.5	33.2	7.2	7.1	100.00
1 son	69.1	13.8	9.2	7.9	100.00
No sons	91.3	2.8	2.8	3.1	100.00
4+ children	62.3	23.8	6.0	7.9	100.00
2+ sons	60.3	25.8	6.0	7.9	100.00
1 son	69.1	15.4	7.6	7.9	100.00
No sons	89.4	6.2	0.0	4.4	100.00
Total	71.9	15.6	6.4	6.1	100.00
Source: NFHS State Level Final Report, Uttar Pradesh, 1999					

Table 3.6: Current Contraceptive Use by Background Characteristics cont'd...

Method	Urban	Rural	Total
Any method	99.7	98.0	98.4
Any modern method	99.7	97.9	98.3
Pill	97.1	81.7	84.7
IUD	92.9	68.7	73.5
Condom	96.6	79.7	83.1
Female sterilisation	99.6	96.9	97.4
Male sterilisation	97.7	91.2	92.5
Any traditional method	72.0	57.3	60.2
Rhythm/safe method	66.5	51.9	54.8
Withdrawal	47.6	29.4	33.0
Other method(trad. or mod.)	3.3	2.9	3.0
Source: NFHS State Level Final Report Uttar Pradesh, 1999			

Table 3.7: Percent of currently married women who know any contraceptive method by specific method and residence.

Desires for Additional Children by Exposure Status Category				
Fertility Intention	Non-User %	Sterilised %	User of Reversible Method %	Total
Wants within 2 yrs	24.5	0.00	7.46	17.64
Wants after 2 yrs	19.67	0.00	13.71	15.19
Wants, unsure timing	2.64	0.00	0.93	1.92
Undecided/Up to God	5.93	0.00	1.96	4.29
Wants no more	40.24	0.00	75.37	37.29
Sterilised	0.00	100.00	0.00	18.82
Declared infecund	7.02	0.00	0.56	4.84
Total	100.00	100.00	100.00	100.00

Table 3.8: Exposure Status and Fertility Intentions for currently married women in Uttar Pradesh

countries, with corresponding sections and question formats. In their report on Indian Fertility and Family Planning, based on comparative data from a number of developing nations, Pathak et al (1998) argue that until the use of temporary contraceptive methods reaches fairly high proportions in the relevant population, such products will not be used for spacing purposes but only for limiting the number of births. They argue that this is due to the social processes through which such methods are accepted: Ordinarily the first women to break social norms and tradition are the older women for whom the need is not for spacing but for limiting. This finding is supported by the results of Miranda (2006), assessing the social networks through which attitudinal changes are transmitted, in turn leading to the acceptability of low fertility regimes and the associated contraceptive use among Mexican women.

Although this may appear adhoc as an explanation for the temporal pattern of uptake of contraceptive methods, it helps explain the role of social factors that are cited by the women as barriers to use; such changes in contraceptive behaviour occur through a gradual process, with the dissemination of knowledge and as attitudes toward modern methods change within a culture, such as in the north of India. Women's decision-making autonomy regarding their own health is seen to improve significantly with age.

Given the very low usage rates of temporary methods in Uttar Pradesh at 6.4 percent and in India as a whole, of less than 7 percent, it is likely too early in the fertility transition to rely on the women changing their spacing and timing behaviour, particularly when they have not even gained control over the primary objective of limiting overall fertility. There has been recent acknowledgement that the link between birth intervals and numbers of children is tenuous and that further fertility decline cannot be expected to occur through a lengthening of birth intervals, Pathak et al (1998).

In light of this, encouraging women in Uttar Pradesh to make use of temporary methods to limit fertility can pick up the group of women who say they are unsure as to whether they desire further children but in any event would not consider sterilisation due to its irreversible nature. The desire to limit fertility is

a necessary condition for uptake of the permanent methods of contraception that have been the mainstay of India's population policy to date, yet this policy fails to address the needs of younger women expecting to continue their child-bearing but wanting better control over the spacing and timing of their births. This same governmental reliance on irreversible contraceptives in Mexico has contributed to the slow acceptance and lack of use of temporary methods, see Miranda(2006).

Chapter 4

Endogeneity and the Demand for Contraception

4.1 Introduction

There are several papers in the socio-economic literature assessing the use of contraception in India.[1] In general, these studies develop several stylised facts concerning the description, whereabouts and motivations of contraceptive users, and the role of the supply side in conditioning demand to greater or lesser degrees. Economics in particular has focused on the role of opportunities, wages and the contributions of children under societal conditions in which financial markets and other mechanisms through which to save and/or insure against loss are largely absent throughout the family's lifecycle.

Further work has highlighted the role of socio-religious practices in conditioning the demand for children and related goods such as schooling and family planning. For example, because it is not socially acceptable for female offspring to perform many economic functions, their longer-term worth is contrained. This has dynamic implications for family formation and for the way in which families make allocation decisions.

The present paper offers both a reassessment of these facts and some addi-

[1] See for example Pal & Makepeace (2003), Bhargava (2003), Mahli & Jerath(1997) and Bairagi(2001) among others.

tional theory regarding the non-monetary costs of using contraception. In particular, we focus on the role of women's autonomy within the home and how this may alter the non-monetary costs of using contraception. Although a formal analytical model is not developed, we draw on and develop an existing specification that is suitable for the cross-sectional data available. It is crucial to test the extent to which a theory on contraceptive costs can be confirmed empirically, not least because our models should reflect actual behaviour. It is also important to understand more rigorously why stylised facts exist and why they may not prevail in certain circumstances.

The purpose of the present paper is to better understand some of the reasons for such low contraceptive prevalence rates in the state of Uttar Pradesh, India. In particular, we hope to shed light on the great variation in prevalence rates existing between rural and urban populations. Although the state as a whole lags well behind the All-India average and suffers continuing high fertility, as compared to the rest of India, this masks considerable variation between the two samples. There are marked differences in the ages at first birth, Total Fertility Rates and in the women's knowledge of contraceptive products between rural and urban areas in Uttar Pradesh that require explanation. The urban population comes close to the All-India averages for these measures and several others. This is likely due to the closer alignment of conditions and opportunities in urban UP with those existing in other parts of India, such that the outcomes bear greater resemblance.

With the disparity in rural-urban conditions, regressions estimated on the pooled UP sample as a whole would mask important and quite different relationships, thereby confounding the analysis. For example, women in rural areas often view child-rearing as complementary to work, whereas in urban areas, the more traditional relationship may hold such the two are seen as competing for the mother's time. The coefficient on a dummy variable for women's labour force participation, taken from a pooled regression on desires for additional children, may be very close to zero, confounding two separate coefficients of different sign.

Furthermore, the ability of women to move about freely depends, among other

things, upon the safety of the immediate communal environment; this is more dangerous in urban centres and changes the way women relate to their community. There remains significant variation in explanatory variables in each of the samples, particularly across regions, so that the separate estimation allows for a richer and more parsimonious representation of relationships.

As the demand for contraception is derived from the demand to space, or limit fertility, preferences for family size, spacing and timing play an important role in determining the perceived benefits of using contraception : Where women do not wish to limit or space further births, they are unlikely to shoulder the sometimes significant psychic costs of using contraception, or pay positive sums in time and money for an imperfect contraceptive product.

Yet even where women express a desire to improve control over their fertility, the monetary and non-monetary costs of use are often perceived as prohibitive, with many women remaining at risk of conception. The latest NFHS report for India points to chronic supply shortages and a lack of support in the use of contraception as reasons for such low prevalence, suggesting there has been an under-estimation of the magnitude of the non-monetary costs involved in the use of such products, particularly where these entail substantial time and information-gathering elements and social opposition. It has been acknowledged that the same sorts of modernizing changes that improve supply and support in the use of contraception can often also change preferences for family size and timing and thus work to stimulate demand at the same time. The present paper attempts to gain an improved understanding of the nature and magnitude of each of these considerations.

Using data from the latest complete round of the NFHS India 1999, which contains information on a wealth of household and community-level variables, in conjunction with rich detail pertaining to the women's fertility histories and current fertility preferences, we estimate the structural form of the equations determining the demand for additional children and the corresponding current contraceptive use status of the respondent women.

Our estimation framework acknowledges the derived nature of contraceptive

demand but also that the lack of temporal information on the women's contraceptive use episodes poses some econometric problems that are less easily overcome with cross sectional data. The implications of estimating a dynamic process with static data are that many of the important explanatory variables that condition the outcome of interest will be correlated with the corresponding equation error. Hence the assumptions underlying single-equation estimation of either the OLS or limited dependent variable models are often violated, for instance that the error is uncorrelated, or independent of explanatory variables.

In the present scenario, we are interested in estimating the effects of the woman's current fertility intention, defined as the number of additional children desired, y_1, on her use of contraception at the time of the survey, y_2, (User/Non-user) and in turn, explore the role of contraceptive use status, y_2, in explaining her current fertility intention, y_1. Assuming that most women reach menopause at around 45 years of age and conditional on their current age, the number of additional children desired by the woman ties down the total number of births to be averted and thus the benefits of currently using contraception.

$$y_1 = \gamma_1 y_2 + \beta_1' X_1 + u_1 \tag{4.1}$$

$$y_2 = \gamma_2 y_1 + \beta_2' X_2 + u_2 \tag{4.2}$$

X_1represents explanatory variables affecting current fertility intentions, which are themselves a function of current family size and X_2 represents other factors influencing the woman's current use of contraception. It is possible there is some overlap in the set of explanatory variables determining each outcome. For example, maternal education is seen to reduce the demand for total numbers of children and conditional on current family size, for numbers of additional children and to therefore stimulate demand for contraception indirectly.

Yet education is also thought to play a more direct role in dismantling the perceived costs of using contraception, independently of the way it affects the perceived benefits. Rosenzweig & Seiver (1982) suggest maternal education also

improves control over past fertility and hence reduces accumulated excess fertility. For the purposes of estimation, the less overlap among these factors, the greater the degree of identification possible. By separating behavioural from cost parameters, the above simultaneous framework is able to uncover the structural form of relationships.

The number of additional children desired is treated as roughly continuous and permitted to take on both positive and negative values: where it is negative, the respondent has greater than her target (ideal) number of children. To the extent that women decide how many additional children to have, in light of the costs of contracepting, the woman's use of contraception may be significant as a right-hand-side variable explaining variation in these fertility intentions.

While estimation methods dealing with simultaneity and endogeneity of one kind or another have been made widely available to a more general audience, the application of estimators addressing these issues for discrete choice models and count variables has been limited. This procedure, the Two-Stage Probit Least Squares has been developed as a programme for STATA more recently by Keshk(2003). Details of the procedure are outlined in the specification of Section Three.

It is expected there will be correlation among the set of unobservable factors present in both equation errors, given the dynamic nature of the problem. There is likely to be variation in woman-specific biological fecundity that will have dynamic implications for family formation (greater accumulated fertility for the more fecund in the population) and as the women become aware of this, may impact the perceived benefits of contracepting in the future.

For example, women with the most children for their age might be those with the greater biological fecundity : Controlling for the number of additional children desired, these women will have the most to gain from contracepting, (in terms of averted births), in anticipation of continuing high fecundity and this will introduce a negative correlation of the fertility intention with the equation error.

One implication of the dynamic nature of family formation is that any measures of the benefits of using contraception, (such as the number of additional

children desired), to the extent that they are affected by past realizations of birth supply and demand, may contain information on the costs of contracepting, particularly where these costs are assumed non-monetary.

This will likely cause the fertility intention variable, y_1, to be correlated with the contraceptive demand equation error, u_2. As current family size is partly the result of past supply conditions, it is expected that those women exposed to the greater costs of contracepting in the past will have accumulated larger families for their age, ceteris paribus, and where this supply is still lacking, will be simultaneously less likely to use contraception currently. These permanently costly contraceptors will introduce a positive bias between the fertility intention and the contraceptive use equation error, since they will on average want less additional children and be less likely to use. This will lead to underestimation of the negative effects of wanting more children on use propensity.

It may be the case that conditions that favour the use of contraceptives are jointly determined with preferences for smaller families. The Reproductive and Child Health (RCH) Programme in UP attempts simultaneously to change the perceived benefits and costs of using contraceptives. These family planning services are offered more comprehensively in urban areas through the existing health infrastructure. Conditions associated with wider access to more and varied medical facilities/suppliers and contraceptive information in urban areas, that are thought to reduce the psychic costs of using such new techniques often also alter family size norms.

It is not possible therefore to sign the coefficient on present fertility intention a-priori and it's endogeneity is an empirical matter that will be addressed in later sections of this paper. In practice, the system estimation procedure can account for this simultaneity. Present fertility intentions and current family size (itself an outcome variable) may be for different reasons correlated with the error term in the contraceptive use equation and may introduce biases of varying magnitude and offsetting sign. We have no measure of accumulating excess fertility, since the data on unplanned pregnancies only extends back 3 years. We cannot say therefore that maternal schooling reduces fertility errors, perhaps it just changes

preferences for the timing of births, particularly in light of the insufficient data on labour market returns.

Our analysis adds to the empirical literature on the role of female agency in family formation. We make use of comprehensive information on behaviours associated with the intra-household relative bargaining power of women that has not so far been used as the basis of any quantitative study examining the non-monetary costs of using contraception. One of the main reasons cited by women for their non-use of contraception, despite a desire to delay or limit further births is opposition by family and the wider community.

We interpret familial opposition (divergent preferences) as a cost of using contraception, whether the opposition stems from differing fertility preferences (in which case it is likely to abate as more children/sons are born), or differing contraceptive use preferences; these nonmonetary costs are hypothesized to be greater for women with weaker relative bargaining power.

While a full bargaining treatment is not pursued in the present paper, the empirical specification will attempt to include some behavioural indicators of household-level bargaining power, along with community-level measures that are thought, a-priori to be associated with women's autonomy and that may reflect greater perceived oppositional costs of using contraception.

Table 4.1 provides a breakdown of the reasons given by the women as to why they were not using contraception at the time of the survey. Almost a third note the desire for additional children and almost 20 percent note they are presently subfecund, post-partum, or breastfeeding, all of which reduce connception probabilities. The most significant contraceptive use costs for women, aside from familial opposition, appear to relate to a lack of knowledge over alternatives, a lack of support in their use and fear of negative health side-effects. Although the physical product is subsidized where it is supplied by government health services, these facilities are not achieving the levels of coverage and support required to overcome the non-monetary costs cited above.

Our estimation results highlight the great disparity in conditions and behaviours between rural and urban populations in Uttar Pradesh. Many of the

Reason Given	Freq.	Percent
Not having sex/Infrequent sex	134	3.99
Menopausal / Hyst./Subfec/Infec	316	7.05
Postpartum/Breastfeeding	513	11.43
Wants more children	1308	29.15
Respondent opposed	52	1.16
Husband opposed	219	4.88
Others opposed	31	0.69
Religious prohibition	130	2.90
Knows no method	84	1.87
Knows no source	175	3.90
Health concerns	182	4.06
Lack of access	44	0.98
Cost too much	45	1.00
Inconvenient to use	5	0.11
Other	569	12.68
Don't Know	105	2.34
Missing	575	12.81
TOTAL	4487	100.00

Table 4.1: Main Reason Why Respondent Not Currently Using a Contraceptive Method

traditional sociocultural practices appear to be overturned by the modernizing influences associated with living in urban areas. We find much greater homogeneity in fertility preferences in the urban sample as a result of more equal access to services, opportunities and labour markets and differences in use that are explained by practical factors such as perceived fecundity and sexual practice, along with maternal educations, rather than by religion or ethnic background.

This work confirms the difficulty in operationalizing measures of female autonomy, given the multidimensional nature of the concept, affecting many spheres of the woman's life. While theoretically, women who hold a greater balance of power within the family are less likely to encounter serious opposition to ceasing fertility or using contraception, it is very difficult to find overarching measures of this bargaining power. We find that certain groups of women score well on some autonomy indicators and poorer on others.

Our results do confirm that women who had input into decisions concerning what to cook were significantly more likely to be using contraception and urban

women who did not reside with their mother-in-laws and who were older at marriage were also more likely to be using some method of contraception at the time of survey. No other significant female agency effects were found.

The following section raises some analytical and measurement issues. This is followed by a discussion of the data and definition of all dependent and explanatory variables in Section 3. Section 4 presents the details of the econometric specification and results follow in section 5. Section 6 offers a discussion and concluding remarks.

4.2 Methodology

Following a similar analytical approach as set out by Rosenzweig & Schultz (1982), the benefits of using contraception are operationalized in terms of the expected benefits of the averted births; the avoided disutility associated with bearing excess numbers of children, or with mistimed births. These expected benefits are weighed against the positive costs of using contraception, in arriving at any optimal contraceptive use strategy. Thus, in the presence of costly and imperfect fertility control, optimising behaviour can result in what is described as excess fertility or mistimed births. These costs are assumed both monetary and non-monetary in the present setting.

While preferences for completed family size exist among households, not all information required to derive decisions over fertility timing, number, spacing and quality will be available at the outset of childbearing. Stochastic events that affect the costs and benefits of bearing and raising children are only realized periodically, such as the survival status and gender of earlier children. Theoretically, in this dynamic setting, irreversible decisions should be avoided; it is always safer to defer decisions until new information is made available, to work at the margin, should circumstances warrant a reassessment (updating) of choices/behaviours. Hence the woman's demand for contraception, being derived from the demand to limit or delay births is also subject to the same dynamic-stochastic circumstances.

Yet crucially such a model would not explain why 75 percent of all contracep-

tive users in our sample choose sterilisation, an irreversible form of birth control.

Given the nature of family formation and the inherent uncertainty regarding the path of future variables, families likely use rules-of-thumb in arriving at any profile over fertility timing, spacing and number, particularly in the presence of imperfect contraceptive efficiency, that varies much across alternative contraceptive methods. For many families the costs of keeping one's options open, by using reversible techniques, are simply too great and the expected benefits too small.

We follow Rosenzweig & Seiver (1982) in proposing that the respondent woman aged a years chooses the number of additional children n to have, independently of the costs of contraception and then subtracts this from the maximal supply of births she expects to have over the remainder of her fertile years, y. This leaves her with the number of births that need averting, n_A and an average contraceptive efficiency, $\overline{e}$ required to avert them.

$$n_A = \int_a^{a+y} f(x)dx - n = (1 - \overline{e}) \int_a^{a+y} f(x)dx \tag{4.3}$$

where $f(x)$ is the probability of a birth at each age in the absence of contraception.

However, in the presence of costly contraception, the couple must then equate the benefits of contraception (the averted births) with the costs of use, be these variable or fixed. Where the woman desires no further children, she may well consider the costs and benefits of irreversible sterilisation, in comparison with a finite marginal reversible contraception strategy and their associated costs.

We test whether, in asking the women about their family sizes, they are responding, conditional on the perceived costs of contracepting. This justifies the estimation procedure, where the binary current contraceptive use variable enters the equation determining the woman's demand for additional children.

Our specification does not distinguish between the need to limit and the need to space births. Where the woman wishes only to delay her next birth she will assess the problem at the margin considering reversible techniques only, or nothing. However, over 70 percent of the women using even reversible contraceptive techniques express a desire for no further children, thus they are not using the

product to delay fertility, at least according to their responses. Whatever the marginal benefit of an averted "mistimed" birth, it is certainly less than the perceived marginal cost of averting that birth, for the great majority of Indian women.

