Birth Spacing and Child Survival: Comparative Evidence from India and Pakistan[*]

Pushkar Maitra[§]
Monash University

and

Sarmistha Pal[a]
Cardiff Business School

March 2004

Abstract

This paper examines the two-way relationship between birth interval and child survival and compares the behaviour of households in the Indian and Pakistani provinces of Punjab. Birth interval and child survival are modelled here as correlated hazard processes, allowing for mother-specific unobserved heterogeneity. We find evidence of significant mutual dependence between birth interval and child survival in both samples. There are also significant differences between Indian and Pakistani households. Part of the difference in behaviour could be explained by differences in female literacy, which in turn highlight the differences in religion and state policies in these two neighbouring states.

Key words: Birth spacing, Child survival, Sibling inequality, Son preference, Role of Religion and State, Correlated hazards models, India, Pakistan.

JEL classification: J13, O10, C41, C24

---

[*] Pushkar Maitra wishes to thank the Faculty Research Grant Scheme, Faculty of Business and Economics, Monash University for research support. Sarmistha Pal wishes to thank Cardiff University and Cardiff Business School for funding this research. We would like to thank John Cleland, Yvonne Dunlop, Gerry Makepeace and participants at the Australasian Labour Econometrics Workshop held at the University of New South Wales and the Econometric Society North American Summer Meetings 2003 for their comments and suggestions. The usual caveat applies.

[♣] Pushkar Maitra, Department of Economics, Monash University, Clayton Campus, VIC 3800, Australia. Email: Pushkar.Maitra@BusEco.monash.edu.au.

[♠] Corresponding author: Sarmistha Pal, Economics Section, Cardiff Business School, Colum Drive, Cardiff CF10 3EU, Wales, UK. Email: pal@cardiff.ac.uk .

Birth Spacing and Child Survival: Comparative Evidence from India and Pakistan

1. INTRODUCTION

The present paper examines the inter-relationship between fertility and child mortality and compares the behaviour between households in the Indian and Pakistani Punjab.

Analysis of the two-way relationship between fertility and child mortality is central to the population planning programmes in low-income countries. While shorter birth spacing and higher fertility may be responsible for higher child mortality in these countries, higher child mortality may also cause higher fertility (and therefore shorter birth spacing). On the one hand, parental investment in children crucially depends on the duration between successive births, especially if parents are resource constrained. In particular, the closer apart the children are (i.e., the shorter the age difference between successive children), the greater is the competition among siblings for limited parental care and resources and the greater is the potential of the child not surviving. This is known as the sibling competition effect. Shorter birth interval also means more maternal depletion and therefore lesser ability of mothers to take care of young children. On the other hand, early child death might also result in a reduction in the duration between successive children because parents want to replace children that have died. This is known as the child replacement effect.

Much of this existing empirical evidence is derived from the estimation of child health functions (for example measures of child survival, child mortality, anthropometrical indicators, like weight-for-age, height-for-weight) only. This literature highlights the role of income and poverty (Behrman and Knowles, 1999), parental especially mother’s education (Behrman and Wolfe, 1984), as well as that of gender differences, birth order and other sibling characteristics (Dasgupta, 1997;

Garg and Morduch, 1998; Pal, 1999) in low-income regions. In this paper we depart from this tradition and argue that child health is closely related to household decision of spacing consecutive births. Consequently, one cannot treat birth spacing to be exogenous while determining child mortality and vice versa for determining birth spacing. In an attempt to reduce the (potential) endogeneity bias, we treat birth spacing and child survival as correlated hazard processes. The hazard of child survival depends on the duration to the next birth while the hazard of subsequent birth depends on child survival, given the values of other individual, sibling, parental, household and community characteristics. A further distinguishing characteristic of our model is to control for mother specific unobserved heterogeneity, which accounts for health or genetic endowment of the couple (which are private information and are not observable in the data-set), but are likely to significantly affect mortality risks of children.

The analysis is based on the National Family Health Survey (NFHS) 1992 – 93 data from the Indian province of Punjab and the Pakistan Integrated Household Survey (PIHS) 1991 data from the Pakistani Punjab province. The comparison between India and Pakistan generates obvious interests: while households in these provinces on either side of the border share a common history they differ in terms of religious and political institutions. The paper contributes to the literature in several ways. First, although attention has recently been turned to the effects of high fertility, largely in the form of shorter birth-spacing and concentration of births, on levels of infant and child mortality (especially in Pakistan, see for example Cleland and Sathar, 1984), most existing estimates of mortality treat fertility to be purely exogenous. We are not aware of any existing study that jointly estimates birth spacing and child survival as correlated hazards in an attempt to reduce the endogeneity bias of estimates of child health. Secondly and more interestingly, the comparison between Indian and Pakistani Punjab gives us a unique opportunity to examine the effects of religion and state policy on child survival that remain much unexplored in the literature.[1] While these provinces are highly prosperous in their respective countries and share a common socio-cultural background, they are sufficiently different in terms of religious composition and state policies (since their partition in 1947). Differences in religion and state policies in the two provinces have for over the last five decades shaped the demographic (e.g., with respect to trends in use of modern contraception, fertility, literacy, especially women's literacy and employment) development differently and could explain at least partly the differential pattern of child survival.

The rest of the paper is organised as follows. Section 2 rationalises the econometric methodology used to jointly estimate child survival and birth spacing. Section 3 discusses the data sets and selected descriptive statistics. Section 4 discusses the results and Section 5 concludes.

2. HYPOTHESES AND METHODOLOGY

Quantity-quality trade-off is central to an understanding of the Beckerian models of the household and fertility (Becker and Lewis, 1973; Becker, 1981). On one hand, resource constrained households care about current income and hence choose to have more children. The decision to have more children is typically reflected in shorter duration between children. On the other hand to the extent children continue to live with their parents as adults, children of higher quality are likely to contribute more to the household resources in the future. Therefore to the extent households maximise the net present value of lifetime earnings, households would prefer to have children of higher quality. An increase in the number of children and/or shorter spacing will reduce the health of the children (via reduced allocation of resources per child and also parental efforts to distribute

[1] Some demographers have argued that Muslim societies are often predisposed to high fertility and unmet need for contraception (Caldwell, 1986) though the underlying rationale behind this observation has seldom been thoroughly investigated. One possible hypothesis is the lack of women's autonomy in the Islamic society though Jejeebhoy and Sathar (2001) reject this hypothesis for their comparative study on India and Pakistan.

resources equitably among living children) and their future earning capacities. This trade-off justifies our interest to examine if there is an empirically significant relationship between birth spacing and child survival in our samples.

2.1. Hypotheses

Most existing evidence of the relationship between fertility and mortality are based on individual uncorrelated estimates of fertility in terms of mortality (assumed to be exogenous) and mortality in terms of fertility (again exogenous). It is however important to treat fertility and mortality as endogenous in household decision-making. This also allows us to examine the nature of mutual causation between these demographic variables.

Existing literature highlights the role of various individual, household and community-level factors on this relationship. Among various household characteristics, World Bank tends to emphasize the role of household income (or expenditure) on malnutrition and child mortality (Behrman and Knowles, 1999). This is because household income or expenditure reflects household command over different inputs, e.g., food, clothing, residence, sanitation, medical care, in the child health production function. Behrman and Wolfe (1984), however, argues that this emphasis on household income, however, tends to ignore the significance of parental, especially mother's literacy, which is an important determinant of the technology of a child's health function.