It is also quite possible that the marginal benefit of an averted birth depends positively on the level of excess births the woman has already experienced. In contrast, the perceived marginal costs of using contraception may fall with the number of "excess" children born and surviving : Costs associated with familial opposition may subside as the fertility preferences of husbands and others become realized. Thus if one sees a positive relationship between numbers of excess children and use of contraception, one cannot say whether this is due to subsiding opposition, or increased benefits of using. Alternatively, women with the most children considered above ideal (excessive) may be the least likely to use, since they have had neither control over their fertility or over their use of contraception in the past, and the same conditions prevail in the present. By including the squared term on the additional children desired variable, we test for these relationships.

As the woman ages, autonomy is generally thought to improve, reducing the psychic costs of wider social opposition also, see Pathak et al (1998) and Miranda (2006) for a discussion of the changing social costs of contraception among differing age groups. To the extent that older women may be more assertive and effective at using a given method, the perceived benefits of the averted births may be greater also.

4.2.1 Autonomy and Excess Fertility

The intra-household bargaining model of Eswaran (2002), presented in the literature review, proposes that women possessing weaker relative bargaining power within the home are more likely to see their preferences for less children overridden by those of other family members, in the Nash bargained household solution. A dynamic implication of this is that such women may end up with more children than what they consider to be otherwise ideal.

If within-family measures of the bargaining power of women explain ex-post excess fertility, it is tempting to assume it is because women with more intra-household bargaining power were better able to institute their fertility preferences for less children and that these fertility preferences must have been different from those of other family members: If the husband's and wife's fertility preferences were identical, any preference weightings in the Nash utility solution would give the same outcome and in a cross section of women, there should not be a correspondence between measures of bargaining power and measures of excess fertility. Thus, if differences across women in relative bargaining power explain differences across women on measures of excess fertility, divergent fertility preferences must have existed. However, perhaps women with greater bargaining power in the home also possess better skills that reduce the effective costs of controlling births and this is why they suffer less excess fertility.

In addition, the lack of information on the fertility and contraceptive preferences of other family members means it is difficult to confirm that divergent preferences exist within the family and are the cause of what women describe as unwanted births, or greater than ideal fertility. Even if such preference information was available, the subjective nature of questions regarding excess births means it may be answered differently by different people, even if underlying preferences are identical.

4.2.2 Autonomy and Contraceptive Practice

In our empirical analysis, excess fertility is not used as the dependent variable. Rather, bargaining power is related to the mechanism by which excess fertility comes about; through the lack of ability of the woman to control her fertility in a situation where she does not wish to reconceive and where the probability of a birth is positive, in the absence of contraception.

The way in which a woman can institute her preference for less children is through better control over fertility, either through abstinence, or by making use of family planning to avoid conception. This leads on to the formulation of tests in the present empirical paper. We propose that among fertile women, controlling

for the number of additional children desired, those with the greater relative bargaining power within the home will be the most likely to use family planning, ceteris paribus. The test is somewhat noisy since some women may have no need for contraception; if a woman wants a further birth soon, she will not be using contraception, whatever her level of autonomy.

As mentioned, intra-household relative bargaining power is multidimensional and difficult to measure and is correlated with so many factors that also affect the woman's ability to control her fertility. It is possible that our measures of intra-household bargaining power are correlated with other conditions that encourage contraceptive use, that are not otherwise included in the model.

A simple tabulation of the empowerment indicators with standard of living suggests that women from households where the standard of living was classified as low appear to have greater freedom of movement, particularly among the urban sample, when visiting friends and relatives and when going to market. These opportunities to move about independently result in greater exposure to modernizing influences and encourage social networking among women that supports the use of modern contraceptive products.

Yet we find that women from the urban sample from households classified as having a high standard of living have more freedom in making decisions concerning their health, which may be particularly important for contraceptive practice. There is no pattern of autonomy by ethnicity (Caste) among either the rural or urban sample, aside from the finding that Scheduled Caste women have more input into cooking decisions in both samples. It is this variable which we find significantly positively affects the probability of using contraception.

By religion, Non-Hindu women have the greater say in cooking decisions and obtaining health care is no higher among Hindus than it is among Muslims in the rural sample. Urban women who needed permission to go to market, or to visit friends and relatives composed a higher proportion of Hindus than the other religions. Thus, much of the discussion about the lower autonomy of Muslim women, viz a viz other religious groups in India, does not hold sway. In no way are the measures of autonomy found to vary systematically with family size

preferences or other socio-demographic factors.

4.3 Data

The NFHS India conducts an individual-level questionnaire on eligible women (ever-married, between 15-49 years of age) from the sampled households, in addition to information obtained from the household head on household living conditions. The section on reproductive health contains information on the woman's current use of contraceptives, by method type and the point at which they were first used, as well as her family size at the time of sterilisation. There is a question on ever-use but no complete contraceptive use episode histories.

The data is comprehensive for such a large-scale project, however the retrospective data on the planning status of births only extends back three years and suffers from severe under-reporting. It cannot therefore be used as the basis of any quantitative study. The analysis is thus restricted to relating current exposure status and current family completion/fertility intention measures to particular circumstances and making static comparisons at one point in time based on these. A family completion question asked the women of their ideal family size and ideal sex composition. This information, in conjunction with information on the woman's existing family size, is used to calculate the dependent variable, the number of additional children desired.

In the state of Uttar Pradesh, there is survey information from 9,292 women. Interviewed women who were visitors to the household and stayed there the night before the survey are dropped since there is no information on their own household of residence; there are 927 such cases, leaving a sample of 8365. From this sample, women who were unmarried at the time of the survey(349), had been medically declared infecund (378), or who were pregnant (673) are further left from the analysis. Currently unmarried women constitute a tiny fraction of ever-married women and in most cases the woman has been widowed, see breakdown, Table 4.2. This leaves a working sample of 6965 women.

Women who were pregnant at the time of the survey will not be current

Current Marital Status	Freq.	Percent
Currently married	8016	95.83
Separated	39	0.47
Deserted	32	0.38
Divorced	14	0.17
Widowed	264	3.16
TOTAL	8365	100.00

Table 4.2: Current Marital Status

Mean number of children	Pregnant	Non-pregnant
Age 15-19	.41 children	.63 children
Age 20-24	1.13 children	1.69 children
Ae 25-29	2.68 children	2.87 children
Age 30-34	4 children	3.78 children
Age 35-39	5 children	4.17 children

Table 4.3: Mean number of children within age group by pregnancy status

users of any form of contraception, regardless of their future fertility intentions. Without data on episode use in the past, we are restricted to assessing current practices only. It is apparent that in any snapshot of data, those with the larger family size preferences, or with the least control over their fertility are those who are the most likely to be pregnant or post-partum amenhorreic at the time of interview: The women expected to be the least likely to use contraception are selected out of the sample.

This is of concern since the pregnant women are likely of higher fertility and in general, younger. A basic calculation reveals the mean age of pregnant women to be 24 years versus 31.5 years old for non-pregnant women. The mean number of children to pregnant versus non-pregnant women is presented in Table 4.3. Among younger women, in the age groups 15-29, the pregnant women are shown to have less children on average so there is no reason to be too concerned over the magnitude of any selection effects. Yet among the older age groups, the mean number of children is greater for pregnant women. The selection effect shows up as the woman proceeds through the fertility cycle. Until better data allows for the assessment of contraceptive use over time, one can only acknowledge the likely magnitude and direction of the bias.

Where the conditions that determine subfecundity in women are thought to be correlated with greater costs of using contraception, consistent estimation is not possible and such selection would need to be modelled separately. This is of some concern in the present Indian dataset, where undiagnosed reproductive health problems that lead to premature sterility and subfecundity in respondents, allaying any need to use contraception, may be correlated with greater contraceptive costs, in the form of absence of medical facilities and support, typical of the rural populations.

The retrospective reporting of past births and deaths leads to some misreporting and the NFHS India 1999 suffers from underreporting of children ever born. This has been confirmed by comparison with the Sample Registration System complied by the Census of India, that collects fertility data each year and is the more accurate of the two sources. The under-reporting feeds through to underestimation of the Total Fertility Rates, Age-specific Fertility Rates and Crude Birth Rates. Because underreporting is most severe for children who died shortly after birth, this feeds through to neonatal mortality statistics as well.

There may be some selection mechanism, wherein the women who suffer the most underreported fertility, often linked with child death, may be more likely to desire further children. There is evidence that experience of infant death within the family is positively related with fertility (Wolpin, Olsen & Wolpin) and that this may deem then simultaneously less likely to make use of contraception. The table of Summary Statistics for the two sets of equations is presented in Appendix B.

4.3.1 Dependent Variables

Our specification attempts to build a picture based upon information on past outcomes, for women of completed fertility, with longer past histories, with information on the expectations of younger women, to identify the costs and benefits of fertility and contraception, while addressing any endogeneity issues that such an approach invites.

The questions on fertility intentions and ideal family size were asked of the

respondent women but not of their spouses or other family members. It is possible that the unobservable preferences of others are at work in determining responses given by the women. Some women may simply respond in line with the fertility preferences of other household members, even where their own are different, for fear of violent reprisal; this bias cannot be avoided but needs to be kept in mind throughout the analysis.

Equation 1 - Number of Additional Children Desired

The dependent variable is defined as the difference between the woman's reported Ideal number of children and her current family size, in the manner of Bollen et al (1995). It can take on both positive and negative values. Controlling for the woman's age, the woman's maximal fertility path minus the number of additional children desired identifies a value for the number of births to be averted and hence the benefits of contracepting. Because there is heterogeneity in woman-specific biological fecundity and sexual practice, women of the same age may perceive different maximal fertility paths, or interval probabilities of birth, in the absence of birth control.

Equation 2 - User - Binary Current User/Nonuser of Any Form of Contraception

In this specification that models current use of any form of contraception as a dichotomous User/Non-User dependent variable, issues concerning the irreversibility of particular methods are set aside. Tabulations on the use of contraception by Indian women suggest over 90 percent are using in order to limit their fertility and not to space births.

4.3.2 Explanatory Variables

Equation 1 - Number of Additional Children Desired

Following the analysis of others, candidate instruments to identify preferences for numbers of additional children include conditions and opportunities, as perceived

at the outset of childbearing, such as permanent wealth proxies, occupations and education levels of parents, their ownership and/or involvement with agricultural land cultivation. Factors such as the mother's current age, that reflect her life cycle fertility profile and cohort group are also thought to affect preferences for completed families and hence how many additional children the woman wants. Other exogenous factors thought to influence preferences over family size include the respondent's level of education and literacy, as well as occupation grouping of the husband and his level of education.

The woman's current family size is also relevant to the decision of how many more children she wants but is likely endogenous in this first equation for the reasons set out above. The approach of Degraff et al (1997) is to identify current family size using backdated infrastructural information on such variables as the provision of schools, sealed road networks, irrigation and health facilities, that affect the supply of births but that do not otherwise affect preferences for completed families.

In the present analysis, such data is not available but the woman's rural/urban residence at age 12, which is not significant in identifying completed family size preferences, is used as an identification restriction for both rural and urban instruments. In addition, among urban women, we also identify current family size with the woman's answer to a question regarding the frequency of visits to the cinema.

A categorical breakdown of the occupation variable is converted into dichotomous dummy variables; one each to indicate the husband's employment in the agricultural sector, in unskilled manual work, or in a professional managerial capacity. It is thought the first two work positively on family size preferences for the way they value child labour contributions. In addition, where the family owns agricultural land under cultivation, the value of productive child contributions is believed to have a positive effect on family size preferences; the indicator variable for ownership of agricultural land is therefore also included.

The NFHS data does not collect information on family earnings. Rather, measures of lifetime wealth, in the form of ownership of particular assets are included

for the way in which they condition opportunities. The father's education level can serve as one proxy of permanent income. In line with other authors, we also include possession of household assets such as television, radio and bicycle, as well as the presence of electricity and a flush toilet. It is thought that the ownership of a radio or television also hastens the introduction of modernizing influences and attitudes that impact upon family size preferences, as well as the acceptability of using contraception. Houses constructed of bricks are of superior quality and further reflect household wealth. The categorical standard of living index (low, medium and high) computed by the DHS is included to capture additional household conditions.

Included are categorical variables reflecting the ethnicity of the respondent, with indicator dummies where the respondent comes from one of the Scheduled Tribe, Scheduled Caste, or "Other Backward Classes". As the composition of castes in Uttar Pradesh varies significantly across the regions, the choice of base category is not clear-cut, however "Other" is chosen as the base category since this is the group composing the higher castes and less disadvantaged peoples. Differing castes may be subject to conditions not otherwise captured in the regression equation, which may affect family formation practices. Religion dummies are included to indicate the effect of being Muslim, or of Other Religion (Sikh, Jain, Christian), in what is predominantly a Hindu population (83 percent).

Village-level data on the presence of health facilities is also included to the extent that these also may affect the demand for contraception through fertility intentions by encouraging the adoption of smaller family sizes. Distance to middle school educational facility and to each of Primary Health Centre and government hospital are included in the equation explaining number of additional children desired, along with an indicator for whether the woman had received a Family Planning visit in the last 12 months. We include an indicator for regular village electrification, distance of the village from an all-weather road, as measures of infrastructure that may affect family formation practices. It is unlikely these community level variables will be endogenous, since they are not formally placed with regional fertility in mind. Although this data is not available for the urban

sample, the urban bias in provision of all forms of health service means they will in general have much better access.

Equation 2 - Binary Current User/Nonuser of Any Form of Contraception

In addition to information on fertility intentions, current prices, incomes and other household and village-level variables that may affect the costs and benefits of using contraception, we include measures of the respondent woman's bargaining power, in the form of her input into household decision-making, freedom of mobility and control over family resources. It is thought these measures of greater autonomy work to reduce the psychic costs of using contraception for women.

We therefore include indicators of the woman's ability to visit health facilities and friends and relatives without permission, or unaccompanied. The estimation also acknowledges whether or not the respondent has at least some input into decisions concerning her own health and that of her children and whether she was permitted to have some money put aside. In addition, the woman's relative bargaining power within the home is often affected by the presence of a mother-in-law, usually signalling that the married couple live with the husband's parents. In such an instance the young woman is expected to follow the wishes of the more senior women in the family, who oversee traditional gender-specific duties, such as household food and health expenditure. It is proposed that this should have a negative effect on the probability that our respondent currently uses any form of contraception.

The exact definition of autonomy, as it relates to fertility practices needs to be seen in the specific context one is assessing, since female autonomy may be low in some spheres of the woman's life but greater in others. Rahman & Rao (2003), in understanding the determinants of empowerment among women in Uttar Pradesh find that their sample of women score well on some indicators and poorly on others. For the present purposes, there is a need to identify measures of autonomy that are closely related to the woman's ability to have a say in her health and that of her children; this is seen to be most closely tied to the ability

to choose fertility and fertility regulating devices.

Oppositional costs are hypothesized to fall with the age of the respondent woman and with the number of children born and surviving. To account for differences in the social acceptability of family planning, across population subgroups, the Caste and Religion variables are included. In addition such factors may reflect differing levels of knowledge and satisfaction with methods and health facilities, both of which affect perceived non-monetary costs of use: Lower caste women are in some cases discriminated against in their use of health services. They are prohibited from entering health facilities because of their "Untouchable" status and are thus offered an inferior quality of service relative to the higher caste groups.

A woman's ability to read and write, along with formal education are seen to improve the woman's standing and confidence, as well as her ability to make independent decisions. Recent work by Rahman & Rao (2003) provides a guide as to the factors correlated with greater opportunities for women that confer power upon them to overcome opposition to controlling their fertility. The authors suggest higher wages for women and the presence of information-disseminating public expenditure such as roads and ownership of radios and televisions, as well as the presence of schools all have a positive impact on measures of empowerment.

A woman's perceived fecundity will also influence her decision to contracept. While it makes sense to account for the woman's amenorrheic or breastfeeding status, both of which affect her ability to conceive and hence the benefits of using contraception, such variables will likely be correlated with unobservable factors present in the equation error, particularly given the cross-sectional nature of the data. These variables are therefore left from the analysis. Included are measures of the woman's knowledge of contraceptive alternatives, as well as her exposure to FP messages, from sources TV, Radio, Newspaper, or Poster. Measures of the current availability of health services, at the level of the village and the woman's contact in the form of a home visit within the last twelve months are also included.

Included also are maternal literacy and maternal education level and father's occupation. The education level of the mother is hypothesized to have a positive

impact on the probability of contraceptive use through more than one channel; it may signal her greater autonomy and confidence to learn and make use of new techniques, as well as act as a proxy for other modernizing influences that reduce the perceived non-monetary costs of use. Education can proxy for a woman's status effect as noted in Degraff (1997). Following Pal & Makepeace (2000), we also include maternal experience of reproductive health problems in the last three months, since these may discourage women from attempting use of family planning. This is supported by research on reasons given by the mothers for non-use, despite a desire for no more children.

Included in the rural regressions are measures relating to the current village infrastructure and provision of health services. These variables include distance to the nearest all-weather road and the nearest community-level health centre. Including indicators of community family planning programs can cause problems as measures of supply, since these are often endogenously placed with fertility and propensity to use and may also affect migration patterns. This may be corrected for by explicitly modelling the determination of placement using supplementary data, see Angeles et al (1998) for a treatment. Bias is likely to come about because services are placed in areas most likely to make use of family planning and because migration to the area may become selective, with higher use-propensity couples, thus leading to over-estimation of the effects of family planning programs on fertility.

Alternatively, family planing programs may be differentially placed, according to fertility, with the highest fertility areas targeted first. This would likely lead to an underestimation of program effects, given the relationship between family size and propensity to use. The current paper makes use of a measure of health service provision that is more general and does not specifically relate to family planning, yet it does proxy for contact with modern health influences that may affect propensity to use.

4.4 Econometric Specification : Two-Stage Probit Least Squares

The initial specification makes use of a procedure outlined in Maddala (1983), wherein a two-equation system is estimated with a two-stage procedure in which one of the dependent endogenous variables is continuous, the other binary. It follows the corresponding Model 3 in Chapter 8.8 of Maddala (1983). The procedure has recently been made available to STATA users by Keshk (2003) who has written a STATA command, inclusive of the adjustments to the covariance matrix. This two-stage procedure involves Maximum Likelihood estimation by probit. The likelihood function to be maximized is of the form $L(\widehat{\theta}_1, \theta_2)$,where $\widehat{\theta_1}$ is a consistent estimate of θ_2. The derivation of the asymptotic covariance matrix of the two-stage estimates follows the method used by Amemiya (1979) for the Nelson-Olsen model (2SLS Tobit). As Maddala(1983) explains, it uses the fact that the asymptotic covariance matrix of the estimator obtained by maximizing the likelihood function $L(\widehat{\theta}_1, \theta_2)$, where some of the parameters have been replaced with their consistent estimates, can be obtained from the following relationship: $\widehat{\theta}_2 - \theta_2 \stackrel{A}{=} -(E\frac{\partial^2 \log L}{\partial\theta_2\partial\theta_2'})^{-1}[\frac{\partial \log L}{\partial\theta_2} + E\frac{\partial^2 \log L}{\partial\theta_2\partial\theta_1'}(\widehat{\theta}_1 - \theta_1)]$

where $\stackrel{A}{=}$ means that both sides of the equation have the same asymptotic distribution.