Gender of the present child may also affect subsequent birth spacing and therefore child survival. Even if we assume that parents cannot choose gender of a child (i.e., gender is exogenous), gender of the first child may influence parents to strategically determine subsequent birth spacing, by updating their fertility preferences. Thus given the gender of the child (known only after the child is born), parental decision to have an additional child will depend on the expected child earnings net of costs of bringing up a child[2] as well as the randomness associated with having another child of desired gender. This in turn suggests that parents characterised by son preferences are more likely to increase the duration between successive births if the current child is a boy than if the current child is a girl, which in turn affects child survival. Pal (1999) argues that this gender differences in childhood malnutrition persists even with increase in household income and female literacy.

Composition of siblings (e.g., that related to birth order, age difference or gender composition of older siblings) may also affect child health outcomes in many low-income countries. This is because more siblings means changes in value of household resources per consumption unit. Also, generally it is assumed that parents attempt to distribute resources equitably so that arrival/demise of siblings means an alteration of allocation of resources among existing siblings. Available findings however tend to vary from one country to another and also with the assumptions of the model. These highlight the role of birth order (Horton, 1988), number of sisters/brothers (Garg and Morduch, 1998), number of older sisters (Parish and Willis, 1994; Dasgupta, 1987)

Role of religion and state: Muslim societies are often predisposed to high fertility and child mortality (compared to non-Muslims). While some argue that this is related to lack of women's autonomy in decisions regarding fertility and child health as promoted by Islam (Basu, 1992), empirical tests do not always support this (e.g., see Morgan, Stash, Smith and Mason, 2002). In our attempt to understand the demographic trends in Muslim and non-Muslim society, we consider two more factors. First one cannot deny that religious identity is intertwined with socio-economic status, health infrastructure and other unobservable determinants of mortality. Second, welfare state can effectively intervene to assist demographic development, as has been experienced elsewhere (e.g.,

[2] This assumption accounts for the male-female differences observed in many south Asian societies including India (e.g., see Rosenzweig and Schultz, 1982). Very often female job opportunities are rather limited and more importantly the female child leaves parents' household after marriage while the male child when adult earns to look after the retired parents.

China) in the continent. The latter has guided our choice of samples, namely, households in the Indian and Pakistani Punjab. While these households are socio-culturally very similar because of their common origin, they were partitioned in 1947 primarily on the basis of their religion and have been ruled by very different types of states since then. Thus the comparison of sample households in India and Pakistan would highlight, ceteris paribus, the differential role of religion and state among other things (see further discussion in sections 3 and 4).

2.2. A Correlated Simultaneous Hazard Model

The relationship between fertility and child mortality is complex and much of the literature has not taken account of the simultaneity between fertility and child mortality. In our empirical analysis this is assessed in terms of correlated hazard models of birth spacing and child mortality with unobserved mother-specific heterogeneity.

The two variables of interest in our analysis are the number of years the child was alive before dying (SURV) and the duration, in years, to the next birth following the birth of a particular child (NEXT). Both these variables are modelled as failure time processes represented by separate log hazard equations – log hazard of mortality and log hazard of subsequent birth.

The analysis is based on an estimation of simultaneous hazard model (Lillard, 1993).[3] The present paper uses the technique of simultaneous hazards to examine the relationship between child spacing and child survival. The log hazard of the next birth equation for the j^{th} woman, $j = 1, \dots, n$ is:

$$h_j^n(t) = b_0 + b_1 T_1(t) + b_2 X_1 + l_n + e \qquad (1)$$

and the log hazard of survival equation for the i^{th}, $i = 1, \dots, k$ child born to the j^{th} woman is:

[3] They used the technique to jointly determine marital dissolution and birth conception hazard. See also Panis and Lillard (1994), Brien and Lillard (1994), Brien, Lillard and Waite (1999) and Gangadharan and Maitra (2003). These papers have used the framework of simultaneous hazards to examine very different problems.

$$h_{ij}^{s}(t) = a_0 + a_1 T_2(t) + a_2 X_2 + l_s + u \qquad (2)$$

Here X_1 and X_2 are two sets of exogenous and potentially endogenous explanatory variables that affect the hazard of survival and the hazard of the next birth.

An interesting feature of our estimation is the inclusion of the terms l_n and l_s that represent the mother/parents specific unobserved heterogeneity in the two hazard equations. They essentially account for the unobserved mother/parents specific biological or health endowments (for example, health or genetic endowments of the parents) that are common to all children born to the same woman. The unobserved heterogeneity terms are assumed to be uncorrelated with other explanatory variables. It is argued here that ignoring these unobserved heterogeneity terms (given by l_n and l_s) might seriously bias our estimates. All other residual variation is captured by e and u, with $e \sim IIDN(0,1)$ and $u \sim IIDN(0,1)$.

Finally $T_1(t)$ and $T_2(t)$ represent separate "clocks" of duration dependence of the hazards that determine the baseline hazard. They are essentially splines in time since the individual becomes at risk of the event – risk of dying or risk of having a younger sibling. Let us denote the time at which an individual enters the risk of an event by t_0 and we subdivide the duration $t - t_0$ into S discrete periods. Then the baseline log hazard function is defined as a spline or a piecewise linear function and the log hazard of the event will have different slopes over the duration. So the baseline hazard functions can be written as:

$$\begin{aligned} b_0 + b_1 T_1(t) &= b_0 + \sum_{k=1}^{S+1} b_{1k} T_{1k}(t) \\ a_0 + a_1 T_2(t) &= a_0 + \sum_{k=1}^{S+1} a_{1k} T_{2k}(t) \end{aligned} \qquad (3)$$

In other words, the baseline log hazard is the sum of the effects of the various sources of time dependence within the period of risk for an individual and the resulting log hazard equation is piecewise linear in time since the episode began.

Both variables of interest (NEXT and SURV) are censored. If a particular child is alive at the time of the survey then SURV is censored and if a particular child is the youngest (or the only) child till the survey date then NEXT is censored. Also SURV equals the age of the child at the time of the survey if the observation is censored and NEXT equals the duration between the birth of the child and the survey date if the observation is censored. The conditional likelihood of child mortality can be written as

$$L^n(l_n) = \begin{cases} S^c = \Gamma\left(t, Z\left(t^c\right), l_n\right) & \text{if the child is alive at the survey date (censored)} \\ S^u = \Gamma\left(t, Z\left(t^u\right), l_n\right) & \text{if the child is dead at the survey date} \\ & \text{or lived to the age of 10(uncensored)} \end{cases}$$

and the conditional likelihood of duration to next birth can be written as:

$$L^s(l_s) = \begin{cases} S^c = \Gamma_2\left(t, Z\left(t^c\right), l_s\right) & \text{if the child is the youngest or only child (censored)} \\ S^u = \Gamma_2\left(t, Z\left(t^u\right), l_s\right) & \text{if the child is first or middle born (uncensored)} \end{cases}$$

The joint marginal likelihood is

$$\int_{l_n}\int_{l_s}\left[\prod L^n(l_n)\prod L^s(l_s)\right] f(l_n, l_s)\, d\,l_n d\,l_s \qquad (4)$$

where $f(l_n, l_s)$ denotes the joint distribution of the unobserved heterogeneity components. Here $f(l_n, l_s)$ is assumed to be a two dimensional normal distribution characterised as follows:

$$\begin{pmatrix} l_n \\ l_s \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} s_n^2 & s_{ns} \\ s_{ns} & s_s^2 \end{pmatrix}\right), s_{ns} = r s_n s_s \qquad (5)$$

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

3. DATA, DESCRIPTIVE STATISTICS AND EXPLANATORY VARIABLES USED

3.1. Data and Descriptive Statistics

The empirical analysis is based on two data sets: the NFHS 1992-93 household-level data and the PIHS 1991 household-level data from the Indian and Pakistani Punjab provinces respectively. Since child mortality is more common among younger children in South Asia, in each case we right censor the age of the children at 10 years. Duration between successive births (birth spacing) is measured by the age difference between a child and its immediate next sibling (NEXT). Naturally, child's birth order is important in any sequential/joint analysis of birth spacing and survival. For example, the question of subsequent birth spacing is not of direct relevance for the only children and also for the youngest ones. Both these groups of children are censored – in this case the duration to the next birth is equal to the duration between the birth year of the child and the survey date. There is no such problem in the estimation of the child survival hazard (SURV), which is measured by the survival duration of the children, age being right censored at 10 years.

Comparative country-study of this sort is useful to study the differences in the nature of the problem across different societies. The comparison between India and Pakistan generates obvious interests. While the two countries differ in terms of their religious and political institutions, households in these provinces on either side of the border share a common socio-cultural background owing to their common origin. Though Pakistan has a higher GNP per capita compared to India, the indicators of demographic well-being are better in India. For example, the infant mortality rate, the crude birth rate and the total fertility rate are all higher in Pakistan.[4] Literacy rates too are significantly lower in Pakistan: the adult female literacy rate in Pakistan was only 22% as against 39% in India in 1992; the corresponding figures for adult male literacy were 49% in Pakistan as against 64% in India. These differences may in part be accounted for by the differences in religious beliefs, which in turn are likely to shape the official population, education and employment programmes in the two countries in the post-1947 period.

Among various Indian states, Punjab had the highest per capita net state domestic product in 1991 – 92 and the lowest poverty head count ratio (both for the rural and urban areas). How has Punjab compared to the rest of India? An interesting comparison can be made with the state of Kerala, which has achieved demographic indicators comparable to more developed countries. In the year 1991 – 92 the net state output per capita in Kerala was half the level in Punjab. However, the infant mortality rate in the Indian Punjab was 57 per thousand live births (as opposed to 17 per thousand in Kerala); the total fertility rate of the state was 3.1 in 1991 (as against 1.8 in Kerala). In addition, male (65.7%) and female (50.4%) literacy rates in 1991 in Punjab were significantly lower than those in Kerala. Unlike Kerala, there is significant evidence of son preference in the state of Indian Punjab (see Dasgupta, 1987).

Among the four Pakistani provinces, (Punjab, Sindh, North-West Frontier Province and Baluchistan) Punjab is the most prosperous and densely populated province in the country containing about 56.5% of the total population. In terms of various demographic and socio-economic indicators, Punjab has performed better compared to the rest of Pakistan. An analysis of the Pakistan Integrated Household Survey (PIHS) 1991 data suggests that the average number of years of education for Punjabi women is 1.34 years compared to 0.91 years for women residing in the rest

[4] In 1992, the infant mortality rate in India was 79, compared to 95 in Pakistan. The crude birth rate was 29 per 1000

of Pakistan. The average number of years of education for Punjabi men is 4.16 years, which is significantly higher than an average of 3.33 years for men residing in the rest of Pakistan. Average household income in Punjab is also significantly higher compared to that of the rest of Pakistan.

While all the sample households in the Pakistani province are Muslims, most households in the Indian Punjab are either Sikhs (58%) or Hindus (39%) - only 1.5% households were Muslims in the Indian sample. One can identify certain behavioural differences between Muslim and non-Muslim households in the Indian Punjab. For example, compared to non-Muslim households, significantly lower proportion of Muslim parents was literate and was using some contraception (sterilisation as well as other traditional or modern methods). As a result number of children ever born was significantly higher among Muslim households in the Indian Punjab. The contraception use was even lower among the Muslims in Pakistani Punjab. Of the four Pakistani provinces, Punjab has the highest prevalence levels (though the NWFP experienced the most rapid rise in contraceptive use in the early 1990s). According to the Pakistan Demographic and Health Survey 1990 – 91, use of any modern non-terminal method has been only 9% as against (14% in India and 32% in Indian Punjab taken as a whole).[5] There are also significant differences in the two countries with respect to both total fertility rates and also women's education. The average number of children ever born was 5.03 for Pakistan as a whole (4.22 for the Punjab province) compared to 3.4 for India as a whole.[6] For India as a whole 61.5% of women had no education, compared to 79.2% for Pakistan as a whole.[7]

---

in India compared to 40 per 1000 in Pakistan and the total fertility rate was 3.7 in India compared to 5.6 in Pakistan.

[5] Source: National Family Health Survey data 1992 – 93, India. Male and/or female sterilization turn out to be a popular method in India, primarily provided free by the Government health services. The proportion of currently married sterilised women below age 49 years was 32% in Indian Punjab while the national average is 27% during the survey year. On the other hand from most accounts, the fertility transition in Pakistan finally began in the 1990's – much later compared to its South Asian neighbours Bangladesh, India and Sri Lanka. See Sathar and Casterline (1998).

[6] The numbers for Pakistan are obtained from the PIHS data set and for India from the NFHS 1992-93 survey.

DHS Pakistan survey 1990-91 and the NFHS 1992-93 survey for India.

Thus, ceteris paribus, this comparative analysis would, to some extent, reflect the differences in household behaviour in fertility and child survival between Muslim and Non-Muslim households.

There are a total of 2995 women in the Indian sample, who have given birth to a total of 8798 children. However, as many as 40% women in our sample were sterilised at the time of the survey and therefore we exclude the youngest child of these sterilised women. This reduces the number of sample children to 7896 of whom 51% were boys. About 34% of these children were First born (which also includes the only children) and the rest (5188) middle-order and youngest (Non-first born) children taken together. Of the total number 7896, 680 (about 8.6%) children died before reaching age 10 years (an overwhelming majority 71% of these children died before they were one year old). While about 8% of First born children died, a slightly higher proportion (9%) of Non-first born children died before reaching their 10th birthday. Child mortality rates in our sample varied with the gender as well as birth order (First born or younger) of the current child: among the children, who died, there were a slightly higher proportion of First born boys (9.5% as compared to 7% First born girls). In contrast, a higher proportion of Non-first born girls (10% as against 8.4% boys) died. Biologically boys are at a higher risk of death than girls and therefore the fact that in the sample under consideration girls are more likely to die (before the 10th birthday) compared to boys is indicative of discrimination against girls in the form of inputs.

The Pakistan sample consists of 9465 children born between 1955 and 1990, born to 1889 women. There were 4859 (51.35%) boys and 4606 girls in this sample. In the case of Pakistan, there were very few twins and these were deleted from the sample. Of the 9465 children in the sample, 1418 (14.98%) survived less than 10 years. 14.55% of the girls died before the 10th birthday while 15.39% of the boys died before the 10th birthday. However the sex differential in child mortality rates was not significantly different. We also consider if there was any birth order differences in child mortality. While 16.92% of the First born children died before the 10^{th} birthday, only 14.46% of the non-first born (middle order and youngest) children died before reaching the 10^{th} birthday. The difference is statistically significant at the 1% significance level.