Following model 3 the dependent variables are thus defined;

y1 is completely observed ($y_1 = y_1^*$), y2 is observed = 1 if $y_2^* > 0$ and y_2=0 otherwise.

The initial model follows

$$y_1 = y_1^* = \gamma_1 y_2^* + \beta_1' X_1 + u_1 \tag{4.4}$$

$$y_2^* = \gamma_2 y_1 + \beta_2' X_2 + u_2 \tag{4.5}$$

with reduced forms as

$$y_1 = \Pi_1 X + v_1 \tag{4.6}$$

$$y_2^* = \Pi_2 X + v_2 \tag{4.7}$$

Because y_2^* is observed only as the dichotomous y_2 variable, one can only estimate Π_2/σ_2, where $.\sigma_2^2 = Var(v_2)$

Hence define

$$y_2^{**} = \frac{y_2^*}{\sigma_2} = \frac{\Pi_2}{\sigma_2} X + \frac{v_2}{\sigma_2} = \Pi_2^* X + v_2^* \tag{4.8}$$

The structural equations can now be written as

$$y_1 = \gamma_1 \sigma_2 y_2^{**} + \beta_1' X_1 + u_1 \tag{4.9}$$

$$y_2^{**} = \frac{\gamma_2}{\sigma_2} y_1 + \frac{\beta_2'}{\sigma_2} X_2 + \frac{u_2}{\sigma_2} \tag{4.10}$$

The two-stage procedure would be to estimate $\Pi_1$in equation 3 by OLS, estimate Π_2^* in equation 5 by Probit ML, then estimate equations 6 by OLS after substituting $\widehat{\Pi}_2^* X$ for y_2^{**}, and estimate 7 by probit ML after substituting $\widehat{\Pi}_1 X$ for y_1. The estimable parameters are $\gamma_1\sigma_2$,$\gamma_2/\sigma_2, \beta_1, \beta_2/\sigma_2, \sigma_1$and σ_{12}/σ_2. The asymptotic covariance matrix can be derived by using a procedure similar to the one used by Amemiya for the Nelson-Olsen 2SLS Tobit model. Amemiya (1979) suggested alternative GLS methods of estimation that were more efficient than the current two-stage probit model. Further, Lee (1982b) suggested there exist some generalized IV estimators that are asymptotically more efficient than the GLS estimator derived by Amemiya. These generalized models are not considered in this paper.

Identification requires excluding on theoretical grounds at least one variable

from each equation, in the absence of any further endogeneity. Where User is assumed endogenous to Number of Additional Children, at least one variable explaining User must be excluded from the first equation. For example whether or not the woman has heard a family planning message in the last six months and her knowledge of differing methods that proxy the psychic costs of use. Similarly, one must exclude from the contraceptive use probit at least one variable that is thought to affect how many more children the woman wants but that does not affect her propensity to use contraception. For example, the occupation grouping and education of the husband.

4.5 Results

Results are reported for the initial Two-Stage Probit Least Squares specification, where the number of additional children desired (ideal family size minus current family size) is defined as the first dependent endogenous variable, with binary contraceptive use status the second dependent endogenous variable.

The initial estimates (Part A) ignore any endogeneity associated with including current family size directly into both equations; these estimates are discussed but not tabulated. The results of Part B, inclusive of the adjustments to the covariance matrix and the standard errors are set out in Tables 4.4 through 4.7; here, the endogeneity of current family size is treated through the instrumental variables procedure of Rivers & Vuong (1988). Conventional t-statistics are valid Wald tests of model restrictions.

4.5.1 Results Part A : Assuming current family size to be exogenous

In this initial estimation, where current family size is included directly into both equations, results raise concern. Controlling for "Number of Additional Children Desired", which is itself conditioned on current family size, the effect on the woman's propensity to use contraception, of having greater numbers of children is negative in both samples (significant among rural sample). Identical women

who both desire, say, two more births will have differing probabilities of using contraception, where they have differing numbers of children; those women with the most children will be less likely to use contraception. We expect this is because preferences for larger families (the sum of current & desired additional children) are associated with conditions not conducive to the use of contraception.

For example, women who suffered poor access to contraception in the past, resulting in a greater family size today (deviations from planned timing/spacing), continue to suffer poor access that makes them equally unlikely to use contraception today. Variation in access to health facilities and family planning has dynamic implications for family formation and becomes embedded in the fertility outcome, current family size and can cause correlation with the contraception demand equation error.

Even where all relevant current access measures are included as explanatory variables, there may well remain permanent unobservable cost differences across women that will cause current family size to be endogenous. This will cause an underestimation of the positive effects of current family size on contraception use probabilities because of the downward bias inherent among women with many children. Because we are allowing costs of using contraception to be nonmonetary, the woman's current family size, in reflecting preferences for the timing of births, may also be correlated with a distaste for using contraception.

Bollen (1995) et al confirm that their identification of the fertility intention is more complete, leaving current family size redundant and insignificant, when included directly into the contraceptive demand equation. The authors possess comprehensive back-dated supply and access information with regard health service availability that is missing from our current dataset.

The following discussion covers the basic findings, results of the exogeneity tests and results from regressions where current family size is instrumented in an initial reduced-form regression, before being included in the 2SLS system determining our two dependent variables, Number of Additional Children Desired and indicator for Current User of Any Method of Contraception. This is followed by some closing comments.

Part A : OLS Regression of Number of Additional Children Desired

The 2SLS regression of the number of additional children desired, inclusive of the instrument for current contraceptive user, provides results in line with previous findings on the demand for children. Among rural women, controlling for number of living children, the instrument for the binary current user of contraception is associated with less additional children desired; this effect is significant at 5 percent level although the effect is small, .075 of one child. This provides evidence that women may be taking account of the costs of using contraception in forming their current demand for children. The effect is insignificant among urban women.

The effect of current family size is to reduce by about .82 of one child the number of additional children desired in both samples. This effect is less than one because women with more children for their age are those with the greater total target family size preferences; they start earlier and space births more closely in anticipation of a larger target. This simultaneity may well be a source of endogeneity for current family size in this first equation.

Rural women who come from the Hill or Bundelkhand regions want less additional children and women from Eastern and Central regions want more additional children, as compared to the base region of Western Uttar Pradesh. The two mobility measures indicate that rural women with more restriction on their personal movements in general hold the lower fertility preferences. Women who needed permission to visit friends and relatives want on average about .13 of a child less than women who did not need such permission and women who lived with their mother-in-laws wanted almost one third of a child less. These results provide some evidence that rural women with the greater freedom of mobility hold the greater fertility preferences and this may be partly related to their patterns of work, particularly in rural agriculture, that is thought to stimulate and complement child-rearing. It is noted that upper-caste women are not permitted to partake in such menial labour tasks. That rural women residing with their mothers-in-law want less additional children is difficult to interpret; since we are conditioning on current family size, it suggests these women hold smaller family size preferences. However, it could be the case that these women have experienced

accumulating excess fertility as a result of the presence of the mother-in-law and are answering cautiously as a result.

In the urban sample, a different result is found; women who have the greater input into the decision concerning obtaining health care have the lower fertility preferences, wanting on average .14 of a child less than equivalent women who have less input into health care decisions. This result is not surprising in light of the strong complementarity in provision of health care with family planning services that work to change family size preferences.

The effects of religion and ethnicity, on both the fertility intention and uptake of contraception appear to be lessened by conditions associated with living in urban areas; many of these coefficients lose significance in the urban regressions. Rural women coming from one of the other Non-Hindu religious groups want on average almost half a child less and this effect is highly significant, yet in the urban sample no such effect remains. This provides support for the claim that the influence of social caste and religion on preferences/behaviours is lessened by conditions associated with urban life, after controlling for all else that determines family size preferences.

The standard of living indicators support economic theory on the demand for children among the rural sample; as compared with women whose standard of living is described as low, women from households where the standard of living is classified as medium or high want less additional children, with the latter effect being the strongest. Urban women who lived in higher quality housing composed of brick/Pucca want one fifth of one child less. In rural areas, women from communities with a regular electricity supply wanted about one tenth of a child less.

Respondents of husbands who work in agriculture, or whose employment can be described as Unskilled Manual want greater numbers of additional children, given current family size. Each of the education categories reduce the number of additional children desired in the rural sample, with the effect strengthening, the more education the mother and father have. For example, as compared with women of no education, those with secondary education wanted about one third

of a child less and those with higher education wanted two thirds of a child less.

In urban areas similar findings emerge with maternal literacy negatively related to the number of additional children desired. Among urban women, age at marriage was negatively related to the fertility intention. Women who delay marriage often do so in order to complete further education, which is associated with a demand for fewer children and a substitution toward quality.

Part A : Binary Probit of Current User of Any Method of Contraception

Results for the binary probit of user/nonuser of contraceptives, inclusive of the instrument for the number of additional children desired, confirm the negative effect on contraceptive use propensity of wanting greater numbers of

additional children in both samples, although the effect is statistically significant only among rural respondents. This supports results found by Bollen et al (1995) and Degraff et al (1997).

In the rural regression, when current family size is included directly in the equation determining the woman's propensity to use contraception, the coefficient is of negative sign; the more children the woman has, the less likely she is to make use of any contraceptive method. This effect is strongly significant. As mentioned, this is likely due to the fact that current family size, being in part the outcome of past access to health services, (as well as preferences for the timing, spacing and number of births), is correlated with factors not otherwise included in the model. Given our few current measures of cost, the lack of health services in the past is highly correlated with the same lack of services currently that makes these women less likely to use some form of family planning. Such an effect is not found among urban women; current family size is insignificant in the contraception probit.

Among rural women, net of the effects of education on fertility intentions, there remain no significant effects of education on the probability of currently using some form of contraception. Among urban women, greater maternal education significantly positively effects contraceptive use propensity at both secondary and higher education levels, independently of the way it affects the fertility inten-

tion measure "Number of Additional Children Desired". This may be proxying certain informal access network effects but may also reflect the greater technical efficiency of educated women in their use of contraception, thereby averting more births for the same cost.

The probability of contracepting generally improves with age, with the age group effects becoming increasingly positive on the response probability in both samples. Ceteris paribus, age at first marriage is negatively related to contraceptive use probability among both rural and urban women. Thus the older the women are at time of marriage, the later they commence childbearing and the less need they have to control their fertility through the use of family planning. There is no women's status effect that makes these women who marry later more likely to use contraception.

The regional dummies indicate that women coming from either Hill, Eastern or Bundelkhand are more likely to use than women from the other two regions. Rural women from one of the Scheduled Tribes, or Other Backward Classes were less likely to be users of contraceptives, along with rural Muslim women. The effects of caste, tribe and religion were all insignificant in the urban regressions, again supporting the notion of the effects of the modernizing urban influences on preferences and tastes. Although the effect of being Muslim is significant and positive on the urban fertility intention, there is no Muslim effect on contraception use propensity directly.

Rural women who came from households where the standard of living was classified as high, or where the family possessed a television were more likely to be current users of some method of contraception, as were urban women coming from households with electricity, or from households who owned a TV or a bicycle. Urban women who resided with their mother-in-laws were much less likely to be making use of any form of contraception and women who had at least partial input into the decision concerning what to cook were more likely to make use of contraception, as were women who were allowed to have some money set aside for themselves (significant among rural sample).

Women who perceived themselves to be subfecund or menopausal were much

less likely to be using contraceptives, as were women whose husbands worked away. Women who had reported reproductive health problems in the last three months were more likely to be using some form of contraception although this may be due to reverse causality, or selection: Women who come forward to report reproductive health problems are often more independent and knowledgeable over their health and more likely to use family planning, than other women. This would accord with the perception of severe under-reporting of women's reproductive health problems in India.

4.5.2 Discussion of Endogeneity

Results of the exogeneity tests, set out below, highlight concern with the variable current family size, for the way it may be correlated with unobservable information embedded in both equation errors. The preceding regression results are reported assuming exogeneity and departure from this will feed into the generated instruments and render inconsistent any parameter estimates obtained.

As noted in Wooldridge(2002) "except in cases where the magnitude of the β have some meaning, omitted heterogeneity in probit models is not a problem when it is independent of x; ignoring it consistently estimates the average partial effects." This hinges on the assumption of normality in the unobserved heterogeneity component and in the probit. However, where this heterogeneity is correlated with the x, or is otherwise dependent on x, say where the heterogeneity component (c) has Var(c|x) depends on x, then omission of c will lead to inconsistent results. For example in the equation,

$$P(y = 1|x, c) = \Phi(x\beta + \gamma c) \tag{4.11}$$

were $c|x \tilde{} Normal(x\delta, \eta^2)$, then probit of y on x gives consistent estimates of $(\beta + \gamma\delta)/\rho$, where $\rho^2 = \gamma^2\eta^2 + 1$,which will in general be different from the usual scaled β/σ unless either δ or γ are zero. For example, in the present contraceptive use equation, where c is understood to be latent biological fecundity and x is, say current family size, this fecundity is likely to be higher among women with more

children; δ is not likely to be equal to zero in such a scenario.

Testing Exogeneity

To test for the exogeneity of current family size, one needs to separately estimate the OLS equation for the number of additional children desired and the binary probit equation for current user of any contraceptive method as reduced forms, inclusive of all exogenous explanatory variables from both equations. To these regressions one adds the actual value for current family size, in addition to it's error from a preliminary reduced-form regression, where current family size is the continuous dependent variable, following the procedure of Rivers & Vuong (1988).

The null hypothesis of exogeneity is validly tested by assessing if the coefficient on the fitted residual is significant, using the usual reported t statistic, though the standard errors do not take into account the estimated nature of the included error. Variables used to obtain the instrument for current family size must include all factors determining both dependent variables and in addition, factors thought to determine current number of children, that are excluded on theoretical grounds from both equations for Number of Additional Children Desired and Current Contraceptive User.

These excluded variables, such as backdated supply conditions that affect past costs of controlling the supply of births ensure that both rank and order conditions are satisfied. For each endogenous variable, a minimum of one exclusion restriction is required. In the present estimation, concern rests with the ability to obtain sufficient instruments for current family size, since information pertaining to past conditions and specifically, back-dated infrastructural information and health service availability measures, employed by Degraff et al (1997) and Bollen et al (1995) are not available with the present DHS data.

Among the rural sample the woman's age in years is found not to be significant in explaining variation in Number of Additional Children Desired and Current User and is used to explain current number of children. In the urban sample, the indicators for Hill and Central Region, woman's age in years, standard of

living index medium, presence of Toilet, monthly cinema visit and ownership of motorcycle and refrigerator, along with residence at age twelve all separately explain current family size and not how many additional children the woman desires, or her use of contraception at the time of survey.

Results of the tests, wherein a linear projection of current family size is regressed on the above exclusion variables, in addition to all other explanatory variables in system provide the following results.

Number of Additional Children Desired Results of the exogeneity test for the reduced-form OLS regression of Number of Additional Children Desired, inclusive of all explanatory variables confirm that current family size is exogenous in both rural and urban regressions; that is, the fitted error is insignificant in the regression.

Contraceptive Use Probit The reduced-form version of the contraceptive probit regression, inclusive of all explanatory variables confirms that current family size is strongly endogenous in the rural sample and borderline exogenous in the urban sample. This is not surprising given the lack of both backdated and current information on the true costs of using contraception, in terms of product availability, distance, support in use etc. In addition, it is quite likely that the conditions which make large family sizes optimal coexist with greater opposition to use. These rural populations have not come into contact with the same sorts of modernizing influences and social forces that change attitudes to using birth control products.

4.5.3 Results Part B : Instrument for Current Family Size used in place of actual value

The results of Part B, in which an instrument for current family size is used in place of the actual value, in addition to instrumenting each of the dependent variables in the Two-Stage Probit Least Squares procedure, are presented in Tables 4 and 5 correspond to the OLS and probit regressions for the rural sample.

Variable	Coefficient (Std Error)
Instrument : Current User of Any Method of Contraception	-0.169*(0.072)
Instrument : Current Family Size	-0.724**(0.093)
Age Group : 20-24 years	-0.185(0.135)
Age Group : 25-29 years	-0.269(0.207)
Age Group : 30-34 years	-0.338(0.262)
Age Group : 35-39 years	-0.280(0.290)
Age Group : 40-44 years	-0.226(0.307)
Age Group : 45-49 years	-0.098(0.301)
Presence of mother-in-law	-0.284*(0.127)
Age at first marriage	0.027†(0.015)
Region : Hill	-0.142(0.106)
Region : Central UP	0.140†(0.081)
Region : Eastern UP	0.216**(0.062)
Region : Bundelkhand	-0.049(0.110)
Permission needed to visit friends/relatives	-0.187*(0.078)
Household Standard of Living Index : Med	-0.052(0.058)
Household Standard of Living Index : High	-0.118(0.107)
Ethnicity : Scheduled Caste	0.099†(0.058)
Religion : Muslim	0.183(0.122)
Religion : Other groups	-0.449†(0.270)
Respondent's Education : Primary	-0.271**(0.074)
Respondent's Education : Secondary	-0.318**(0.090)
Respondent's Education : Higher	-0.656**(0.159)
Husband's Education : Secondary	-0.149**(0.057)
Husband's Education : Higher	-0.197*(0.078)
Occupation of Husband : Unskilled Manual	0.133†(0.069)
Regular village electrification	-0.094(0.058)
Intercept	2.241**(0.401)
N= 4377, R^2=.384, $F_{(27,4349)}$=73.159	Signif. levels: †:10%, *:5%, **:1%

Table 4.4: Results Part B : 2SLS Number of Additional Children Desired (Rural Sample)

Variable	Coefficient (Std Error)
Instrument : Number of Additional Children Desired	-0.658**(0.107)
Instrument : Current Family Size	-0.146(0.096)
Instrument : Number of Add. Chld. Desired Squared	0.050†(0.028)
Age Group : 20-24 years	-0.070(0.162)
Age Group : 25-29 years	-0.038(0.218)
Age Group : 30-34 years	0.003(0.246)
Age Group : 35-39 years	0.160(0.263)
Age Group : 40-44 years	0.310(0.280)
Age Group : 45-49 years	0.807**(0.301)
Region : Hill	0.332**(0.097)
Region : Central UP	0.140†(0.084)
Region : Eastern UP	0.363**(0.065)
Region : Bundelkhand	0.414**(0.094)
Allowed to have money set aside	0.108*(0.050)
Household Standard of Living Index : Med	0.100†(0.060)
Household Standard of Living Index : High	0.308**(0.110)
Perceived Infecund/Menopausal	-1.039**(0.104)
Husband staying elsewhere	-0.286**(0.088)
Decision made by respondent/jointly: What to cook	0.098(0.066)
Ethnicity : Scheduled Tribe	-0.343*(0.159)
Ethnicity : Other Disadvantaged Caste	-0.093†(0.054)
Religion : Muslim	-0.422**(0.106)
Last 3 months : Reproductive Health Problem D	0.317**(0.079)
Household has Television	0.188*(0.074)
Distance to Community Health Centre (in kms)	0.006**(0.001)
Decision made by respondent/jointly: Staying with family	-0.070(0.055)
Regular village electrification	0.098(0.061)
Intercept	-0.550†(0.313)
N=4377, Log-likelihood= . , $\chi^2_{(27)}$=1298.729	Signif. levels: †:10%, *:5%, **:1%

Table 4.5: Results Part B: 2SLS Probit Current Contraceptive User (Rural Sample)

Variable	Coefficient (Std Error)
Instrument : Current User of Any Method of Contraception	-0.046(0.058)
Instrument : Current Family Size	-0.818**(0.098)
Age Group : 20-24 years	-0.128(0.242)
Age Group : 25-29 years	-.200(0.297)
Age Group : 30-34 years	-0.145(0.352)
Age Group : 35-39 years	-0.046(0.384)
Age Group : 40-44 years	0.038(0.445)
Age Group : 45-49 years	0.108(0.416)
Age at first marriage	-0.026(0.021)
Religion : Muslim	0.358**(0.138)
Can read and write	-0.394**(0.117)
Decision made by respondent/jointly: Obtaining health care	-0.127(0.082)
Occupation of Husband : Unskilled Manual	0.249(0.159)
Building material of household: Pucca (higher quality)	-0.195†(0.107)
Intercept	3.041**(0.471)
N=1179, R^2=0.374, $F_{(14,1164)}$=26.423	Signif. levels: †:10%, *:5%, **:1%

Table 4.6: Results Part B: 2SLS Number of Additional Children Desired (Urban Sample)

Tables 6 and 7 correspond to the OLS and probit regressions for the urban sample.