Table 1 summarises the means and standard deviations of selected variables for the two samples. It follows that mortality rates in 0 – 10 years age group is higher in Pakistan while birth spacing is slightly lower. Also number of children ever born to sample women is higher while parental literacy levels, especially mothers' literacy levels, are significantly lower for the sample children in the Pakistani sample.[8] Religion may have a direct impact on fertility and child mortality in our sample, but it may also interact with socio-economic and cultural factors and other unobservable variables (e.g., health and public services) to affect female literacy, which in turn may exert some indirect influence on these demographic variables.[9]

3.2. Explanatory Variables Used

The only child characteristic that we include in both the hazard equations relates to the gender of the child (BOY). Given the bias (perceived and otherwise) against girls in the Indian subcontinent, one could expect higher mortality rates among girls and a greater duration to the subsequent birth following the birth of a son.

Early death of child i could result in reduced duration between child i and child $i+1$. This is the child replacement effect. Hence we include SURV as an explanatory variable in the estimation of NEXT. On the other hand NEXT could have a significant effect on SURV as well. Reduced

---

[8] Lower female literacy may explain higher fertility in a number of ways: (a) lower age at marriage and age at first birth; (b) lack of knowledge of modern contraception and their efficacy; (c) lower female autonomy in fertility and child health matters.

duration between successive children, given finite household resources, could result in lower child quality and hence increased likelihood of child death. On a similar vein it is likely that duration between child i and child $i-1$ (PREV) is likely to have a significant effect on both child survival and the duration to next birth. One would expect a reduction in the duration between child i and child $i-1$ to reduce the hazard of child survival, but we have no prior as to what the effect of PREV on NEXT will be. But we include them as important indicators of competition among siblings for limited household resources. We also include an interaction term between NEXT and BOY, namely, INEXTBOY, which captures the gender differential in the posterior birth spacing on child survival. We tried including this variable for both the Indian and the Pakistani samples; but since this variable turned out to be insignificant for the Pakistani sample, we decided to drop it. We also include is the proportion of elder siblings at birth that are females (POLDF) as an explanatory variable. This could also reflect the extent of inequality among siblings. However, the effect of 'having older sisters' on child survival may be ambiguous. For example, Garg and Morduch (1998) argue that having more sisters at birth results in improved child health in Ghana, particularly for boys. In contrast, Dasgupta (1987) and Pal (1999) find that Indian girls are worse off if they have older sisters.

Among various parental, household and community characteristics, we include characteristics pertaining to each parent like age at birth and education. In case of Pakistan we include two dummies to reflect parental age at birth, namely, AGEM1 and AGEM3 for the mother and AGEF1 and AGEF3 for the depending on the age distribution in each sample. For the Indian sample, however, we include three age splines (AGEM1, AGEM2, AGEM3 and AGEF1, AGEF2, AGEF3 respectively for mother and father) depending on the quartile distribution of age father (see Appendix for further definition of these variables). These age variables (dummies in the case of Pakistan and

---

[9] We cannot however test the differences between Muslim and non-Muslims in the Pakistani sample as all sample

splines[10] in the case of India[11]) account for the possible non-linearity in the parental age effect on child spacing and child survival. Of particular importance are parental education levels. Mother's educational attainment is captured by including two dummies: EDUCM1 (the highest education attained by the mother is primary school) and EDUCM2 (the highest education attained by the mother is more than primary school).[12] The same dummies are used for both the Indian and Pakistani samples. To account for father's educational attainment in the regressions using data from Pakistan we include two dummies: EDUCF1 (the highest education attained by the father is primary school) and EDUCF2 (the highest education attained by the father is more than primary school).[13] However for the Indian data set, information on father's education is not as detailed and we only include a dummy variable to indicate whether the father can read or write (LITDAD). One would expect mortality rates to be lower for children with educated parents. It is argued that education lowers the cost of information and it is likely that more educated parents have a better understanding of the value of public health infrastructure and are better able to utilize these services. Educated parents are also likely to be better aware of the fact that reduced duration between children is likely to have an adverse effect on child quality and therefore are more likely to increase the duration between children.

For the Indian data set, there is no information on household income/expenditure. We therefore included a variable PCASSET, which is a composite asset index.[14] The Pakistan data set

---

households were Muslims.

[10] We transform the continuous age variable into piecewise linear age splines. Each new variable represents the original age variable on a specific segment of its range so that the estimated effect of the splines is no longer linear, but piece-wise linear. These spline coefficients may directly be interpreted as slope coefficients (Panis, 1994).

[11] We chose these two different sets of age variables for the two samples as these yielded the best results in terms of the measures of goodness of fit (e.g., Log-Likelihood functions, t-statistics).

[12] The reference category is that the mother has no education.

[13] Once again the reference category is that the father has no education.

[14] We use principal component analysis to construct this index from household ownership of agricultural land, farm equipment, cycle, scooter, car, radio and television.

has information on household expenditure, which is an indicator of the economic status of the household. However the problem is that household expenditure could be correlated with the unobserved determinants of both child mortality and duration between successive children, leading to a standard endogeneity problem. Hence we generate an instrument for log household expenditure as follows. We regress log of household expenditure on a set of household characteristics including educational and demographic characteristics of the household head and a set of household infrastructural variables. The predicted value of log household expenditure was used as an explanatory variable in the hazard regressions. The results for the first-stage regression are presented in Table A1.

For the Indian data we include two religion dummies (HINDU and SIKH where the omitted category includes minority religious groups like Muslim, Buddhist and Christians). In the Pakistani sample, however, there were no non-Muslim households and hence we do not need to control for religious groups.

In addition to the individual/household level demand factors, we also need to consider effects of the provision of health and other medical facilities (related to family planning and child health programmes) on both the duration between successive births and child survival. To this end, we include a rural dummy to denote the rural residential location and examine the effects of rural-urban dichotomy in the provision of public services on both birth spacing and child survival. In addition, we include a number of infrastructural variables, e.g., household access to safe drinking water, modern toilet and drainage (only in the Pakistani sample; see Appendix) facilities in explaining child survival.[15]

[15] In principle we should also include community characteristics like availability of health facilities, including health centres, availability of doctors and the availability of nurses. However since the datasets are not retrospective including these community characteristics could result in endogeneity problems. For example, health centres could have been built in a particular region in response to historically high child mortality rates. See Rosenzweig and Wolpin (1986) for more on this issue.

Finally we include a number of birth cohort dummies in explaining both birth spacing and child survival. These birth cohort dummies will, to some extent, capture the trends in these demographic variables over time and as such will reflect the relative importance of the underlying demand and supply factors. In the Indian case we include three dummies – child born between 1970 and 1980 (YEARB2), born between 1980 and 1990 (YEARB3) and born after 1990 (YEARB4). In the Pakistani case we include two dummies – born between 1970 and 1980 (YEARB2) and born after 1980 (YEARB3). In both cases the reference category is that the child is born before 1970.

As argued in Section 2, the baseline hazards are specified as splines. The two baseline hazards $T_1(t)$ and $T_2(t)$ measure the duration dependence of survival and subsequent birth. These essentially measure the time varying risk of child mortality and subsequent childbirth from the time the child is at risk of the event. The time dependency starts once the child is born. Several specifications of the baseline hazard were tried and we finally chose the one that fitted the data best.