The initial reduced-form regressions for current family size explain just over half of the total variation in family sizes among the sampled women. Certain variables that affect the pace of child-bearing, such as backdated supply-side infrastructure measures and access to health facilities are absent from our dataset and render the instruments only partial measures of what determines current family size. Nonetheless, all variables used to compose the instrument for current family size are exogenous to the other two dependent variables, so any remaining variation in this variable that is correlated with variation in either of the dependent variables will fall out of the instrument for current family size.

We also include in the contraceptive probit, the squared term of the instrument for the number of additional children desired, in order to assess the effects of absolute distance from Ideal family size on contraception use propensities: Women who are the furthest above or below their ideal family size are hypothesized to be less likely to use contraception. Given the very low demand for spacing births, coupled with the very high social costs of using reversible modern methods, women who are at the beginning of their fertility cycle are thought to have

Variable	Coefficient (Std Error)
Instrument : Number of Additional Children Desired	-0.270(0.246)
Instrument : Current Family Size	-0.042(0.156)
Instrument : Number of Add. Child. Desired Squared	-0.158**(0.056)
Age Group : 20-24 years	0.039(0.385)
Age Group : 25-29 years	0.340(0.512)
Age Group : 30-34 years	0.808(0.572)
Age Group : 35-39 years	1.032†(0.586)
Age Group : 40-44 years	1.201†(0.626)
Age Group : 45-49 years	1.581*(0.629)
Perceived Infecund/Menopausal	-1.916**(0.182)
Age at first marriage	-0.047*(0.021)
Husband staying elsewhere	-0.605*(0.253)
Allowed to have money set aside	0.115(0.103)
Respondent's Education : Secondary	0.390**(0.139)
Respondent's Education : Higher	0.579**(0.182)
Household has electricity	0.308†(0.166)
Presence of Mother-in-law	-0.800†(0.440)
Household has television	0.320**(0.120)
Household has bicycle	0.127(0.102)
Decision made by respondent/jointly: What to cook	0.159(0.141)
Permission needed to go to market	0.149(0.113)
Last 3 months : Reproductive health problem B	0.287*(0.127)
Intercept	-0.378(0.887)
N=1179, Log-likelihood=., $\chi^2_{(22)}$=461.828	Signif. levels: †:10%, *:5%, **:1%

Table 4.7: Results Part B : 2SLS Probit Current Contraceptive User (Urban Sample)

very little chance of using any method. This result is confirmed among urban women, where the sign on the squared term is negative and strongly significant, yet one cannot say if this is from being either far above, or far below the Ideal.

Among the rural sample however, there is a small positive effect on the probability of using contraception of being further from one's Ideal family size.

We interpret this as possible evidence that women often don't contracept until they have reached a few excess children and as the marginal disutility of an excess birth rises sufficiently. So too, the costs of contracepting may be declining with additional children, as the preferences of other family members are realised.

The coefficient on the instrument for current user in the rural equation determining Number of Additional Children Desired is larger than the coefficient obtained from Part A. Results remain unchanged and insignificant in the urban sample. The coefficient on the instrument for current family size becomes somewhat less negative in the rural sample and unchanged in the urban regression.

The age coefficients become slightly larger in the rural sample equation one but lose significance; this is likely because they also compose the instrument for current family size and it is partly through this channel that they affect fertility intention. The age coefficients were insignificant in urban initial results and remain so. Most of the other coefficients in the first equation explaining fertility intention remain unchanged. The standard of living indicators have smaller coefficients and lose significance in the rural sample; the same occurs with the effect of Muslim among the rural sample. Hence these variables have some of their effect through current family size.

Results for equation two, determining contraception use probabilities show that the coefficient on the instrument for Number of Additional Children Desired becomes slightly larger in the rural sample, remaining highly significant and the urban coefficient remains insignificant and of the same magnitude. However, in both samples, the coefficient on the instrument for current family size becomes much smaller and loses significance, confirming that much of their endogenous contribution has been successfully discarded from the instrument. The age effects also become much smaller and lose significance in this second equation in both

samples.

The R squared terms for the first equation determining Number of Additional Children Desired across both samples drop by almost half due to the fact that our models lose much explanatory power. This is due to the instrumenting procedure that rids our variable current family size of the information on backdated conditions that identify past supply of births. The pseudo R squared terms in the second equation (Probit User/Non-User) remain unchanged in both rural and urban samples, when this endogeneity is addressed. Because the system estimation takes account only of the estimated nature of the two dependent variables, and not the estimated nature of current family size, the standard errors need adjusting upwards. Thus the impact of variables may appear overly significant. A 3SLS procedure would allow for this adjustment.

Estimates of the cross-equation error correlations suggest this is present to a greater degree among the rural sample. The cross-equation error correlation in the Two Stage Least Squares procedure is initially =-.2143 among rural sample, rising to -.6018 once the endogeneity of current family size is accounted for. This suggests that the true negative cross-equation correlation was under-estimated. Likewise the error correlation rises in urban regressions, initially -.0340 to .1120. This is as expected, where more unexplained information is embedded in the errors, rather than correlated with included variables.

Variable	dy/dx	Mean(x)
Instrument: Number of Additional Children Desired	-.2145	.1624
Instrument: Current Number of Children	-.0477	3.1026
Number of Additional Children Desired Squared	.0163	1.5186
Age group 20-24 years	-.0225	.1892
Age group 25-29 years	-.0121	.2072
Age group 30-34 years	.0009	.1732
Age group 35-39 years	.0538	.1455
Age group 40-44 years	.1082	.1058
Age group 45-49 years	.3017	.0669
Region : Hill	.1164	.1035
Region : Central	.0472	.1410
Region : Eastern	.1216	.3646
Region : Bundelkhand	.1476	.0891
Allowed to have money set aside	.0353	.4791
Household Standard of Living : Medium	.0324	.5584
Household Standard of Living : High	.1073	.1211
Perceived Infecund / Menopausal	-.2592	.1828
Husband works away	-.0860	.0966
Decision made by respondent or jointly: What to cook	.0315	.7804
Scheduled Tribe	-.0993	.0256
Other Disadvantaged Class	-.0301	.3023
Muslim	-.1213	.0902
Last 3 months suffered reproductive health problem	.1107	.0957
Household has TV	.0631	.2150
Distance to Community Health Centre	.0018	15.8483
Decision made by respondent or jointly: Respondent staying with family	-.0226	.3459
Village has regular electricity supply	.0323	.2246

Table 4.8: Marginal Effect at means of explanatory variables - Rural sample Probability of Positive Outcome : Current User of a Contraceptive Method =.2626

4.5.4 Marginal Effects

The average partial effects and predicted probabilities are set out in Tables 4.8 and 4.9, for both rural and urban samples at the mean of all explanatory variables. The model predicts that the mean urban woman has a probability of currently using some form of contraception that is twice that of the mean rural woman.

Variable	dy/dx	Mean(x)
Instrument: Number of Additional Children Desired	-.1074	-.3240
Instrument: Current Number of Children	-.0168	3.0044
Number of Additional Children Desired Squared	-.0629	1.2108
Age group 20-24 years	.0156	.1578
Age group 25-29 years	.1325	.1891
Age group 30-34 years	.2984	.2053
Age group 35-39 years	.3663	.1959
Age group 40-44 years	.3969	.1221
Age group 45-49 years	.4568	.0865
Perceived Infecund / Menopausal	-.5918	.1654
Age at first marriage	-.0187	17.95
Husband works away	-.2335	.0390
Allowed to have money set aside	.0457	.7023
Maternal Education: Secondary	.1519	.2400
Maternal Education: Higher	.2230	.2850
Household has electricity	.1224	.9008
Presence of mother-in-law	-.2976	.0127
Household has TV	.1272	.7583
Household has bicycle	.0505	.6802
Decision made by respondent or jointly: What to cook	.0633	.8422
Permission needed to go to market	.0588	.2799
Last 3 months suffered reproductive health problem	.1122	.1603

Table 4.9: Marginal Effect at means of explanatory variables - Urban sample Probability of Positive Outcome : Current User of a Contraceptive Method =.5350

4.6 Conclusions

These results reiterate the difficulty in estimating dynamic behavioural equations with cross sectional data. Without further information on within-family behaviours and biological processes, in conjunction with fertility outcomes corresponding to contraceptive use episodes, one cannot uncover the reasons underlying results obtained, or estimate any woman-specific effects that affect subsequent choice.

The degree to which endogeneity causes inconsistency and bias depends upon the extent to which it is assumed correlated with the right hand side variables. That one is replacing a suspect variable with a poor proxy results in parameter estimates with larger variances and this needs to be weighed against the "desirable asymptotic properties". Until better data allows more control in the modelling of such dynamic behaviour and simultaneity, one would attach a health warning to the results obtained.

The findings give some guide to policy in that they confirm the wide divergence in behaviours between rural and urban populations, as a result of differential provision and exposure to modernizing influences that break down cultural norms and change tastes for children and for using family planning products. One must give warning to an oversimplified definition of behaviours associated with greater female autonomy, since these may not necessarily go hand-in-hand with lower fertility, particularly in rural areas. For this reason, it is necessary to understand more fully the true strucutural behavioural model and make explicit the relationships being tested.

It is for further work to understand more completely the way in which womens' bargaining power develops, both within the home and community and relate this to decision-making over fertility control. Such a model would need to be specific to the population under study since even very simple differences in endowments and conditions can have large impacts upon decision-making. In the present study, we have attempted to inform the reasons for the signs of coefficients and relate this to some of the underlying theory, rather than relying solely on stylised

facts but the nature of available data means that it is empirically difficult to test many of the proposed relationships. At the very least, there needs to be some effort put into understanding why certain realationships exist, when interpreting the results obtained and assess the extent to which better data might help test such propositions.

The fertility intention measure used, defined as the number of additional children desired is a somewhat noisy measure of the benefits of contracepting. It is unable to discriminate the need for spacing births from the need for limiting further fertility and it cannot separate out the role of excess fertility. Since any women who desire additional children are excluded from considering sterilisation, they have a separate decision problem over alternatives from women who want no further children.

An extension to the present paper could therefore assesses the demand for contraception in a multinomial framework, among women who do not desire further children, accounting for selection into this complete fertility group. These women therefore have open to them the option of using reversible techniques each period, or choosing permanent sterilisation, or nothing.

Initial mulinomial probit models of use of reversible and irreversible contraception methods are estimated but results fail to converge. We expect this is due to the data. A Heckman binary selection equation on desire for additional children, with the binary user of reversible contraception methods is also estimated. Results confirm the selection of women who desire further children; this strongly reduces the probability of using any contraception. These results are not presented but available upon request to the author.

Chapter 5

Child Time Allocations

5.1 Introduction

Empirical studies estimating the determinants of school enrolment and school attainment of Indian children find evidence of a continuing sex differential and are commonly left with fairly sizeable unexplained components in empirical specifications. There has been extensive research on the gender gap in earnings and more recently researchers have directed their focus to explaining the gender gap in schooling and in the process improve the performance of their models.

Investments in education, following the human capital model of Becker (1975), typically depend upon perceived returns, as well as the explicit and implicit costs of sending children to school, along with preferences to educate children (quantity versus quality), all of which may vary by gender of the child and other crucial factors. In addition, the household must use all information on incomes, wealth and access to credit and tastes for work/leisure in choosing optimal levels of schooling for each of their children.

At the same time, a parallel literature has examined the drivers of child labour, assessing the role of household poverty, gender, adult labour supply, household resource constraints and the role of school cost and quality. Beegle, Dehejia & Gatti (2003) and Edmonds (2004) develop simplified two-period household labour supply models with credit constraints and assess the impact of anticipated and unanticipated income shocks on child labour supply using comprehensive panel

Reason given	**Male**	**Female**	**Total**
School too far away	25*(7.20)*	80*(12.07)*	105*(10.40)*
Transport not available	4*(1.15)*	10*(1.51)*	14*(1.39)*
Education not considered necessary	21*(6.05)*	60*(9.05)*	81*(8.02)*
Required for household work	7*(2.02)*	54*(8.14)*	61*(6.04)*
Required for work on farm/family business	0*(0.00)*	6*(0.90)*	6*(0.59)*
Required for outside work for payment	2*(0.58)*	5*(0.75)*	7*(0.69)*
Cost too much	111*(31.99)*	164*(24.74)*	275*(27.23)*
No proper school facilities for girls	N/A	20*(3.02)*	20*(1.98)*
Required for care of siblings	1*(0.29)*	14*(2.11)*	15*(1.49)*
Not interested in studies	69*(19.88)*	80*(12.07)*	149*(14.75)*
Other	106*(30.55)*	166*(25.04)*	272*(26.93)*
Don't Know	1*(0.29)*	4*(0.60)*	5*(0.50)*
Total	347*(100.00)*	663*(100.00)*	1010*(100.00)*

Table 5.1: Main reason never went to school

data from Tanzania and South Africa, respectively. Both papers confirm the negative response of child labour supply to positive income shocks within the household, providing support for their proposition that among credit-constrained populations, families use child labour as a form of consumption smoothing.

In order to test whether poverty drives children into work, Bhalotra (2003) assesses the wage elasticity of child labour supply using survey data from rural Pakistan. She finds a significant negative wage elasticity for boys in support of the above proposition but no evidence for girls. Numerous studies confirm the importance of household poverty and of other resource constraints as drivers of child labour, see Pal (2004), Duraisamy (2000), Bacolod & Ranjan (2004).

Table 5.1 sets out the responses of the person interviewed for the household survey to a question regarding the main reason why children had never attended school, for children who had never been enrolled.

The table suggests "costs too much" and "Other" compose the most important responses for both genders. Distance to school was more commonly mentioned for girls. Given the differential mobility of women, in part tied to sociocultural practices, it is not surprising that distance has a greater impact on attendance for female children.

Despite the Government Of India's claim of universal and free access to pri-

mary school education, time, opportunity and monetary cost still appear to play a central role in preventing children from attending school. The interpretation of cost by the household head may be more general than just book fees.

A complementary framework adopted by Bacolod & Ranjan (2003), Deb & Rosati (2003) and others, and the one applied in the present analysis, models a time allocation decision of the parent/s for each of their school-age children, formally linking the literature on child schooling with that on child labour, among credit-constrained populations[1]. This approach accords with the simultaneous equations formulations of labour supply models with endogenous schooling.

These recent studies confirm the existence of a substantial group of children reported to be "idle"; that is, neither "working", nor "attending school" across India, Vietnam, Ghana and Peru. In general in much of South Asia and Africa, girls help out in the home, while the formal child labour market is predominantly the realm of male children. Where the data is not sensitive to this taxonomy, female children may be perceived as idle, rather than involved in home production, which itself responds to changes in household variables, incentives, as well as income and health shocks of other household members.

One of the contributions of the present paper is to understand more thoroughly the duties performed by this "idle" group and in so doing, achieve a more complete explanation of the gender gap in time allocations. This is thought to be particularly relevant in light of the sex-delineated nature of home production activities and child labour opportunities in India. Table 5.2 shows that female children compose almost 70 percent of the children described as at home, while almost 80 percent of children described as working are male. Female children compose less than half of our sample. This is due in part to slightly unbalanced sex ratios at birth but more importantly, to the differential infant and child mortality of girls.

A number of factors specific to India are thought to affect the gender differential in child time allocations. The exogamous marriage practices, typical

[1]See Jacoby & Skoufias (1994) who provide evidence of the detrimental effects of credit market imperfections on educational allocations among poor families.

Time Allocation	Male	Female	Total
Child in school	2540(58.47)	1804(41.53)	4344(100.00)
Child at home	362(30.83)	812(69.17)	1174(100.00)
Child works	119(79.87)	30(20.13)	149(100.00)
Total	3021(53.31)	2646(46.69)	5667(100.00)

Table 5.2: Time Allocation by child's gender

of the north of India, mean that the female child leaves her natal home permanently to reside in a geographically separated village. Any returns to education are therefore realized by the in-laws and not the natal parents and it is thought this dampens incentives to invest in female child schooling; see Gandhi-Kingdon (2002) for an in-depth analysis.

Time allocation decisions of the mother have been found to impact those of her children asymmetrically by gender, where childrearing and household chores, if not done by the mother, are performed by other female family members. In assessing differences in mean schooling for age, Afridi (2003) finds that first born girls receive less education than middle-parity girls because they are expected to be the support carer for younger siblings and Gandhi-Kingdon (2002) confirms that girls of working mothers fulfill household chores significantly more often and are less likely to be enrolled in school than similar girls whose mothers do not work. This "mother working" effect was not found to affect the enrolment probability for boys. Ilahi (2001) finds female child schooling and labour supply to be more responsive to parental sickness and parental work than that of boys in the LSMS Peruvian panel study.

Jensen(2002) points out that the mere fact that girls on average have more siblings than boys, as a result of Differential Stopping Behaviour (DSB) [2], means that among resource-constrained populations, they will on average receive less schooling than boys; equal treatment, unequal outcomes. This is seen to occur even where the explicit cost of education is fully covered by the state. Further, those parents who can least afford to save for dowry because they have the largest

[2]The term DSB is given to the practice whereby the probability of parents choosing to progress to a higher parity depends on the sex of the last child born. Where the child is male, the parents are less likely to proceed to have more children, ceteris paribus.

families are also those that must provide the most dowry per child, since on average, they have a larger proportion of female offspring.[3] This symptom and its implications for the schooling of children from female-heavy households has not been adequately highlighted or understood.