There may arise important endogeneity problems if the explanatory variables are not carefully chosen. For example, Rosenzweig and Wolpin (2000) suggest that the use of 'any sisters' in the child quality function as in Butcher and Case (1994) may cause problems. The gender of siblings may affect parental investments in a given child in a number of ways. However, the existence of sisters, even if gender is randomly determined, depends on the choice of family size – although the gender of a particular child is random, the probability of having a sister increases with the number of siblings. Accordingly, we normalise the number of older sisters at birth of a child by total number of elder siblings to obtain the proportion of elder sisters at birth (POLDF). For similar reason, we do not include if the mother had prenatal check-up or if the child has been vaccinated after birth (both in the Indian sample). However, we use PRENAT (if the woman *ever* had a pre-natal check-up, for

Pakistan case) and REPPROB (if the woman *ever* faced any reproductive problems, the Indian case), since these are not specific to a particular child. An endogeneity problem however still remains – decision to have a pre-natal check-up could be related to unobserved women specific characteristics that are not observed to the researcher and is private information for the woman. We continue to include these variables (only in the child survival hazard function) because of the absence of viable instruments and more importantly these variables are indicative of the couple's attitude to modern health and family planning facilities and in our opinion are important determinants of child survival.

4. EMPIRICAL RESULTS

It is argued that individual, sibling, parental, other household and community characteristics would affect birth spacing and child mortality hazard equations. Though we include similar characteristics in the two hazard functions, we ensure identification by including certain variables in one equation and not in the other.

For each country, we jointly estimate birth spacing and survival hazards, for (a) First born children and (b) middle order and youngest (Non-first born) children[16] taken together. Remember that in the regressions for the First born children we do not include PREV and POLDF as explanatory variables, as they are not defined. Our results suggest that the coefficient estimates for the First born children are quite different from those for the Non-first born children, thus justifying separate regressions for these two groups of children.

Various specifications were estimated, though we finally present the results for the most complete model – correlated joint hazard estimates for SURV and NEXT. For each case, the null hypothesis of no correlation $(r = 0)$ is rejected. The unobserved mother-specific heterogeneity is significant for both groups of children in India and Pakistan, thus ignoring heterogeneity would have led to biased and inconsistent estimates. These correlated hazard estimates are presented in Table 2 for India and Table 3 for Pakistan.

4.1. Results for India

Child Spacing:

Non-first born Children: Spacing hazard significantly depends on parental age and education. For example, the hazard of subsequent birth falls with mother's age, signifying the attainment of the couple's reproductive goal as well as women's fecundity. The hazard of a subsequent birth is lower if the father is literate and also if the mother has more than primary schooling.[17] Among various household characteristics, the hazard is significantly higher for children from male-headed households while it is lower for wealthier households (with more assets). It also falls if the couple had ever used any contraception (reversible methods), which is indicative of parental awareness of the effect of increased duration between children on child health.

Among individual child's characteristics, longer duration of child survival (SURV) lowers the hazard of subsequent birth, lending support to the commonly observed replacement effect. Gender (BOY) of the current child is also significant and the estimated coefficients imply that the hazard of subsequent birth is significantly lower if the current child is a male. This is evidence in favour of son-preference: parents choose to delay having a child following the birth of a son. We also have some indirect evidence in this respect: after controlling for various individual, household and other

---

[16] For the Indian case we exclude the youngest child of the sterilised women. We cannot, however, identify the sterilised women for the Pakistani case.

characteristics, larger proportion of older girls at birth (POLDF) increases the hazard of subsequent birth. This also indicates parental willingness to have more sons, given that they have more daughters at a point of time. Among other sibling characteristics, longer prior birth spacing (PREV) significantly lowers the hazard of subsequent birth.

Rural location (RURAL) is significant and the hazard is higher for the households living in rural areas, which implies limited supply of publicly provided contraception, or limited knowledge of contraception and/or prejudice against using modern contraception for the rural population. Finally, it follows that compared to the 1960s, middle-order and youngest children born in the 70s, 80s or 90s have significantly lower hazard of subsequent birth. Thus, there is indirect evidence of significant improvement in family planning in India so that there is generally a lower concentration of births in the recent decades.

First born Children: The results with respect to parental son preference in birth spacing and sibling competition (with respect to subsequent birth spacing) still hold. However, interestingly enough, there are some significant differences in the estimates between the First born and other children. (1) Religion plays a significant role in child spacing: compared to the Muslim and other minority religious groups, the hazard of subsequent birth is significantly lower for women belonging to Hindu or Sikh households. The latter perhaps indicates a greater degree of acceptance of modern contraception methods among Hindus and Sikhs as compared to Muslim households. (2) The hazard is higher even if the child lives longer. (3) Literacy of father and primary schooling of mothers both enhance the hazard of subsequent birth. (4) The hazard of subsequent birth is significantly higher for the children born in the 70s, 80s and the 90s. Taken together, observations (2), (3) and (4) are suggestive of the

---

[17] See also Murthi, Guio and Dreze (1995) for analysis using district level data from India.

desire among sample couples for more than one child to achieve their reproductive goal. Interestingly, however these results change when we consider the middle-order and youngest children reflecting, among other things, stronger competition among siblings for limited parental resources.

Child Survival:

Non-first born children: Coefficients of the prior and posterior birth spacing (PREV and NEXT) are negative and statistically significant indicating that the greater the duration between successive births, the lower is the hazard of child mortality (i.e., the child is less likely to die). As already indicated, this accounts for competition among younger siblings for parental time, care and resources. The hazard is lower if a child has proportionately higher number of older sisters at birth (POLDF), indicating that resource-constrained parents with pro-male bias may have more resources for the current child since they would invest less for larger number of older daughters with fewer intrinsic advantages.

Among various parental, household and infrastructural characteristics, the composite asset indicator PCASSET is negative and significant, thus suggesting that children from more wealthy families have lower mortality hazard, lending direct support to the resource constraint hypothesis. Children born to older fathers have significantly lower hazard, also indirectly signifying the wealth effects. However, parental education variables do not turn out to be very significant in child survival hazard, after taking account of their influence on child spacing in this correlated hazard framework.

First born children: While results with respect to subsequent birth spacing (NEXT) and birth cohorts are generally similar for First born and other younger children, there are interesting differences with respect to some other variables in child survival. (1) The coefficient of BOY is positive and significant in the survival function so that a male child has a significantly higher hazard of dying, which is generally a biological regularity observed across most societies. (2) The interaction between NEXT and BOY is significant, suggesting that if the current child is male, the subsequent birth spacing is significantly greater, again lending indirect support to the 'son-preference' in survival. (3) Index of household's composite assets is not significant, suggesting that the resource constraint does not significantly affect the duration following the birth of the first child, though it turns out to be significant for the subsequent children.

4.2. Results for Pakistan

Child Spacing:

Non-first born children: The sex of the child dummy BOY is not statistically significant in explaining the duration to the next birth. However, the coefficient estimate of POLDF is positive and statistically significant, suggesting parental inclination to try for a male child, if they already have more female children. This could be viewed as indirect evidence in favour of the son-preference hypothesis. Prior birth spacing PREV is not statistically significant. However the coefficient estimate of SURV is negative and statistically significant. This implies that parents have an early next child if the current child does not survive. This is simply a different manifestation of the child replacement effect.

The highest levels of education attained by the mother dummies (EDUCM1 and EDUCM2) are both negative and statistically significant; the effect is stronger if the highest level of education attained is grade 6 or higher. This is not a surprising result. Presumably educated women are more aware of the problems of child care if there is higher concentration of births which in turn affect child quality; in other words, they are better placed to realise that increased duration between children is likely to increase the quality of children and therefore are more likely to space their children apart.

Turning to the highest level of education attained by the father, we do not find a statistically significant effect. The age dummies of the father are both statistically significant, though of opposite sign. The duration between children is lower for younger fathers while it is higher for older fathers. There are therefore significant life-cycle effects in the age of the father at birth and the duration between successive children. Also household expenditure does not have a significant effect on subsequent birth spacing implying that household resource constraints do not play an important role in determining NEXT. Finally the two birth cohort dummies (born between 1970 and 1980 and born after 1980) are both positive and statistically significant, indicating a lack of success of the family planning programmes in the Pakistani Punjab in achieving longer birth spacing in the recent decades.

First born children: The coefficient estimates for the First born children are quite interesting. As with younger children, SURV is negative and statistically significant. Mother's education also plays a favourable role on birth spacing. There are, however, significant differences compared to the coefficient estimates for the Non-first born children. (1) The coefficient estimate of BOY is negative and statistically significant. This implies that the duration between the first and the second child is higher if the First born child is male, compared to the case where the First born child is female. Once again SURV is negative and statistically significant. This implies that the duration between the first and the second child is higher if the first child survives longer. (2) The hazard of having a subsequent sibling is significantly higher for children belonging to richer households while it is insignificant for younger children. (3) Surprisingly, the coefficients of both dummies reflecting fathers' education levels are statistically significant and positive. Thus the hazard of having a sibling is higher for children with more educated fathers, which is also similar to the wealth effect.

Child Survival:

Non-first born children: In this case, neither the sex of the child (BOY) nor the proportion of older sisters at the birth of the child POLDF is statistically significant. There is therefore no direct or indirect evidence in favour of the son-preference hypothesis in child survival. However both NEXT and PREV are negative and statistically significant. These essentially imply that an increase in the duration between child i and child $i-1$ reduces the hazard of child i dying (and increases the number of days child i is alive), as does an increase in the duration between child i and child $i+1$. Parental education appears to have little impact (except EDUCM1 being significant only at the 10% level) on the hazard of child survival. Household expenditure has a significant effect on the hazard of child survival. An increase in household expenditure reduces the hazard of child mortality.[18] This supports the hypothesis of resource constraint among sample households. Thus, households with higher expenditure are typically richer households that are able to provide more resources and better health and infra structural facilities for the child, resulting in significantly lower child mortality rates.

Among the household infrastructural variables only DISPOS2 (garbage is disposed by dumping) reduces the hazard of child mortality and none of the other variables have a statistically significant effect. PRENAT (the woman has ever had pre-natal check up) is positive and statistically significant, implying that the hazard of child mortality is higher for women who have ever had pre-natal check up.[19] Finally the two birth cohort dummies, namely, YEARB2 (born between 1970 and 1980) and YEARB3 (born after 1980) are both negative and statistically significant. This implies that the hazard of child mortality is lower (and the number of days survived prior to death, if dead, higher)

[18] In this case remember the explanatory variable is the predicted value from the first stage regression of log of household expenditure on a set of household characteristics. This solves the potential problem of endogeneity arising from the correlation between household expenditure and the unobserved determinants of child survival hazard.

[19] This could be the result of an endogeneity problem because poor Indian women might go for pre-natal check up only if they face some reproductive health problems though this was not observed.

for children born after 1970, compared to that for children born before 1970 (the reference category). This is possibly a consequence of the provision of improved health services and facilities in Pakistan in the 70s and the 80s.

First born children: As with child spacing, compared to the younger children, there are some significant similarities and differences observed in the estimates for the First born. The coefficients of NEXT and LHHEXPH (the predicted value of log household expenditure from the first stage estimation) are both negative and significant as before. However, the differences are quite interesting: (1) unlike in the case of the Non-first born children, BOY is positive and statistically significant. This implies that the hazard of child mortality is higher if the First born child is a boy relative to the case where the First born child is a girl. Biologically boys have higher child mortality rates compared to girls, so *per se* this is not a surprising result. What is interesting however is that we do not find a statistically significant effect for the sex of the child on child mortality rates for the higher birth order children. (2) EDUCM1, EDUCF1 and EDUCF2 are all negative and statistically significant (and even though EDUCM2 is not statistically significant, it is still negative). (3) Several of the household infra structural variables have a significant effect on child mortality. DWATER1 (the main source of drinking water is tap inside house, DRAIN1 (sanitation system consists of underground drains) and DISPOS2 (the garbage is disposed by dumping) are all negative and statistically significant (all reduce the hazard of child mortality), while TOILTYP5 (the household has no toilet) increases the hazard of child mortality.

4.3. Comparison of the results for India and Pakistan

Finally, in this section, we compare the Indian and the Pakistani results with respect to household decisions in birth spacing and child survival. This brings out some interesting similarities and differences between the two states divided by the partition in 1947. In general, after controlling for various parental, household and community characteristics, there is evidence of significant mutual dependence of birth spacing and child survival. These results also reflect some aspects of gender differences and inequality among siblings in child health outcomes. However, there are some interesting differences too in the two sets of results that we highlight here.

Differences in birth spacing hazards

(1) In general hazard of having a subsequent sibling is higher if the current child is female and/or if the current child has more older sisters, indicating some evidence of son-preference in both the countries; the effect seems to be stronger in India where both the BOY dummy as well as POLDF are significant for Non-first born children and BOY is significant for first born children. In contrast, only BOY is significant for first born while POLDF is significant for younger children in Pakistan.

(2) Household expenditure is significant only for the First born children in Pakistan and wealth effect enhances the hazard of subsequent childbirth. In contrast, the composite assets index is significant for all children in India and it lowers the hazard in this respect.

(3) Parental education is important in birth spacing in both countries, but the effects are somewhat different. For example, any level of mother's literacy lowers the hazard of subsequent birth in Pakistan; however, more than primary schooling of the mother is required to have any

perceptibly favourable effect on subsequent childbirth in India. Secondly, any level of father's literacy lowers the hazard of subsequent birth in India while father's literacy seems to have an adverse effect on subsequent birth among First born children in Pakistan. It appears that effects of father's education on birth spacing in Pakistan are rather similar to the wealth effects.

(4) The hazard of subsequent birth is lower between the Hindu and the Sikh communities, as compared to the Muslims and other minority groups in India (though we could not test the role of religion for the Pakistani sample since all sample households were Muslims). This is indicative of favourable attitude towards modern family planning methods among non-Muslim households.

(5) There are interesting differences in birth cohort dummies in the two countries. The hazard of subsequent birth significantly drops in the 70s, 80s, and 90s in India (for the Non-first born children), perhaps signifying the relative efficacy of the supply side factors, e.g., the family planning programme in altering birth spacing. This could also have been supported by increasing female literacy in India over the decades. In contrast, these dummies are significantly positive in Pakistan, suggesting an increasing (rather than decreasing) hazard of subsequent birth among sample women in the country in the recent decades. The latter may signify the relative importance of household-level demand factors (e.g., low female education) as against the supply side factors like provision of effective family planning services by the state.

Differences in mortality hazards

(1) While parental education is not significant in child survival in India, education turns out to be significant in child survival in Pakistan (though the effect is weaker than in birth spacing).

(2) Compared to India, infrastructural variables, e.g., access to safe drinking water or modern health care system, are more significant for child survival in Pakistan.