Angeles et al (2004) address the possibility that in addition to the detrimental effects of marriage practices and labour market discrimination, there is an implicit consideration by parents of the likelihood that their daughter will overshoot her family size later in life and be forced to forego market work to stay at home and care for her children. The authors suggest that among communities where there are local examples of women controlling their fertility in a way that renders them free to capitalize on past educational investments and where there is wider knowledge of family planning, parents will be encouraged to invest greater educational resources in their female children. Hence valid variables to include in any schooling regression explaining gender differences are the presence of family planning facilities locally.

These findings have important policy implications, particularly if there are gender objectives for schooling attainment. For example, the higher elasticity of female child labour supply, to changes in the labour supply of mothers, requires directed childcare policies to working mothers to ensure girls are not pulled from school to work at home or care for younger siblings. In addition, policies aimed at reducing child labour need to account for the very low perceived gains from schooling and the role of school quality in the decision to send children to work or school. Blanket banning of child labour without concurrent income support may aggravate the problem.

The efficiency or otherwise of child labour is covered in Baland & Robinson (2000), and Grootaert & Kanbur (1995), who identify the externalities created by child labour but warn that outright bans are a second-best solution. See Basu (1999) for a discussion of international child labour standards and the increasing support emerging for more progressive discouragement of child labour, through compulsory schooling initiatives, non-legislative cash transfers for enrolment, mid-

[3]This occurs as a result of DSB although at the aggregate level the sex ratio is unaltered.

day meal provision and improved school quality and income support.

Given the nature of household production and the need to coordinate the roles of differing family members, each of whom may hold different preferences, it is not immediately clear which is the appropriate decision framework within which to analyse child time allocation decisions. For a discussion of competing analytical approaches to the modelling of child labour, see Basu (1999) who assesses both intra-household and inter-household bargaining frameworks.

In the present paper, given the low bargaining power of children, we follow a unified household framework and assume that parents make all decisions relating to work, school and idleness/home production, for all family members and control the resultant income stream. We allow parents to hold differential tastes for the schooling of boys and girls. The analytical framework adopted in Deb & Rosati (2003), (2004) offers a simple two-period overlapping generations model where parent's decide on the time allocation of each of their children only once they observe how many children have survived from infancy. A similar two-stage model is proposed in Cigno (2004).

In a dynamic setting, where decisions concerning fertility are made simultaneously with those concerning schooling, parents can be seen to assess a periodic trade-off between child quality and quantity, in response to shocks and new information, along the lines of Foster & Roy (1997). This behaviour will have an effect on the time allocation choices of existing children the following period. These trade-offs also take account of the opportunities for unschooled children to contribute to household income formally at the going child wage, or informally via some form of household production.

In the present paper we therefore focus only on the estimation of existing children's activities, assuming any decisions concerning fertility are made optimally. A central contribution of this paper will be to account for the nonindependence of decisions across children of the same family, in choosing an appropriate empirical specification. Decisions concerning the parent's labour supply, particularly that of the mother, cannot be assumed independent of those concerning the children's, given the above discussion. Nor will a particular child's time allocation be inde-

pendent from those of their other siblings and preferences for work and leisure may lead to unknown correlations across all labour supply/schooling decisions within the household.

We treat more completely the implications of a lack of data on perceived returns to schooling and child wages for the choice of appropriate econometric specification. As noted by Train(2003), while a chosen model such as the logit may be appropriate in instances with more complete information, in light of what is known about the underlying behavioural process, the less than perfect datasets commonly encountered in developing countries may render it unsuitable.

The Multinomial Logit model, with which we shall commence imposes some fairly restrictive assumptions on behaviour that more flexible modelling frameworks such as the Mixed Logit are able to avoid. We therefore use the most recent round of the NFHS data for the rural part of the state of Uttar Pradesh, India 1999, a large cross-sectional household dataset, to investigate the role of child, household and village characteristics in explaining gender differences in child time allocations. We allow flexible correlation patterns and heteroskedasticity among the errors for each choice situation (child) and across choice situations(children) within the same family with implementation of the Mixed Logit, comparing results to the more standard multinomial logit model. We also cover suitability of the Nested Logit model, one within the class of Generalised Extreme Value models that also permit more flexible substitution patterns than the standard logit.

A recent treatment applying a version of the Mixed Logit model to child time allocation decisions in India, Deb & Rosati (2004) groups families into latent types (discrete distribution) and confirms the substantial importance of unobserved household-level heterogeneity. The authors find that households with a high propensity to send their children to school are poorer and have less educated parents than other latent classes.

Recent applications of the Mixed logit model, allowing for continuous distributions for the random parameters have been widely applied in transport economics and elsewhere, see Bhat (1998), Hole & Fitzroy (2004), Revelt & Train (1998)

and Brownstone & Train (1999); see Borah (2005) for a health provider choice application in India and Glasgow (2001) for an application to voting behaviour. A review on the "State of Practice" of the Mixed Logit model is given in Greene & Hensher (2001).

5.2 Model Specification

The standard logit model is the basis of much discrete choice modelling, in part because of it's easily interpretable, closed-form choice probabilities. It is also fairly robust to misspecification. It does, however, impose fairly tight assumptions on the resultant errors; that they are distributed iid extreme value. This independence means that the unobserved portions of utility across alternatives must be assumed entirely unrelated.

For this reason, the logit model is unable to represent variation in tastes that is at least partly random, or appears so because it is related to unobservable variables. Nor can it handle any correlation across errors as a result of repeated choice. Our dataset, with more than one choice observation (child) per family represents a form of repeated choice. Yet household-level taste variation (preference heterogeneity) relating to intensity of parental preferences to educate children or to send them to work will be common to all children of the same parents. These tastes may be related to observed characteristics (such as parental educations) but may also be partly random and related to characteristics not observed, causing a correlation in the errors across alternatives and children.

The Logit model also implies proportional substitution across alternatives that may not accurately represent behaviour; this is called the Independence of Irrelevant Alternatives (IIA) assumption. This implies that the relative probability of falling into one category rather than another, such as going to school versus being idle, will be unaffected by adding alternatives or changing the attributes of existing alternatives, such as the return to formal child labour. This is a very restrictive assumption and unlikely to hold in the present choice setting.

For example, if the wage of the third category "child works" were to rise, the

relative probability of going to school (base category) versus being idle (second category) would not in general be expected to remain the same. A rise in the child wage would induce a reassessment of the trade-off between present and future returns to children. Future consumption becomes relatively more costly. Higher child wages today would be expected to increase the relative probability of the child working versus attending school, given the returns to schooling. Higher child wages today would also be expected to increase the relative probability of the child working versus being idle, since the productivity of working formally, relative to the productivity of working within the home (or doing nothing) has improved. To impose the restriction that the ratio of probabilities of going to school versus being idle remain the same is unnecessarily restrictive. Tests of the IIA assumption by Small & Hsiao (1985) will be performed in the empirical section.

Moreover, the lack of comprehensive data on such variables as school quality, labour market conditions and child and adult wages, which define the perceived returns to schooling and the productivity of current child labour, is likely to result in further correlation in the errors across individuals and alternatives. While the goal is to specify utility such that the logit model is appropriate, this may not be possible given the data available.

One solution is to make use of a different econometric specification that permits more flexible modelling of substitution patterns and correlations in errors. We discuss two possibilities; one from the class of Generalised Extreme Value models, the Nested Logit, and one that makes use of simulation methods, the Mixed Logit. We discuss the advantages and disadvantages of each and perform estimation using the latter procedure, with NFHS India data for rural Uttar Pradesh.

5.2.1 Multinomial Logit Estimator

A standard multinomial logit model on a pooled cross section of children, assuming $(\mathrm{x}_i,\mathrm{y}_i)$ to be a random draw from the population of children gives response probabilities of the following form

$$P(y=j|x) = \frac{e^{x\beta_j}}{[1+\sum_{h=1}^{J} e^{x\beta_h}]}, \qquad j = 1, ..., J \tag{5.1}$$

where β_j is Kx1, j=1,....,J alternatives and the i children from each of n=1,....,N households are pooled. Because of the presence of household-specific unobservable effects, c_n, the y_{nji} will appear dependent across children, conditional only on the observable variables x_n. The researcher can deal with this problem either by assuming that the unobserved effect is normally distributed and independent of x_{ni} and proceed to estimate an unobserved random effect logit. Alternatively, if the researcher suspects that the independence assumption may not hold, or that the random effect is not normally distributed, a conditional MLE, Fixed Effects (fe) logit can provide an alternative estimation route.

Although the FE Logit permits the relationship between (c_n, x_n) to be unrestricted, the cost is that any factors that do not vary within the household (ie across children), such as household-level and village-level explanatory factors, must be dropped from the model since their effects cannot be distinguished from those of the fixed effect.

This formulation is highly restrictive in the current analysis, since such familial and local village-level factors are thought to be crucial in tying down the perceived returns to schooling and in proxying local child earnings opportunities, as well as representing variation in familial tastes for work, schooling and leisure that are correlated with observable family characteristics. Much understanding of how preferences and opportunities are related to explanatory variables is lost. More flexible models are able to deal with such problems in a more appropriate way, without sacrificing such richness and information. The FE logit continues to invoke the IIA assumption, which may be no more appropriate than in the standard logit.

Ignoring any unobservable variables within a standard multinomial logit model and testing for the presence of non-independence will be performed initially and results compared with the Mixed Logit. Tests for the presence of remaining unobservable heterogeneity will also be performed.

5.2.2 Generalised Extreme Value Models : The Nested Logit

The GEV models all share in common the attribute that the unobserved portions of utility for all alternatives are jointly distributed as a generalised extreme value. This distribution allows for some correlations over alternatives and collapses to the standard logit model where such correlations are absent. The Nested Logit is suitable for situations where the set of alternatives can be partitioned into natural subsets in such a way that the IIA assumption holds for alternatives within the same subset but need not do so for alternatives in differing subsets.

Potentially one could separate the schooling decision from the two work alternatives, such that the IIA need only hold for the relative probability of working at home versus working in the market, say if one were to change the returns to schooling. And in contrast to the standard logit, a change in the formal child wage need not impose the restriction that the relative probability of attending school viz a viz staying at home remain the same, since they are in different nests.

However, if we think there exists random taste variation, or correlations in errors across children in the same family, a Nested Logit specification will be inappropriate. It cannot handle situations in which variation in the effects of variables is at least partly random and unrelated to observable factors. For example, it may be the case that a preference to educate sons exists in varying degrees and not all of this variation can be explained by such factors as ethnicity, social class, or religion. Tastes for leisure and schooling, at the level of the family will also likely depend upon unobservable variables. The presence of such correlation in errors across choice situations (children) will again render the Nested Logit unsuitable. Tests on the Mixed Logit will establish to what extent these factors are present.

5.2.3 The Mixed Logit Model

A Mixed Logit Model is proposed as an alternative estimation procedure in which household n=1,.....,N is seen to face a time allocation choice among j=1,...,J alternatives, for each of it's i=1,..I children (choice situations), with each choice

alternative providing relative utility

$$U_{nji} = \beta'_{nj} x_{ni} + \varepsilon_{nji} \tag{5.2}$$

where x_{ni} is a vector of observable variables, the random coefficient vector β_{nj} is unobserved and assumed to vary across households and alternatives, with density $f(\beta_{nj}|\theta)$, where θ describes the true parameters of this distribution such as the mean b and variance W and ε_{nji} is the remaining random term that is distributed iid extreme value type 1, independent of β_{nj} and x_{ni}.

In the present setting, where there are no explanatory factors that vary over alternatives (such as attributes of alternative), one has a standard multinomial logit in which parameters for each of the conditioning variables, (which vary over villages, households and children), are permitted to have differing effects on the response probabilities across alternatives.

A random parameters interpretation of the mixed logit model is normally adopted in order to allow coefficients of attributes of alternatives, such as travel time for a particular mode of transport, to vary in the population, say for people with the same income. In general, the random parameter allows the effects of observable variables to vary randomly in the population, with mean and variance, not just with other observable variables. β_{nj} is decomposed into it's mean α_j and deviation, μ'_{nj}, where a new composite error is defined $\eta_{nji} = \mu'_{nj} x_{ni} + \varepsilon_{nji}$. The goal is to estimate this mean and deviation.

In their random parameters formulation, where data varies over alternatives and individuals, Revelt & Train (1998) compare the standard logit to the Mixed Logit under the assumption that the true model is as follows;

$$U_{nji} = b' x_{nji} + W \mu_n x_{nji} + \varepsilon_{nji} \tag{5.3}$$

where W is a diagonal matrix whose elements are standard deviations (for each parameter permitted to vary) and μ_n is a vector of independent standard normal variates (for a normally distributed random parameter). The authors note that the mean coefficients in the mixed logit can be expected to be larger

than the fixed coefficients in the standard logit model, because one is modelling more of the unobservable heterogeneity and hence normalizing parameters on a smaller remaining portion of utility. The parameters b are normalised such that ε_{nji} has the appropriate variance for extreme value error.

In the mixed logit, variation is related to parameters and treated explicitly as a separate component of the error ($\mu_n' W x_{nji}$) such that the remaining error is net of this extra variation.

Under an error components interpretation, the mixed logit model is used to represent stochastic components that create correlations among the utilities for different alternatives. This interpretation fits with the current application, where we are concerned with family-specific preferences for schooling and work that are not captured in the data. The composite stochastic error η_{nji} is decomposed into a part that allows for these correlations over alternatives and heteroskedasticity ($\mu_{nj}' z_{ni}$) and a part that is purely iid extreme value over alternatives and children, ε_{nji}. The terms in z_{ni} are chosen as error components and are observable variables whose coefficients, μ_{nj} are random terms possibly with zero means. The relative utility for household n, from alternative j, in choice situation i (child) can be written as;

$$U_{nji} = [\alpha_j' x_{ni}] + [\mu_{nj}' z_{ni} + \varepsilon_{nji}] \tag{5.4}$$

where we allow fixed coefficients for x_{ni} but random coefficients with zero means for variables z_{ni}. One must specify the response heterogeneity, it's distribution, in order to put structure on the correlation matrix. For the standard logit, z_{ni} is zero so there is no correlation in utility over alternatives and households: Any non-zero error components will break with the IIA in the standard logit setup. It is a desirable extension and does not impose normality on all parts of the unobservable components of utility.

With either interpretation, conditional on β_{nj}, the probability that household n chooses alternative j for child i is standard logit ;

$$L_{nji}(\beta_{nj}) = \frac{e^{\beta'_{nj}x_{ni}}}{\sum_h e^{\beta'_{nh}x_{ni}}} \tag{5.5}$$

However, β_{nj} is unobserved and varies in the population with density $f(\beta_{nj}|\theta)$ where θ are the parameters of interest to be estimated. The unconditional probability of household n choosing alternative j, for child i, is obtained by integrating the conditional probability above over all possible values of β_{nj}.

$$Q_{nji}(\theta) = \int L_{nji}(\beta_{nj}) f(\beta_{nj}|\theta) d\beta_{nj} \tag{5.6}$$

This mixed logit probability is a weighted average of the logit formula evaluated at different values of the random parameter, with the weights given by the chosen density f. Since the expression cannot be solved analytically, it is approximated using simulation methods. It is the simulated log likelihood function that is then maximized.[4]

This specification is very general and allows for almost any pattern of correlation across alternatives and children within the same family. In the following application, competing models are estimated, with normal, triangular and log-normal distributions for the elements of β_{nj}.

Tests

Revelt & Train (1998) propose a Likelihood Ratio Index as a measure of goodness of fit, defined as 1 -$[\frac{SLL(\theta_E)}{SLL(\theta_0)}]$, where SLL(θ_e) is the value of the simulated log likelihood function at the estimated parameters and SLL(0) is the value with all parameters equal to zero. The index ranges from zero (for a model no better than chance) to 1 for a model that provides a simulated probability of one. Bhat (1998) uses a similar index.

[4]For details see Train (1999),(2003)

Model Choice Issues in Current Application

In the current model there are no alternative-specific variables such as choice attributes; information pertains only to characteristics of the individual child, household and village. We allow variation in these characteristics to affect the propensities of falling into each of the j alternatives. This systematic portion of preference heterogeneity is thus related to the observable characteristics of the children and their families and estimable parameters are therefore allowed to vary over each alternative, as in the standard multinomial logit.

It is likely there remains additional preference heterogeneity that may not be captured by observable variables that will fall out in the error and cause correlation in these errors across alternatives and children. This random preference heterogeneity may relate to preferences for child schooling, versus working, versus leisure and for schooling children differently by gender. Son preference is thought to exist in varying degrees throughout India but certain groups or families may hold greater intensity of son preference than others for both observable and unobservable reasons.

Systematic response(effect) heterogeneity related to observable variables is handled by including interaction effects, where the coefficient on one variable depends upon the value taken by another. For example, the effect of having a working mother may depend on whether or not the child is female. The effect of standard of living index may depend upon ethnicity, or religion, that can proxy labour market discrimination; even where parents can afford to send the child to school, they see less benefits from doing so if they are denied access to labour markets.

There will also likely exist random response heterogeneity unrelated to explained factors. Candidate variables whose coefficients are thought likely to vary randomly within the population of households are child's gender and birth order. The effect of being female may vary with region, religion, birth order, land ownership or ethnicity but also with further, unobservable tastes for investing in daughters relative to sons that will be distributed within the population of families and otherwise left unexplained.

The effect of religion on the relative odds of the child working or staying at home, relative to the base category of being in school, may vary in the population with observable factors but also with factors not observable to the researcher such as perceived labour market returns. We do not hold information on the presence of past or present programmes to promote employment for differing scheduled castes but such factors may impact on families' perceived opportunities and returns from schooling. Much of the variation particularly in perceived returns to schooling is left unexplained in the model for lack of data on labour market conditions, wages and ethnic employment composition across work categories. Competing models will be compared on the grounds of improved explanatory power using the adjusted LR Index. We commence by estimating random parameters on all explanatory variables and test for significance.

5.3 Data and Descriptive Statistics

5.3.1 Data

The data used for this analysis comes from the most recent round of the NFHS for India 1999, in conjunction with the International Institute for Population Sciences in Mumbai (IIPS), as part of the wider international Demographic Health Surveys (DHS), conducted in numerous developing countries. These studies are designed to be comparable across countries and the format for rural Uttar Pradesh follows the standard questionnaires, with minor changes, representative within states by rural and urban areas. The sample consists of 5766 children from 3109 mums spread over 247 villages and five regions of rural Uttar Pradesh.

Detailed data is collected from an adult household member on household living conditions, ownership of assets, land and livestock, along with further demographic and socioeconomic information on the household and it's members. Questions are also asked covering the age, sex, educations and occupations of all household members. These questions are used to construct the dependent variable characterizing the children's activities at the time of the survey.

This information is then matched to the individual woman's questionnaire,

which contains detailed information on family composition, gender and age of all other siblings, along with complete birth history information. This woman-level questionnaire contains further information relating to the parent/s; their educations, occupations, ethnicity, religion and their preferences for family, health and schooling.

5.3.2 Child Activity

Following Deb & Rosati (2004), we define eligible children as those between the ages of 6 and 15 years old, where at least one parent is present in the household. The analysis is restricted to the rural sample to the extent that sex selective abortion has altered the urban mix considerably since the mid-1990's.

While there are children over the age of fifteen present in the household, these are left from the analysis; they likely constitute a select group, affected by marriage practices that have removed some girls of the same age from their natal household to live with in-laws. The mean age at marriage for girls in rural Uttar Pradesh is less than 15 years old and the marital decisions of parents are not made independently from those for schooling.

The dependent variable is characterized as the three mutually exclusive categories of child time allocation over formal work, full-time schooling and idle/engaged in home production. More recent work on child labour and schooling choices has extended the child works/child goes to school dichotomy to a multinomial assessment, acknowledging the important differences across children, families and villages that exist and explain why a child may neither work nor attend school, or do both.

Bacolod & Ranjan (2004) using detailed information on children from an urban city in the Philippines, find that among the poorest households, children commonly need to work part-time in order to make schooling possible. In such a situation schooling may be readily available and of sufficient quality to attract children but only possible if the child can contribute economically to it's household, even if only on a part-time basis. With the current rural Indian data, initial tabulations reveal that only eight children within the specified ages are

How much education should be given to girls ?	Frequency	Percent
No education	29	0.50
Less than primary	80	1.39
Primary	607	10.53
Middle	842	14.61
High School	1181	20.49
Higher Secondary	634	11.00
Graduate and above	229	3.97
Professional degree	63	1.09
As much as she desires	1505	26.11
Depends	491	8.52
Don't Know	102	1.77
Total	5763	100.00

Table 5.3: Maternal Preference for Educating Girls

How much education should be given to boys ?	Frequency	Percent
No education	7	0.12
Less than primary	1	0.02
Primary	35	0.61
Middle	234	4.06
High School	699	12.13
Higher Secondary	797	13.83
Graduate and above	552	9.58
Professional degree	226	3.92
As much as he desires	2418	41.96
Depends	722	12.53
Don't Know	72	1.25
Total	5763	100.00

Table 5.4: Maternal Preference for Educating Boys

both working and attending full-time school. This is not surprising in rural areas where schooling is probably further away and less easily combined with some form of work. We therefore estimate the multinomial models with three mutually exclusive time allocation alternatives.

5.3.3 Explanatory Variables

Characteristics of the children and of their households and villages will go some way toward explaining time allocations. The child's age, gender and birth order can identify their likely role within the household that may determine the

opportunity cost of going to school.

Outcome variables such as the number of siblings present in the household and proportion female, that are also deemed important in regressions explaining child time allocations, may be correlated with unexplained processes embedded in the equation errors because they are also the outcome of expectations over future earnings opportunities and the present trade-off between child quantity and quality.

Studies focusing on a cross-sectional associations between family composition and time allocation decisions for boys and girls, must be wary of bias in estimates because unobservable tastes for more schooling (quality) may be associated with smaller families. As noted by Foster & Roy (1997), if such correlation is not appropriately treated, it may lead to biased estimates of both effects. A commonly-used instrument for number of siblings is the sex of the first child born, used by both Deb & Rosati (2003) and Jensen (2004). In order to ensure that such instruments are truly exogenous, it is crucial to check sex ratios at birth for the relevant sample of children.

Family composition effects are complex and difficult to isolate. Some studies assessing family composition effects suggest children fare better with sisters as opposed to brothers, Garg & Morduch (1998) because parents allocate more to sons, controlling for number of siblings. Yet there is also evidence that children with older brothers fare better because these older siblings contribute to household income. We include the number of other siblings as an explanatory variable but note it's possible endogeneity.

It is important to recognise the differing circumstances faced by boys and girls; in both opportunity costs of schooling and in perceived returns.

Table 5.2 presents a breakdown by gender and age of these child activity categories, the dependent variable. It is clear that girls make up a disproportionately large share of children described as at home, while boys dominate the formal child labour category and take up more than their share of children going to school. Descriptive statistics for all variables used in the analysis are presented in Appendix B.

Children identified as idle are often involved in some form of household production that is not recorded as labour. In India daughters are often expected to perform household chores and act as carers for younger siblings, while their brothers may be expected to work for the family business, perhaps on family land, neither of which is recorded as work outside the home.

The index child's gender is interacted with each parents occupational status. The girl child may need to differentially replace her working mother in household chores and so be less likely to remain in school full-time. Sons may also be differentially expected to work with their fathers in unskilled labour, or where there is a family business, or land under cultivation.

It is recognised that much of what determines child activity choices and remains unexplained in regressions relates to expectations of returns to schooling, that are difficult to measure and depend upon a host of cultural factors specific to India. In addition the job of obtaining good proxies for the implicit and explicit costs(in time and transport) of schooling and the returns to child labour poses a serious challenge.

It is possible there are unobservable influences jointly affecting all household labour choices that will render the parents' occupational choices correlated with the errors of the child's activity equation. One can model the parent's labour choices, jointly with those of their children but this will be left for later work. There is no information on access to credit among our sampled households however the standard of living indices, in conjunction with the ethnicity and religion of the household and whether the household is female-headed can proxy such constraints.

The caste and religion of the parent/s describe preferences for leisure, work and schooling and omitted factors relating to perceived returns that are not otherwise captured by the model. Traditionally, the disadvantaged Scheduled Tribes and Castes have been excluded from taking particular jobs, or gaining access to credit and agricultural land and capital, making up the lowest rung on a very strict hierarchical Hindu social order. Such deep-rooted social ostracisation dampens the perceived returns to schooling for Scheduled Tribes in Uttar Pradesh in the

same way that being female reduces labour market returns[5].

The parents' educational attainments are included to the extent that these may proxy attitudes to schooling and other networking effects that affect the perceived returns to schooling. The DHS develop a household standard of living index by assigning values to household characteristics and grouping the summed scores into high, medium and low standard of living. This is achieved over numerous dimensions representing living conditions; type of residence, size and material construction, source of lighting, drinking water, sanitation, cooking fuels used, ownership of household assets, land and livestock. This index is used in the analysis.

To investigate the role of particular household wealth indicators, we will separately include variables representing land ownership and other durable goods such as a car or tractor, phone, scooter, radio, bicycle, fridge, cart, thresher. We also include village-level characteristics relating to the quality and presence of schools, by including indicators for the presence of each of primary, middle and secondary school in the village, in addition to an indicator for whether the village has what can be described as a regular electricity supply. This indicator is interacted with the school presence indicator variable to measure school quality, in the absence of other information. Schools lacking basic electricity for lighting and heating have been found to discourage schooling significantly, see Bacolod & Tobias (2003) using Philippino data.

One further factor that may also help explain variation in the gender differential in perceived returns to schooling is the presence of family planning facilities in the village and the mother's knowledge of family planning products. To the extent that communities with a thriving group of women in control of their fertility are able, through informal social networks, to engender more positive perceptions of the opportunities for women among their members, parents may be encouraged to invest more in female schooling than otherwise identical families in communities without such facilities and local social examples. We therefore

[5]See ILO Global Report "Time for equality at work", a follow-up to 2003 Declaration on Fundamental Principles and Rights at Work.

include variables for the distance of household from a health subcentre and a governement dispensary.

5.4 Results

5.4.1 Results : Standard Multinomial Logit

The basic multinomial logit model of Tables 5.5 and 5.6 explains around 23 percent of the variation in relative probabilities of child time allocations and explains the relative odds of being at home versus in school much better than child works versus in school. This poor performance is unsurprising, given the lack of data on labour market conditions, for both adults and children that ties down opportunities to earn. In addition, the data are thought to underestimate the incidence of child labour.

Home versus school

The effect of being female appears significant and strongly positive on the relative probability of remaining in the home, as compared to the base category of being in school. There is a small but significant negative birth order effect found in this sample, confirming that lower birth order children (ie the eldest) are at a disadvantage relative to their younger siblings of higher birth orders, who are less likely to be in the home. This result is consistent with the carer role of older children that is incompatible with schooling. There was no significant interaction of this variable with the child's gender.

The child's age is significant and increases the relative probability of being in the home versus remaining in school. Children with more siblings are also significantly more likely to remain in the home but the effect is not of great magnitude. This may reflect tighter resource constraints, or preferences for child quantity versus quality that cause a preference for smaller families to be correlated with preferences for more schooling.

All indicators for the parent's education levels are significantly negative on

Variable	At Home versus In School	Works versus In School
Birth Order Number	-.050** (.025)	.052 (.059)
Household has electricity	-.398** (.124)	-.091 (.327)
Sep. room used as kitchen	-.281** (.103)	-.079 (.260)
Age of household member	.086** (.017)	.504** (.052)
Hill Region	-1.917** (.255)	-1.790** (.664)
Eastern Region	-.291** (.092)	-.600* (.235)
Female child	1.575** (.141)	-.892† (.471)
Religion Muslim	.419** (.142)	.321 (.349)
HH Standard of Living Index: low	.621** (.153)	.874** (.276)
Ethnicity: Scheduled Caste	-.263* (.104)	-.046 (.250)
Mother's Education: Primary	-.424** (.154)	-.386 (.372)
Mother's Education: Secondary	-.826** (.283)	-1.219 (.932)
Father's Education: Primary	-.830** (.194)	-.208 (.275)
Father's Eduation: Secondary	-.911** (.108)	-1.244** (.305)
Father's Education: Higher	-1.877** (.210)	-2.287** (.798)
Father's Occupation: Unskilled Manual	.287** (.106)	-.093 (.280)
Primary school in village	-.339** (.110)	-.397 (.278)
Middle school in village	.241* (.100)	.442† (.247)
Secondary school in village	-1.069** (.199)	-.375 (.396)
Distance to health sub-centre	.019* (.008)	-.016 (.019)
Distance to government dispensary	.011** (.003)	.007 (.007)
Number of children living at home	.123** (.030)	.030 (.066)
Mother currently working	.373** (.094)	.861** (.216)
Interaction: Female child*low liv. stan.	-.449* (.182)	.367 (.534)
Interaction: Female*Father's Ed'n Prim	.474* (.231)	-.893 (.698)
Interaction:Sec school*Sched. Caste	1.421** (.329)	1.297* (.644)
Intercept	-2.847** (.281)	-8.968** (.920)

Table 5.5: Standard Multinomial Logit Results: Child at home, Child works, relative to base category Child in School

N	4632
Log-likelihood	-2124.8847
Chi-square (52df)	781.35
Pseudo R^2	.2313
Standard errors in brackets, significance levels : † : 10% * : 5% ** : 1%	

Table 5.6: Model Statistics Standard Multinomial Logit

the relative probabilities of being at home versus in school but the interaction of gender with father's education suggests female children of fathers with primary education only are more likely to remain in the home. This may be a signal of resource-constraints where income (not included) is correlated with parental schooling attainment and any network effects associated with the school system.

Where the father works in an unskilled manual job, the relative probability that the child remains at home rather than in school is positive and significant. This could reflect the fact that children are able to contribute to their father's unskilled work, even though they are formally described as being in the home. Such unskilled work, being paid low wages would also necessitate the need for contributions from children.

The effect of having a mother working at the time of survey is highly significant and positive on the relative probability of remaining at home. This mother working effect demonstrates the need for children to replace their mothers in home production. There was no gender interaction effect as found in Gandhi-Kingdon (2002), where girls are differentially affected by their mother's labour decisions.

The low standard of living indicator operates to significantly increase the relative odds that the child is at home or working, as compared to the base category of being in school. This association does not confirm that poverty drives children out of school and into work, since children from families with a low standard of living may have reduced access to schools (face higher costs), or to schools of the same quality as children from wealthier households, where these factors are not sufficiently accounted for elsewhere in our specification. Such factors will impact upon the perceived benefits of schooling.

The interaction of low living standard with the child's gender suggests that the negative effect on school attendance of low living standard is somewhat reversed if the child is female. Why this may be the case is not known. Possibly there are certain unobservable means-tested benefits offered to families of keeping their female children in school, or perhaps they possess more equal gender preferences for investments in children.

The effect of being Muslim is to increase one's chances of remaining in the

home or in child work, as compared with the base category of attending school. This is not to say that Muslims value education less, particularly when one considers how the quality and value of schooling may also vary with religion and in turn, affect it's perceived value. There is evidence of considerable labour market discrimination against Muslims in parts of northern India.

In contrast, the effect of belonging to one of the Scheduled Castes appears to reduce the relative probability that the child remains in the home, as opposed to school; this may reflect recent initiatives to target the attendance of children from disadvantaged groups. However, the interaction of Scheduled Caste with presence of Secondary school in the village suggests that these children do not appear to benefit from such close proximity to the extent of their Non-Scheduled Caste neighbours.

Where the household has electricity, or uses a separate room for the kitchen, each child's relative odds of remaining at home are reduced and they are more likely to attend school. Assessing the coefficients on the dummy variables indicating the presence of differing levels of schooling within the village suggests that the presence of a primary or secondary school in the village reduces the child's chances of being in the home, relative to the base category of attending school; the effect is also negative but insignificant on the relative probability of working versus attending school. This is as one would expect, given the transport, roads and time costs associated with sending children to schools at a distance.

However, the indicator for the presence of a Middle School in the village has a significant positive effect on the relative probability of being in the home or working, compared to the base category of being in school. Why this should be so is possibly down to the fact that 68 percent of children who come from villages with a middle school do not also have a secondary school in their village and this half-way high-school alternative may be proxying poor labour market opportunities.

Greater distance to a health sub-centre, or a government dispensary was positive on the relative odds of remaining in the home versus being in school; families that live closer to medical facilities either face lower schooling costs, or hold pref-

erences for the greater schooling of their children. As mentioned, modernising influences associated with greater fertility control can impact the perceived returns from schooling, particularly for female children.

Regional effects of residing in the Hill, or Eastern region of the state appear to improve one's chances of attending school, over both remaining in the home, or working formally in child labour market.

Work versus school

The effect of being female on the relative probability of working versus being in school is negative. This supports the notion that if females are out of school, they are more likely to be working in the home caring for siblings and performing chores, whereas boys out of school are more likely to work in the formal labour market. The positive effect of age on the relative probability that the child works confirms that productive opportunities for children improve as they get older. The hazard of being pulled from school each year would be compounded as the child grows older and is better able to contribute productively in the formal labour market.

The father's occupation in unskilled manual work has no significant effect on the relative probability of the child working versus being in school but the effect of fathers with middle or higher eduation is to decrease greatly and significantly the probability that the child works versus attends school. Again this is probably reflecting network effects wherein the families possess greater access to higher quality private schools. It may also proxy an income effect that negates the need for the child to contribute economically.

As with the home versus school probability, the presence of a middle school in the village appears to increase the relative probability that the child is working, rather than attending school. Again this middle school is thought to proxy poor opportunities since in most cases it is not coupled with a secondary school. The effect of low standard of living is positive on the child's relative probability of working, versus attending school.

The effect of having a working mother is to increase the probability that the

Omitted	lnL(Full)	lnL(Omitted)	χ^2	df	P>χ^2	Evidence
Child at home	-231.632	-151.480	160.304	27	0.000	against Ho
Child works	-890.602	-878.273	24.658	27	0.594	for Ho

Table 5.7: Small-Hsiao Test of IIA Assumption

child works, again this likely reflects an income effect. It is possibly proxying poverty and low wealth that necessitates the child working formally in order to contribute financially to the household, not just in home production. Child and maternal work have been found complimentary in Pakistan, Ray (2000). In addition, although the effect of Scheduled Caste on the relative odds of working versus attending school is insignificant, the interaction of the presence of a Secondary school in the village with Scheduled Caste is positive and significant, confirming that access to the village Secondary school depends on ethnicity. This is likely picking up an effect that is missed with the simple Caste dummy, since perhaps such discrimination only becomes manifest after primary school.

5.4.2 Results : Mixed Logit

We begin by adding to the standard multinomial logit model, random parameters with normal distributions for all variables, testing for the significance of these random coefficients. The choice of distribution is admittedly somewhat ad-hoc but the model Likelihood Ration Index is used to assess superior fit. Results are reported in Tables 5.8 and 5.9, for the model with normally distributed random parameters. Model selection criteria were used to choose the model with triangular distributions only marginally over the model with random parameters distributed normally.

The models with only normal or triangular distributions outperformed any that employed log-normally distributed random parameters. Significant random parameters were found on the intercept and on the variables Hill Region, Eastern Region, child's gender, Mother works, Mother with Primary Education, and Father with Higher Education.

As expected, the fixed and the mean coefficients in the Mixed Logit are signif-

icantly larger than their multinomial logit counterparts, hugely so in some cases. This accords with the normalisation based on a lower remaining unexplained portion of the error, since our model incorporates more of this variation into the parameters themselves.

For example, in the random parameters logit, the effects of being Muslim and of each of the education categories almost double, while the coefficients on some of the variables whose effects vary significantly are much larger; the effect of coming from the Hill region increases from just under -2 to -33 the relative probability of remaining in the home, versus being in school. The greatest jump in coefficient estimates occurs with the relative probability of working, versus attending school; here, a number of the coefficients are more than ten times the size of their counterpart from the multinomial logit. This occurs particularly with the regional dummies and the effects of being female and with father's education. The mean effects on the other varying coefficients were all larger than their fixed coefficients from the multinomial logit.

The estimated standard deviations are also of considerable magnitude. For example, compared with the mean effects, the standard deviations on the Eastern region dummy and on Mother's Primary Education are larger across both alternatives. The standard deviations on the other random parameters are in most cases at least half as large as the mean effect. This implies considerable variation that is not captured elsewhere in the model with observable variables. The need for Maximum Simulated Likelihood requires choosing the type and number of random draws, which in turn affects estimation results. We implement Halton sequences, a quasi-random number draw strategy at 200 draws. Bhat (2001) shows the improved performance, with far fewer draws, when compared with the standard psuedo-random number generator.

Only particular variables such as the gender, school access and parental education variables were thought possibly to be distributed log-normally, such that their effects would all be of the same sign in the population. For example, the effect of price on propensity to use will be negative for all consumers but some

may be more price sensitive than others, even controlling for income.

Although theoretically distance to a secondary school should always increase cost of attending and therefore always reduce the probability of choosing the schooling alternative, there may be other things going on that we do not have data on that may condition this dislike. In the study of health provider choice in rural India, Borah (2005) allows the coefficient on "distance to facility" variable to be random within his Mixed Logit specification but notes that although one would expect the coefficient to always be negative, unobserved factors such as facility quality may alter this relationship. People may be willing to travel greater distance where it means visiting a cleaner facility. Empirically therefore, the author allows the coefficient to vary normally and we do the same in our analysis. Hensher & Greene (2003) expand on the strengths and weaknesses of the differing distributions, noting that these usually relate to the spread or standard deviation of the distribution at its extreme values. For example, the log-normal has a very long (unbounded) right hand tail which makes willingness-to-pay caclculations difficult. The normal distribution also results in standard deviations that appear behaviourally unrealistic because the tails are unbounded. The real distribution may be bi- or multi-modal such that none of the distributions applied are suitable.

A non-parametric plot of the distribution of parameters, estimated from data on each individual (repeated choice) where rich enough, can reveal information about the empirical distribution of parameters. Hensher & Greene (2003) propose estimating a separate model for all but one respondent, each time removing an individual and then re-estimating the the parameters. A comparison of the marginal parameters provides the individual's contribution to the distributions.