One possible way of interpreting these differences in results (1) and (2) would be that the average parental literacy, especially, mother's literacy is significantly higher in India. Thus, a marginal increase in parental literacy would have a less pronounced effect in the Indian Punjab (compared to the Pakistani Punjab). Similarly one could argue that the Indian state of Punjab has achieved a better infrastructure compared to the Pakistani state and that is why a marginal increase in the provision of any of these infrastructural services may not make any significant difference in child survival.

5. CONCLUSION

Evidence from most developing countries suggests that mortality and fertility have declined in close succession, thus justifying the need to jointly determine child survival and birth spacing. While most existing studies do not address this simultaneity issue, we use correlated simultaneous hazard models to examine the two-way relationship between birth spacing and child survival. In doing so, we also compare the behaviour of Muslim and non-Muslim households in the Indian and Pakistani Punjab provinces who share a common socio-cultural background. These correlated estimates do suggest a two-way causality between birth spacing and child survival in both samples. The greater the duration between successive children, the lower is the likelihood that the child dies; the longer duration of child survival lowers the hazard of subsequent child birth in both samples. There are also some interesting differences in the two samples: first, there is evidence of son preference in birth spacing, though the effect seems to be stronger in India. Second, wealth effects (for example, composite assets in India or instrument of household expenditure) turn out to be significant in both birth spacing and child mortality though the effect is more pronounced (for all groups of children) and also favourable in the Indian sample. Third, parental education has a significant favourable impact on spacing birth than on child survival in India. However, effects of parental education are pronounced in both spacing and survival in Pakistan. Fourth, compared to the Muslims in the Indian sample, the hazard of subsequent birth is significantly lower among the Hindus and Sikhs (this comparison was not possible for the Pakistani sample). Finally, results with respect to the birth cohort dummies tend to indicate that compared to the 1960s, the hazard of subsequent birth is significantly lower in recent decades in India, while the trend is just opposite in Pakistan. The latter could be attributed to a rather passive attitude of the Pakistani households towards modern family planning methods. Some may argue that this could be a result of their religion while one cannot deny the fact that the effects of religion on birth spacing is also closely related to lower female literacy in Pakistan.[20] More importantly, higher hazard of birth spacing in Pakistan over the decades could also be partly attributed to rather passive official population policy in Pakistan for much of the post-independence period, which started to gather momentum only in the early 1990s.

REFERENCES

Basu, A. (1992). Culture, the Status of Women and Demographic Behaviour, Oxford: Clarendon Press.

Becker, G. S. (1981). A Treatise on the Family. Cambridge, Harvard University Press.

Becker, G. S. and H. G. Lewis (1973): "On the Interaction between Quantity and Quality of Children", *Journal of Political Economy*, **81**(2(Part2)), S279-S288.

Behrman, J. R. and J.C. Knowles. 1999. 'Household Income and Child Schooling in Vietnam', *The World Bank Economic Review*, 13(2) pp. 211-56.

Behrman, J. R. and B. L. Wolfe (1984): "Evidence on Nutrition Demand", *Journal of Development Economics*, 105 - 128.

Brien, M. J. and L. Lillard, A. (1994): "Education, Marriage, and First Conception in Malaysia", *Journal of Human Resources*, **29**(4), 1166 - 1204.

Brien, M. J., L. A. Lillard and L. J. Waite (1999): "Interrelated Family-Building Behaviors: Cohabitation, Marriage and Nonmarital Conception", *Demography*, **36**(4), 535 - 551.

Butcher, K. and A. Case (1994): "The Effect of Sibling Sex Composition on Women's Education and Earnings", *Quarterly Journal of Economics*, **109**(3), 531 - 563.

Caldwell, J. A. (1986): "Routes to Low Mortality in Poor Countries", *Population and Development Review*, **12**, 171 - 220.

[20] We are unable to identify if the lower female literacy among Pakistani households is a product of Islamic beliefs since there are no non-Muslim households in the Pakistani sample.

Cleland, J. and Z. A. Sathar (1984): "The Effect of Birth Spacing on Childhood Mortality in Pakistan", *Population Studies*, **38**(4), 401 - 418.

Dreze, J. and A.K. Sen. 1995. *India Economic Development and Social Opportunity,* Oxford: Clarendon Press.

Dasgupta, M. (1987): "Selective Discrimination against Female Children in Rural Punjab", *Population and Development Review*, **13**.

Gangadharan, L. and P. Maitra (2003): "The Effect of Education on the Timing of Marriage and First Birth in Pakistan", *Journal of Quantitative Economics,* **New Series, 1**(1), 114 - 133.

Garg, A. and J. Morduch (1998): "Sibling Rivalry and the Gender Gap: Evidence from Child Health Outcomes in Ghana", *Journal of Population Economics*, **11**(4), 471-493.

Horton, S. (1988): "Birth Order and Child Nutrition Status: Evidence from the Philippines", *Economic Development & Cultural Change*, **36**(2), 341 - 354.

Jejeebhoy, S. J. and Z. A. Sathar (2001): "Women's Autonomy in India and Pakistan: The Influence of Religion and Region", *Population and Development Review*, **27**(4), 687 - 712.

Lillard, L. A. (1993): "Simultaneous Equations for Hazards: Marriage Duration and Fertility Timing", *Journal of Econometrics*, 189 - 217.

Morgan, S. P., S. Stash, H. L. Smith and K. O. Mason (2002): "Muslim and non-Muslim Differences in Female Autonomy and Fertility: Evidence from Four Asian Countries", *Population and Development Review*, **28**(3), 515 - 537.

Murthi, M., A. Guio and J. Dreze (1995): "Mortality, Fertility, and Gender Bias in India: A District-Level Analysis", *Population and Development Review*, **21**(4), 745 - 782.

Pal, S. (1999): "An Analysis of Childhood Malnutrition in Rural India: Role of Gender, Income and Other Household Characteristics", *World Development*, **27**(7), 1151 - 1171.

Panis, C. W. A. (1994): "The Piecewise Linear Spline Transformation with an Application to Age at First Marriage", *Stata Technical Bulletin*, **18**, 27 - 29.

Panis, C. W. A. and L. A. Lillard (1994): "Health Inputs and Child Mortality: Malaysia", *Journal of Health Economics*, **13**, 455-489.

Parish, W. and R. Willis (1994): "Daughters, Education and Family Budgets: Taiwan Experiences", *Journal of Human Resources*, **28**(4), 862 - 898.

Rosenzweig, M. R. and T. P. Schultz (1982): "Market Opportunities, Genetic Endowments and Intrafamily Resource Distribution: Child Survival in Rural India", *American Economic Review*, **72**(4), 803-815.

Rosenzweig, M. R. and K. I. Wolpin (1986): "Evaluating the Effects of Optimally Distributed Public Programs: Child Health and Family Planning Interventions", *American Economic Review*, **76**(3), 470-482.

Rosenzweig, M. R. and K. I. Wolpin (2000): "Natural 'Natural' Experiments in Economics", *Journal of Economic Literature*, **38**(4), 827 - 874.