In the Mixed Logit of Revelt and Train (1998), the price coefficient is not permitted to vary in the population. However, given their attribute-specific information, whose coefficients are permitted to vary randomly, the ratio of attribute coefficient to price coefficient can be interpreted as willingness to pay, that is distributed as the attribute coefficient is distributed.

As Train (2003) also points out, variation in the coefficient on the ratio of price

over income, can be interpreted as variation over people with the same income in the value they place on cost, which is more meaningful and relates to the notion of price elasticity.

Bhat (1998), in the study of travel mode choice permits the lognormal distribution for journey cost and travel time coefficients, so that the ratio of coefficients for travel time and cost is also log-normally distributed, for people with the same observed attributes, such as income. Again, this willingnes to pay can be interpreted as the money value of time, since it shows the tradeoff being made for a quicker journey, in terms of cost/price for people with the same incomes.

The author proposes utility of the form

$$U_{qi} = \alpha_i + \delta_i^{'} z_q + \varepsilon_{qi} + \sum \left[\exp(\gamma_k + \beta_k^{'} w_{qk} + v_{qk}) \right] x_{qik} \tag{5.7}$$

where w represents observed attributes that interact with the variables in the x vector. The v terms are assumed normally distributed with mean zero and variance σ_k^2. This implies a log-normal distribution for the response coefficients of interest. The author goes on to compute some elasticities of market share to changes in travel attributes for each of the differing modes of transport. A similar exercise is performed in Hole & Fitzroy (2004).

As noted in Hensher & Greene (2003), the mixed logit model is capable of representing extremely rich substitution patterns if the data exist. In the present instance, the benefits of the mixed logit over the standard multinomial logit relate to the model's ability to incorporate random taste variation and correlation in choices across children of the same family. The data is not rich enough to perform the sort of willingness-to-pay assessment given the lack of attribute-specific information on costs. For example, the returns to work, versus school, versus home production would be relevant in this instance but there is a lack of information on local wages and earnings opportunities. Furthermore, it is difficult to get information on the true costs of schooling with enough accuracy to be of use. We did not therefore perform any imputation for missing values, such as foregone child wages, or local school costs, qualities and returns; this is partly due to the dynamic nature of the decision and difficulty in attaching meaningful

Variable	At Home versus In School	Works versus In School
Birth Order Number	-.079*(.038)	.033(.122)
Household has electricity	-.524**(.193)	.449(.677)
Sep. room used as kitchen	-.306†(.161)	-.579(.565)
Age of household member	.118**(.024)	1.163**(.333)
Religion: Muslim	.775**(.241)	.251(.688)
HH Standard of Living: Low	.697**(.226)	1.652**(.664)
Ethnicity: Scheduled Caste	-.358*(.165)	-.183(.569)
Mother's Education: Secondary	-1.156**(.453)	-2.751*(1.686)
Father's Education: Primary	-1.077**(.275)	-.290(.548)
Father's Education: Secondary	-1.248**(.185)	-2.279**(.771)
Father's Occupation: Unskilled Manual	.410*(.179)	-.388(.639)
Primary school in village	-.375*(.185)	-1.099(.715)
Middle school in village	.332*(.165)	.365(.534)
Secondary school in village	-1.460**(.311)	-.810(.791)
Distance to health sub-centre	.031*(.014)	-.046(.055)
Distance to government dispensary	.016**(.005)	.010(.018)
Number of children living at home	.177**(.051)	.018(.132)
Interaction: Female*low liv. stan.	-.390(.252)	3.120†(1.814)
Interaction: Female*Father's Ed: Prim.	.596*(.304)	-2.949(2.182)
Interaction: Sec school*Sched.Caste	1.933**(.540)	1.313(1.681)
Mean : Hill Region	-33.507**(10.051)	-800.502**(235.405)
Standard deviation	-18.735*(10.432)	410.700**(118.927)
Mean : Eastern Region	-4.251*(1.832)	-15.806(10.078)
Standard deviation	-5.930(6.421)	21.248†(12.886)
Mean : Female child	2.083**(.228)	-13.830**(5.303)
Standard deviation	.417(.581)	8.556**(2.821)
Mean: Mother's Education: Primary	-1.045†(.535)	-1.305(2.047)
Standard deviation	1.699†(.933)	2.906(2.471)

Table 5.8: Random Parameters Logit with Normal Distributions on random components

numbers.

5.5 Concluding Remarks

The mixed logit offers a way to incorporate unexplained variation that is related to variables not available because the model and data are not perfectly specified. In this particular application a large portion of unobservable heterogeneity

Variable	At Home versus In School	Works versus In School
Mean: Father's Education: Higher	-2.513**(.326)	-58.630**(16.322)
Standard deviation	-.189(.500)	27.393**(7.741)
Mean: Mother currently works	.393*(.194)	1.466†(.772)
Standard deviation	.959*(.454)	.665(.866)
Mean: Intercept	-3.940**(.456)	-18.796**(5.308)
Standard deviation	1.391**(.227)	2.576**(1.034)
N	4632	
Log-likelihood	-2040.562	
Standard errors in brackets, significance levels: † : 10% * : 5% ** : 1%		

Table 5.9: Random Parameters Logit Continued....

was captured through the random parameters. On this basis alone, the model performs much better than the standard logit. Such findings have important implications for the interpretation of results, particularly for policy purposes, where the magnitude of effects is all-important.

The fact that the only datasets available permit at best a partial analysis of the phenomenon under study must be recognised by those using the results and the present paper's findings are no exception. The use of new econometric procedures such as the Mixed Logit, which at least gives a clue as to the areas where greatest unobservable factors are at work, such as with the effect of gender, parental educations and region of residence, is recommended, even though the results should continue to be interpreted with caution.

Another advantage of this Mixed Logit specification comes with it's ability to incorporate heteroskedasticity and correlation in the errors that is not tolerated in the standard logit setup. Tests of the IIA assumption confirm a possible problem in the initial standard multinomial logit model estimated.

There is some concern with the under-reporting of children working in the home or in the labour market and thus an over-reporting of school attendance. The questions were not answered by the children themselves but by the person selected for household interview, which was often but not always the head of the family. Further research would seek to collect timely, purpose-specific data on child time allocations, in conjuction with data on local child and adult wages

across industries and communities, along with more comprehensive school quality measures.

Some econometric problems possibly remain unaddressed in the present specification, given that there is likely to be some correlation of the chosen explanatory variables with the equation error. For example, the number of children in the family and the labour supply decisions of other members may contain information on preferences that will be correlated with the equation error. These need to be addressed in future work.

Chapter 6

Conclusions to Thesis

The study of family formation by economists and others has increasingly embraced the inter-dependence of decisions concerning how many children to have, with those concerning how much to work and even where to live. The information set pertaining to this decision problem necessarily spans the family's entire life-cycle and extends to expectations of future income and survival opportunities, not just for the parents, but for their children also. As mentioned, in India as elsewhere, such decisions are also affected by social norms and traditions that do not always have their foundations in any economic optimising behaviour.

All of this has set a considerable challenge for economists, both analytically and empirically. While the empirical literature on fertility and contraceptive choice offers a wealth of competing specifications, there has been an emerging consensus on how the demand for contraception should be modelled analytically, with recognition that the choice to control fertility entails significant monetary and non-monetary costs and is part of a larger dynamic problem.

In analytical work, the dynamic nature of the decision problem, coupled with the complexities of biological reproduction, serve to limit the extent to which the models are representative of all aspects of life-cycle behaviour. In practice, the models can become extremely computationally expensive even when behavioural processes are greatly simplified.

The models ususally simplify in one dimension in order to focus on a particular aspect of the decision problem. As such, empirical estimates obtained

from dynamic-stochastic models do not always tally with observed behaviour. In fertility research, model assumptions change fundamentally with the populations under study; some of which have made the transition to low birth and death rates, others, like the 160 million populace of Uttar Pradesh that have not.

Issues specific to India such as the role and breadth of social and religious norms have strong implications for the kind of choices that families can justify making. There is a preference for sons across All-India that has existed for many generations and this tempers the extent to which investments in female children make economic sense. Although the legal framework no longer forbids women from inheriting property, or participating in a political sense, or from working and borrowing money, these activities are still discouraged among many ethnic and income groups throughout India.

The circle is far from virtuous, since the very discrimination, founded in non-economic social tradition actually serves to propagate economic-based son preference. More and more recent evidence emerging from India confirms the negative effects family planning has had on sex ratios at birth and on the gender differential in child school attainment.

For this reason, efforts to improve the lives of Indian women must not only dismantle the explicit legal frameworks that exclude women from participation and limit their freedoms but also and arguably more importantly, work to change informal social and religious attitudes, through encouraging later marriage and workforce participation and discouraging dowry marriages and other such illegal practices. Only if the wider participation and emancipation of women can be sold as something that will benefit all members of society, will change truly occur.

The poor governance and weak civil society of Uttar Pradesh, where corruption is widespread, means that certain development initiatives are infeasible; small-scale projects out-with governmental hands have the best chances of making a difference. There have been many very successful small-scale projects in Uttar Pradesh giving women the opportunity to gain marketable skills and access to credit and markets for their products, in an effort to become more contributive to economic growth.

The Government of India's concern over continuing high fertility has lead to numerous advertising campaigns and small-family promotion programs and incentives that have largely passed over rural populations and given no account to the gender split in such fertility reduction. It is estimated that since the introduction of amniocentisis in 1985, over 10 million female foetuses have been selectively aborted throughout India.

Many of the governments initiatives that were designed to encourage and incentivize smaller families have had little impact in rural villages, due to the poor quality and availability of health facilities that are largely focused on urban populations.

However, even in the absence of changes to family size norms, some see a significant fertility reduction as possible simply by reducing unwanted or mistimed births. There is acknowledgement that for numerous reasons, mothers may end up with more children than they deem optimal. Where families hoard children ex-ante, in anticipation of infant mortality, there is always the possibility that more than the expected number of children will survive.

To explain excess births one needs to look elsewhere: "Excess" births may come about due to the failure of contraceptive devices, or because the woman could not afford to use such products to avert pregnancy. The efficiency with which contraception is actually used is important too. In addition, other family members, including husbands, whose family size preferences may out-number those of the woman, may exert considerable control over her fertility choices, such that she is coerced into bearing more children than she would herself choose to bear.

It is proposed here and elsewhere that where women possess greater bargaining power within the home, they will be less susceptible to this external control over their fertility, a non-monetary cost/barrier to use. The first empirical paper assesses the role of indicators of women's intra-household bargaining power, in explaining the woman's use of contraception, net of any effects such bargaining power may have on her demand for children, which in part ties down the benefits of contracepting.

It is proposed that deeper gender equality, associated with the wider participation of women within economic spheres, will not only reduce the costs of using contraception, where such costs take the form of familial and social opposition, but will also change preferences for family size and hence the benefits of contracepting. Maternal education has been held up (contentiously) as one such factor in this process.

Our empirical specification takes account of the confounding effects of family size preferences with propensity to use contraception and offers a Two-Stage Instrumental Variables Least Squares procedure to isolate the effects of variables on the benefits of contraceptive use, from the costs of use. The presence of other unobservable factors common to the errors of each equation, such as woman-specific frailty are also treated.

The IV procedure also takes account of the possible dual causality existing between decisions concerning fertility and contraceptive use. For example, we find evidence that rural women decide how many additional children to have based on the likely cost of contracepting, yet women also make contraceptive use decisions based on their immediate demand for additional children. It is possible that our measures of bargaining power are to some extent correlated with other behaviours that improve the woman's propensity to use contraception, such as the efficiency with which she employs it and this effect cannot be separated out. Women's autonomy is difficult to define and capture in specific indicators.

We find clear evidence among the urban sample that the presence of a mother-in-law is associated with a much reduced propensity to use contraception, although it has no impact on the urban woman's demand for additional children, net of her current family size. This undoubtedly represents lower within-family bargaining power and has been found in numerous studies.

We find that rural women who have the greater freedom of movement hold larger family size preferences. This is likely related to their patterns of work that mean they must leave the household to labour in fields and on nearby farms. In such a setting, child-rearing and work may be complementary, contrary to assumptions made in most fertility/labour supply models. Autonomy is related

to freedom of choice and this may not always tally with smaller family sizes. We find that the presence of a mother-in-law in the rural household is associated with a demand for less additional children from the respondent woman, controlling for her current family size. We cannot be sure why this occurs; perhaps this is proxying smaller family size preferences.

Rural women were more likely to use contraception where they were allowed to have some money set aside. No such effects were statistically significant among urban women. Indeed none of the religion or ethnicity indicators were significant in explaining urban contraceptive use, despite being significant in the rural regressions. The Two Stage Least Squares procedure also allowed for the estimation of the cross-equation error correlation. In both samples this was found to be negative but changed sign with the urban sample once the endogeneity of current family size was accounted for.

We expect the negative correlation among the urban sample is due largely to the fact that conditions associated with the optimal bearing of more children are also correlated with the lack of health facilities through which such products are made available; coupled with our lack of data on costs, this is not surprising.

While our results should be interpreted with caution, particularly in light of the difficulties inherent in operationalising measures of women's autonomy and our lack of data on back-dated conditions, it is likely that the significant social and economic changes that have occurred in urban areas in Uttar Pradesh go hand-in-hand with reductions in family sizes and a greater acceptability and availability of modern contraceptive methods.

This however says nothing of son preference which has been seen to continue among the urban Indian populations transiting to smaller family sizes. In theory, women with greater bargaining power within the home should be better equipped to control their fertility and less vulnerable to the wishes of others but this does not guarantee the emancipation of women on a wider footing that eradicates the preference for male children. Until such subtle yet fundamental social changes come about, the security of female children cannot be guaranteed. We were unable to incorporate data on wider measures of women's social and economic

participation at the level of the community/local area that might have helped explain fertility behaviour and so offer only a partial analysis of factors associated with women's autonomy.

The second empirical paper carries these themes over to a discussion of the schooling of children, in light of the opportunity costs of attending, that may vary with the child's gender. An empirical specification is chosen that brings together the literature assessing the determinants of child school attainment with that concerning child labour. In this vein, one is able to appreciate more fully the significant opportunity costs of sending children to school that exist, even where such education is provided free by the state. Such a framework also goes further in explaining the gender gap in schooling because these opportunity costs are believed to vary significantly with the child's gender. We also recognise the possibility that children described as being in the home are not necessarily idle, particularly where they are female. This identifies the female child opportunity cost of schooling in many cases.

An empirical specification is chosen that reflects the way in which parents assess the trade-offs between present and future consumption, through the work or schooling of their children. We define a trinomial child time allocation choice for each of a rural couple's children between the ages of 6 and 15 years, where at least one parent is present in the houshold.

Because of the way the choice probabilities behave with our data, certain assumptions in the standard discrete choice logit are violated; that the errors are independent across choices (in our case, children) and that the relative probabilities are unchanged with the removal or change in attributes of an irrelevant alternative. In the present case it is likely that the lack of data on such factors as school quality, child wages and opportunities results in a correlation in the unobserved portion of utility that further justifies use of the Mixed Logit model. Tests of the IIA assumption are performed and confirm it to be violated.

In an effort to impose less restrictions on behaviour, a more flexible specification is then implemented. This Mixed Logit specification allows for correlation among the unobserved portions of utility across children in the same family and

does not impose the strict substitution patterns that the IIA assumption invokes. By building heterogeneity into the model in the form of random parameters that may have a different distribution from the logit error, a richer description of behaviour is achieved.

We find significant normally distributed random parameters with large means and deviations on the regional dummies, the child's gender, mother's binary work status, father's higher education and mother's primary education. This random variation no doubt relates to omitted/unobservable variables that condition the effects of included variables. Our findings confirm that the children of educated parents are more likely to attend school and that older children and those whose mothers work are less likely to attend school. The effect of being female appears to reduce strongly the relative probability of going to school, versus being in the home and to reduce strongly the relative probability of working versus attending school. The presence of a primary or secondary school in the village, effectively lowering the costs of sending children to school, was associated with reductions in the relative probability of being at home or work versus school, unless the child came from a disadvantaged caste.

The aim of this thesis was to assess empirically some of the aspects of family life-cycle decision-making, with reference to choices over the number and quality of children to bear, in light of the biological supply of births that renders fertility control costly and imperfect. In addition, our aim was to shed further light on the role gender plays in conditioning family formation decisions in India and investigate any relationship between a woman's ability to control fertility and measures of her familial bargaining power. We would suggest greater attention be paid to an assessment of behaviours associated more directly with female autonomy, both within the home and wider community.

One important message to take from the analysis on family size preferences is that they are not unambiguously negatively related to female autonomy. We therefore recommend a separation of the issues until further research can explain more fully the economic and social role of women. As noted, the popularity of smaller families is increasing, along with female infanticide so the wider valuing

of women is yet to take hold.

Furthermore, it is easy to obtain simplified relationships of the effects of caste, or religion, on such things as family sizes, without a true understanding of the decision processes behind such outcomes. Many supply-side variables, such as wages, school quality, health provision and opportunities to work, migrate and invest are thought to vary with social class, ethnicity and religion in India. It would be for further work to enquire more fundamentally on such issues and assess the true costs and benefits to differing members of Indian society.

Further research and future work on the economics of family formation in India would as a priority therefore look to developing more informed analytical models that are based on testable hypotheses. With this would also come demand for better data to test such relationships and for more efficient computational procedures. We would recommend the development of dynamic bargaining models that incorporate decisions concerning children and would shed further light on the most likely paths through which women's autonomy is to be secured at different points in the lifecycle. The ways in which decision-making come about within Indian families are not always understood by policy-makers. A better appreciation of the roles of differing family members is vital in designing policies aimed at changing behaviour.

Analytical models need build in a richer set of parameters that impose restrictions on behaviour but ultimately lead to more informed empirical tests. Hotz & Miller(1993), in their joint fertility-labour supply estimable dynamic model, assume that the maternal time input depends upon child's age and that the non-monetary costs of contraception are alternative-specific and depend upon further factors such as the mother's age and education. Ahn(1995) allows variations in childbearing behaviour to identify the age-sex values of children in a dynamic programming framework. These approaches permit a more meaningful confirmation of behaviours and can be designed for the particular population under study.

Secondly, not enough is understood about the link between a woman's standing in the home and her standing in wider society, suffice it to say that in the event of marital breakdown, the conditions a woman experiences can worsen and this

has implications for her motivations/incentives within marriage. As mentioned in Bose & Trent (2006), future research may find it useful to examine community contextual effects of fertility behaviour and how such factors can serve as proxies for expectations that shape today's decisions.

Such bargaining models could assess how external changes in the economic functions performed by women impact upon their more immediate bargaining power in the home and analyse how this may also work to change family decision-making, concerning the value of boys viz-a-viz girls, by both parents. A deeper appreciation of the economic role/function fulfilled by children, by gender, will also help in understanding why families make the human capital investments they do.

All of this would require much improved data; on local wages, of children and adults, on prices, on methodologies to estimate incomes in rural v urban areas; on the quality of provision of both schools and health facilities and the way in which service may depend upon demographic factors. Clearly a full dynamic-stochastic estimable framework would also require comprehensive data on the womens' fertility and contraceptive use histories, as well as a full account of the costs of using differing methods.

The more parameters there are to be estimated, the more complicated the computations become when using backwards recursion solution methods. For example, Ahn(1995) chooses a seven period decision horizon with three possible states each period and notes that even this leads to significant calculations. In an effort to simplify greatly the computations required to solve such models, Hotz & Miller (1993) derive a new solution method that negates the need for backwards induction in estimating the model parameters. This is achieved by applying a "semi-reduced form representation of the value function". Errors associated with the alternatives must however be serially independent and individual-specific heterogeneity is not permissible in most cases. Eckstein & Wolpin (1989) do however point to the "not unimportant" computational tractability of such semi-reduced form approaches but note the disadvantages, particularly in relation to data requirements. As the authors note an alternative to either the full solution

method or the semi-reduced form method is to develop approximate solutions, which trade off between computational and data limitations and point to the work of Wolpin(1989) as one example. Further work in this area would greatly assist in the estimation of richer dynamic programming models, for fertility and many other dynamic choice situations.

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Appendix A DHS Data
Background of Survey

The National Family Health Survey (NFHS) 2, 1999 India was part-funded by the United States Agency for International Development and also by UNICEF. The Ministry of Health and Family Welfare gave the International Institute for Population Sciences (IIPS) the central role of coordinating the efforts of a number of organisations in the second survey. Thirteen field organisations were selected to collect the data, consisting of both private and public bodies. ACNielsen Research Services Private Limited, New Delhi, was selected as the field organisation for NFHS 2 in Uttar Pradesh.[1]

The study was designed to provide national and state-level information on fertility, family planning, infant and child mortality, reproductive and child health, nutrition of women and children, as well as the quality and coverage of family welfare and health services. The work also focussed on the collection of socio-cultural perceptions and behaviours. The survey also provides estimates at the regional level for Uttar Pradesh, along with three other states.

The All-India survey covers more than 99 percent of India's population living in all 26 states, although since this time the state of Uttaranchal has divided away. NFHS is a householdsample survey with an overall sample size of 90,303 ever-married women in the age group 15-49 years.

Uttar Pradesh is the most populated of the Indian states, with more than one sixth the nation's population in a tenth of the land area of the country. The state was divided into five regions at the time of the survey and is predominantly agriculturally-based with 80 percent of the population living in rural areas. The state ranks third in the national per capita production of food grains. Although there has been a slow economic move away from agriculture toward manufacturing and other industries, it is noted that 71 percent of the labour force relied on this sector for employment.[2] Major crops include kharif and rabi, along with wheat, rice, sugarcane, bajra and potatoes.

[1] Source:NFHS State Level Final Report Introduction
[2] Census of India, Office of Registrar General 1992

Industry is much less developed in Uttar Pradesh than in other parts of the country and the state is one of the most educationally backward in India, with literacy among the seven-year old+ population at 42 percent compared with 52 percent for India as a whole.

Questionnaires

The survey collected information on three different forms, from different people in the selected villages and households: The Woman's Questionnaire, the Household Questionnaire and the Village Questionnaire.

The household questionnaire collected information pertaining to the living conditions of the household, such as the type of building material of the dwelling, source of lighting, heating and drinking water. It asked questions about the ownership of land and assets, religion, ethnicity of the household head, as well as questions pertaining to the health of family members and risky behaviours. It also collected basic information on all peoples resident in the household the night before the survey, even where they were not a usual resident. This information pertained to their age, education, gender, marital status and relationship to household head.

The Woman's Questionnaire collected information from ever-married women aged 15-49 years and covered numerous topics relating to maternal and infant health, in addition to background characteristics of the women. The questions cover the full birth history for each woman, with dates of all births and deaths, as well as the future fertility intentions for each woman. Questions were posed regarding the woman's knowledge and experience of using both modern and traditional contraceptive products and the source of supply. Questions also covered the women's perceptions of the quality of health services provided and asked about their experiences with ante-natal care, delivery and post-partum care.

The survey also asked each woman questions pertaining to her role within the family and behaviours thought to be associated with the autonomy of women, such as their ability to move about freely and to contribute both financially and intellectually to household decisions.

The village survey asked the village head about the availability of health and

education facilities locally and the distance to other amenities. It collected information on further infrastructural facilities and the presence of any development and welfare progams operating at the time of the survey.

Survey Design and Sample Implementation

The sample size for each state was specified in terms of a target number of completed interviews with eligible women: The target sample size was set at 10,000 for Uttar Pradesh. The sample was designed to provide estimates for the state as a whole, for urban and rural breakdowns and for each of the five regions.

Within each region, the required sampling rates for rural and urban areas were determined by allocating the sample proportionally to the rural/urban population split. However, some regions have higher concentrations of urban people and the sample reflects this. Two regions were deliberately over-sampled to obtain reliable estimates since they were fairly small. Urban and rural samples within each state were drawn separately and to the extent possible, allocated proportionally to the size of the rural/urban population proportions. With five regions in Uttar Pradesh, this provides ten sampling domains from which to sample. Thus these ten areas are statistically independent and compose the first strata.

Within each of the ten domains, a systematic, multi-stage stratified sampling design was used. The rural sample in each region was selected in two stages: first, from the Census list of villages, the selection of villages, Primary Sampling Units (PSUs) with probability proportional to size such that the larger villages have the greater chance of selection, reflecting the fact that any household at random would be more likely to come from these larger communities, thus probability is equal to population of village as a percent of rural regional population domain, followed by the selection of households using systematic sampling within each selected PSU.

The urban sample was selected in three stages. In each region separately, from a Census list of wards, urban wards were selected, with pps sampling. Then from each selected ward, one Census Enumeration Block (CEB) was chosen, again with pps. Then from each CEB a selection of households was chosen, using systematic sampling.

Sample Selection in Rural Areas

The 1991 Census list of villages was used as the rural sampling frame for each of the five regions. Within each region, the list was stratified on a number of variables. The first level of stratification was geographic, with districts being assigned to the five regions and the two large regions being further subdivided into contiguous geographic strata.

In each of these geographic strata, villages were further stratified by village size, percent of the population from Scheduled Castes, or Scheduled Tribes and the percent of males engaged in non-agricultural activities. The final level of stratification is implicit, by ordering the villages within each stratum by the level of female literacy. From this ordered list in each strata, villages were selected systematically with pps of the village as per the 1991 Census.

Then a listing of all households was performed in the sampled villages and from this frame, the households were selected. The interval for household selection was determined to obtain a self-weighting sample of households.

After geographic stratification, within each region, the sample was selected in two stages: the Selection of Primary Sampling Units, which are villages, with probability proportional to population size (pps) at the first stage, followed by the random selection of households within each PSU in the second stage.

The domain sampling fraction, defined as the probability of selecting a woman (f) in a domain (of which there are five rural) is computed as;

$$f = \frac{n_i}{N_i} \tag{6.1}$$

where n_i is the number of women to be interviewed in the ith domain, after upward adjustment for nonresponse and other loss and N_i is the projected

population of eligible women in the ith domain in December 1998. The probability of selecting a village (PSU) from the domain f_1 is calculated as

$$f_1 = \frac{a * s_i}{\sum s_i} \tag{6.2}$$

where a= number of PSUs to be selected from the domain,

s_i= population size of the ith PSU in the domain,

$\sum s_i$= total population of the domain.

The probability of selecting a household from a selected PSU, (f_2) in the domain, (the rural part of one of the five regions) is computed as

$$f_2 = \frac{f}{f_1} \tag{6.3}$$

On average thirty households were initially targeted for selection in each selected enumeration area, with a minimum of fifteen and a maximum of sixty.

Sample Selection in Urban Areas

The 1991 Census of India list of urban wards, for each of the five major regions was arranged according to districts and within districts, by the level of female literacy, and a sample of wards was selected systematically with pps. Next, one CEB 150-200 households was selected from each selected ward using the pps method. Then a listing operation was carried out for each selected CEB and this served as the necessary frame for selecting households in stage three. Thirty households per block were initially targeted.

The domain sampling fraction ie the probability of selecting a woman (f) in a domain was computed as

$$f = \frac{n_i}{N_i} \tag{6.4}$$

where n_i is the number of women to be interviewed in the ith domain, after upward adjustment to account for nonresponse, or other loss. N_i is the projected population of eligible women in the ith domain in December 1998.

The probability of selecting a ward from the domain (f_1) was computed as

$$f_1 = \frac{a * s_i}{\sum s_i} \tag{6.5}$$

where a = number of wards selected from the domain,

s_i = population size of the ith ward over the total population of the domain,

$\sum s_i$= total population of the domain.

The probability of selecting a census enumeration block (CEB) from a selected ward (f_2) was computed as

$$f_2 = \frac{B_i}{\sum B_i} \tag{6.6}$$

where B_i= population size of the ith CEB,

$\sum B_i$= total population of the ward.

In the third stage of sample selection, the probability of selecting a household from a selected CEB, (f_3),was computed as

$$f_3 = \frac{f}{f_1 * f_2} \tag{6.7}$$

Sample Weights

Sample weights for households and women are based on design weights, adjusted for the effect of differential nonresponse in different geographical areas. The method of calculating the weights is specified below.

Let R_{Hi} and R_{Wi} be the response rates for households and eligible women, respectively. Then the household weight (w_{Hi}) is calculated as follows

$$w_{Hi} = \frac{w_{Di}}{R_{Hi}} \tag{6.8}$$

where w_{Di} = the design weight for the ith domain (rural or urban part of one of the five major regions), calculated as the ratio of the overall sampling fraction (F= n/N) and the sampling fraction for the ith domain ($f = \frac{n_i}{N_i}$).

The eligible woman's weight (w_{Wi}) is calculated as

$$w_{Wi} = \frac{w_{Di}}{R_{Hi} * R_{Wi}} \tag{6.9}$$

After adjustment for nonresponse, the weights are normalised so that the total number of weighted cases is equal to the total number of unweighted cases. The final weights are then calculated.

Sample Implementation

A total of 333 PSUs were selected, with 266 rural and 67 urban PSUs. The survey achieved an overall response rate of 90 percent. Interviews were successfully completed with 93 percent of the identified eligible women, with two percent refusing the interview.

Estimates of Sampling Errors

Nonsampling errors are the result of errors committed during data collection and data processing, such as failure to locate and interview the correct household, misunderstanding of the questions on the part of either the interviewer or the respondent, and data entry errors. These are difficult to evaluate statistically but their likely magnitude and importance can be assessed. These are likely to stem from misreporting due to the way the questionnaire was completed. For instance, it is known that the NFHS survey under-estimates fertility because the question is posed ex-post, referring to a sometimes significant and distant past. The Sample Registration System (SRS) collected by the Office of the Registrar General does not suffer this same bias since the data is collected annually.

Sampling errors can be evaluated statistically. The sample of women selected in NFHS 2 is only one of many samples that could have been selected from the same population, using the same design and expected sample size. Each of these samples would yield results that differ somewhat from the results of the actual sample selected. The sampling error is a measure of the variability among all possible samples. Although the degree of variability is not known exactly, it can be estimated from the survey results.

Table 1: Summary Statistics Child Time Allocations

Variable	Mean	Std. Dev.	Min.	Max.	N
Birth Order Number	2.964	1.853	1	12	4632
Has electricity	0.267	0.443	0	1	4632
Separate room used as a kitchen	0.306	0.461	0	1	4632
Age of household member	9.952	2.821	6	15	4632
Hill Region	0.107	0.309	0	1	4632
Eastern Region	0.375	0.484	0	1	4632
Female Child	0.472	0.499	0	1	4632
Religion - Muslim	0.094	0.292	0	1	4632
Household Standard of Living Index - Low	0.377	0.485	0	1	4632
Ethnicity - Scheduled Caste	0.231	0.421	0	1	4632
Mother's Education - Primary	0.142	0.349	0	1	4632
Mother's Education - Secondary	0.074	0.261	0	1	4632
Father's Education - Primary	0.176	0.381	0	1	4632
Father's Education - Secondary	0.359	0.48	0	1	4632
Father's Education - Higher	0.158	0.365	0	1	4632
Father's Occupation - Unskilled Manual	0.166	0.372	0	1	4632
Primary School in village	0.825	0.38	0	1	4632
Middle School in village	0.365	0.481	0	1	4632
Secondary School in village	0.12	0.326	0	1	4632
Distance to Health Sub-centre	4.15	5.073	0	40	4632
Distance to Government dispensary	14.517	15.278	0	90	4632
Number of children living at home	4.283	1.554	0	11	4632
Mother currently working	0.301	0.459	0	1	4632
Interaction; Female child * H-hold Standard of Living Index - Low	0.176	0.381	0	1	4632
Interaction: Female*Father's Edn Primary	0.082	0.275	0	1	4632
Interaction: Sec. school in village*Scheduled Caste	0.024	0.154	0	1	4632

Table 2: Summary Statistics Two Stage Probit of Contraception Use : Urban Sample

Variable	Mean	Std. Dev.	Min.	Max.	N
Current user of any contraceptive method	0.541	0.499	0	1	1179
Number of Additional Children Desired	-0.324	1.726	-10	8	1179
Instrument : Number of Additional Children Desired Squared Term	1.211	1.38	0	10.012	1179
Age Group 20-24yrs	0.158	0.365	0	1	1179
Age Group 25-29yrs	0.189	0.392	0	1	1179
Age Group 30-34yrs	0.205	0.404	0	1	1179
Age Group 35-39yrs	0.196	0.397	0	1	1179
Age Group 40-44yrs	0.122	0.328	0	1	1179
Age Group 45-49yrs	0.087	0.281	0	1	1179
Age at first marriage	17.95	3.393	12	36	1179
Instrument Current Family Size	3.004	1.44	-0.98	6.493	1179
Decision made by respondent or jointly: What to cook	0.842	0.365	0	1	1179
Decision made by respondent or jointly: Obtaining health care	0.506	0.5	0	1	1179
Permission needed to go to market	0.28	0.449	0	1	1179
Allowed to have money set aside	0.702	0.457	0	1	1179
Husband staying elsewhere	0.039	0.194	0	1	1179
Perceived Infec/Menopausal	0.165	0.372	0	1	1179
Last 3 mths - Reproductive Health Problem B	0.16	0.367	0	1	1179
Presence of mother-in-law	0.013	0.112	0	1	1179
Occupation of Husband - Unskilled Manual	0.079	0.27	0	1	1179
Religion-Muslim	0.232	0.422	0	1	1179
Can read and write	0.622	0.485	0	1	1179
Respondent's Education-Secondary	0.24	0.427	0	1	1179
Respondent's Education-Higher	0.285	0.452	0	1	1179
Has electricity	0.901	0.299	0	1	1179

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... table 2 continued

Variable	Mean	Std. Dev.	Min.	Max.	N
Building material of household residence - high quality	0.778	0.416	0	1	1179
Has television	0.758	0.428	0	1	1179
Has bicycle	0.680	0.467	0	1	1179

Table 3: Summary Statistics Two Stage Probit of Contraception Use : Rural Sample

Variable	Mean	Std. Dev.	Min.	Max.	N
Current user of any contraceptive method	0.314	0.464	0	1	4377
Number of Additional Children Desired	0.162	1.984	-7	21	4377
Instrument : Number of Additional Children Desired Squared Term	1.519	1.918	0	13.132	4377
Age Group 20-24yrs	0.189	0.392	0	1	4377
Age Group 25-29yrs	0.207	0.405	0	1	4377
Age Group 30-34yrs	0.173	0.378	0	1	4377
Age Group 35-39yrs	0.146	0.353	0	1	4377
Age Group 40-44yrs	0.106	0.308	0	1	4377
Age Group 45-49yrs	0.067	0.25	0	1	4377
Age at first marriage	15.749	2.335	12	38	4377
Instrument Current Family Size	3.103	1.474	-0.560	6.824	4377
Decision made by respondent or jointly: What to cook	0.78	0.414	0	1	4377
Decision made by respondent or jointly: Respondent staying with family	0.346	0.476	0	1	4377
Permission needed to visit relatives/friends	0.104	0.305	0	1	4377
Allowed to have money set aside	0.479	0.5	0	1	4377
Region - Hill	0.103	0.305	0	1	4377
Region - Central UP	0.141	0.348	0	1	4377
Region - Eastern UP	0.365	0.481	0	1	4377
Region - Bundelkhand	0.089	0.285	0	1	4377

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... table 3 continued

Variable	Mean	Std. Dev.	Min.	Max.	N
Husband staying elsewhere	0.097	0.296	0	1	4377
Perceived Infec/Menopausal	0.183	0.387	0	1	4377
Last 3 mths - Reproductive Health Problem D	0.096	0.294	0	1	4377
Household Standard of Living Index - Medium	0.558	0.497	0	1	4377
Household Standard of Living Index - High	0.121	0.326	0	1	4377
Presence of mother-in-law	0.035	0.183	0	1	4377
Occupation of Husband - Unskilled Manual	0.147	0.354	0	1	4377
Ethnicity-Scheduled Caste	0.227	0.419	0	1	4377
Ethnicity-Scheduled Tribe	0.026	0.158	0	1	4377
Ethnicity-Other Disadvantaged Class	0.302	0.459	0	1	4377
Religion-Muslim	0.09	0.287	0	1	4377
Religion-Other	0.008	0.087	0	1	4377
Respondent's Education-Primary	0.142	0.349	0	1	4377
Respondent's Education-Secondary	0.115	0.319	0	1	4377
Respondent's Education-Higher	0.032	0.177	0	1	4377
Husband's Education-Secondary	0.377	0.485	0	1	4377
Husband's Education-Higher	0.187	0.39	0	1	4377
Has television	0.215	0.411	0	1	4377
Distance to Community Health Centre: Rural sample only	15.848	19.182	0	98	4377
Regular village electrification : Rural sample only	0.225	0.417	0	1	4377

DEVELOPMENTS	YEAR	AUTHORS
NEOCLASSICAL FERTILITY MODELS	1973	DeTray
No infant mortality or biological supply factors incorporated		Becker & Lewis
Static decision horizon, unitary household framework		Schultz
No variation in tastes incorporated	1974	Becker
Contraception assumed perfect and costless		
FERTILITY STUDIES INCORP. GENDER PREFS	1976-1986	Ben Porath & Welch & Others
Estimated parity progression ratios	1991	Leung(Dynamic anal. framework)
Tests of sex preference		
Estimation of relative costs and benefits of boys v girls	1995	Ahn (Estimable Dynamic framework)
DYNAMIC MODELS INCORP. BIOLOGICAL SUPPLY OF BIRTHS	1974/75	Heckman & Willis
AND COSTLY & IMPERFECT CONTRACEPTION		
Reduced-form approximations of dynamic responses	1985	Rosenzweig & Schultz
	1989	Rosenzweig & Schultz
ESTIMABLE DYNAMIC-STOCHASTIC MODELS		
Structural econometric models	1984	Wolpin
	1988/89	Montgomery
Semi-reduced-form approach to estimation	1988	Hotz & Miller
Implementation of CCP Estimator	1993	Hotz & Miller
	2002	Carro & Mira
INTRAHOUSEHOLD BARGAINING & CHILD QUANTITY & QUALITY	2003	Eswaran
	1999	Echevarria & Merlo (dynamic framework)

Table 4: Schema Development of Literature on Economics of Family Formation