Table 1. Means and standard deviations of Selected Variables

Variable	India	Pakistan
Eldest Child	0.3102	0.2105
	(0.45)	(0.41)
Youngest Child	0.2709	0.1756
	(0.44)	(0.38)
Dead at the Time of the Survey	0.0826	0.1487
	(0.28)	(0.36)
SURV (in years, sample not censored)	1. 4368	1.0357
	(2.05)	(1.95)
NEXT (in years, sample not censored)	2.5224	2.2708
	(1.54)	(1.34)
Children ever born	4.02	4.22
	(1.65)	(3.00)
Average Years of Education for Mother	-	1.2477
		(2.90)
Average Years of Education for Father	-	4.0868
		(4.48)
Highest School Attainment of Mother: Primary School (EDUCM1)	0.1639	0.1149
	(0.37)	(0.32)
Highest School Attainment of Mother: More than Primary School	0.20	0.0814
(EDUCM2)	(0.40)	(0.27)
Highest School Attainment of Father: Primary School (EDUCF1)	-	0.2388
		(0.43)
Highest School Attainment of Father: More than Primary School	-	0.3326
(EDUCF2)		(0.47)
If father is literate (LITDAD)	0.5827	-
	(0.49)	

Note: Standard deviations in parentheses.

Table 2: Simultaneous Hazard Estimates for Birth Spacing and Child Survival, India

Duration to the next birth	**Non-first born**	**First born**
CONSTANT1	-4.4403***	-13.0637***
	(0.8795)	(1.1935)
Duration 0 – 3	2.2845***	2.7130***
	(0.0839)	(0.1245)
Duration 3 – 5	-0.1618***	0.1428**
	(0.0529)	(0.0661)
Duration 5+	-0.3955***	-0.3199***
	(0.0354)	(0.0533)
HINDU	0.1855	-0.4677**
	(0.2120)	(0.2032)
SIKH	0.0485	-0.4477**
	(0.2078)	(0.1946)
BOY	-0.3016***	-0.2059***
	(0.0593)	(0.0784)
POLDF	0.2506***	-
	(0.0793)	
PREV	-0.2674***	-
	(0.0232)	
SURV	-0.0526***	0.2140***
	(0.0139)	(0.0170)
AGEM1	-0.0539	0.1153**
	(0.0352)	(0.0480)
AGEM2	-0.0337	-0.0616
	(0.0499)	(0.0561)
AGEM3	-0.1111***	-0.1171***
	(0.0280)	(0.0267)
AGEF1	0.0042	0.0714**
	(0.0241)	(0.0352)
AGEF2	0.0303	-0.0642**
	(0.0248)	(0.0306)
AGEF3	0.0102	0.0067
	(0.0144)	(0.0204)
EDUCM1	0.0476	0.2511*
	(0.0964)	(0.1139)
EDUCM2	-0.5231***	0.1253
	(0.1192)	(0.1274)
LITDAD	-0.1391*	0.2110**
	(0.0788)	(0.0978)
REPPROB	-0.0568	-0.0329
	(0.0808)	(0.1023)
EVERUSE	-0.1524***	0.0418
	(0.0137)	(0.0411)
HEADMALE	0.1555***	-0.0269
	(0.0107)	(0.0406)
PCASSET	-0.2295***	-0.1499***
	(0.0437)	(0.0498)
RURAL	0.2633***	0.0671
	(0.0864)	(0.0938)
YEARB2	-0.1736	0.3257**
	(0.1492)	(0.1354)
YEARB3	-0.5507***	0.8543***
	(0.1559)	(0.1387)

YEARB4	-0.4875**	2.6677***
	(0.2318)	(0.2615)

Child Survival

	Non-first born	**First born**
CONSTANT2	1.6302	13.3845**
	(1.6721)	(5.9828)
Duration 0 – 1	-1.9272***	-0.2184
	(0.2349)	(0.7191)
Duration 1 – 5	-0.6540***	-0.5637***
	(0.0784)	(0.1279)
Duration 5 +	0.1733**	0.5203***
	(0.0727)	(0.1159)
HINDU	0.1201	0.3412
	(0.3311)	(0.8336)
SIKH	0.0730	0.4837
	(0.3219)	(0.8308)
BOY	0.0192	2.2398**
	(0.1407)	(1.0493)
NEXT	-0.0934***	-2.6318***
	(0.0267)	(0.3816)
INEXTBOY	-0.0359	-0.7734*
	(0.0337)	(0.4115)
POLDF	-0.5020***	-
	(0.1420)	
PREV	-0.2604	-
	(0.0441)	
AGEM1	-0.0156	-0.3972*
	(0.0555)	(0.2242)
AGEM2	0.1402	0.3350
	(0.0885)	(0.3287)
AGEM3	-0.0246	-0.0108
	(0.0552)	(0.1604)
AGEF1	-0.0584	-0.2819
	(0.0382)	(0.2036)
AGEF2	-0.0264	0.1299
	(0.0437)	(0.1598)
AGEF3	-0.01	-0.0269
	(0.0246)	(0.1262)
EDUCM1	0.0151	-0.5504
	(0.1858)	(0.6191)
EDUCM2	0.1089	-0.8893
	(0.2199)	(0.7432)
LITDAD	0.1685	0.3519
	(0.1409)	(0.5028)
HEADMALE	0.0130	-0.0109
	(0.1766)	(0.0274)
PCASSET	-0.4127***	0.0774
	(0.08)	(0.2927)
RURAL	0.1209	1.5438**
	(0.1608)	(0.6540)
DWATER	-1.1816	-0.9119
	(0.9741)	(1.9345)
MODTOILT	-0.2402	-2.1146***
	(0.1589)	(0.7339)
YEARB2	-0.1995	-0.6537

	(0.2094)	(0.6100)
YEARB3	-0.3544	-1.1090*
	(0.2220)	(0.6218)
YEARB4	-0.4983*	-2.5441***
	(0.2779)	(0.8710)
Heterogeneity and Correlation Terms:		
	Non-first born	**First Born**
σ_ε	1.5108***	1.7714***
	(0.0782)	(0.0904)
σ_u	0.7631***	7.0098***
	(0.1044)	(1.3229)
ρ	-0.6796***	-0.9542***
	(0.2368)	(0.0122)
Ln-L	-9707.13	-4651.56

Notes: Asymptotic standard errors in parentheses;
Significance: '*'=10%; '**'=5%; '***'=1%.

Table 3. Simultaneous Hazard Estimates for Birth Spacing and Child Survival, Pakistan

Duration to the next birth

	Non-first born	**First born**
CONSTANT	-3.3654 ***	-8.5239 ***
	(0.4144)	(0.6729)
Duration 0 – 2	1.8787 ***	5.3402 ***
	(0.0358)	(0.2052)
Duration 2 – 5	0.0051	1.0321 ***
	(0.0190)	(0.0618)
Duration 5+	0.0635 **	0.5072 ***
	(0.0282)	(0.0424)
BOY	-0.0158	-0.1375 **
	(0.0247)	(0.0618)
POLDF	0.1614 ***	
	(0.0419)	
PREV	0.0004	
	(0.0104)	
SURV	-0.0983 ***	-0.5172 ***
	(0.0071)	(0.0174)
AGEM1	0.054	-0.3684 ***
	(0.0342)	(0.0796)
AGEM3	0.0189	0.6420 **
	(0.0381)	(0.2605)
AGEF1	0.0691 **	-0.8387 ***
	(0.0339)	(0.0690)
AGEF3	-0.0870 **	-0.6973 ***
	(0.0391)	(0.1535)
EDUCM1	-0.1554 **	-0.2167 **
	(0.0631)	(0.1095)
EDUCM2	-0.2113 ***	-0.6244 ***
	(0.0752)	(0.1041)
EDUCF1	0.0796	0.8950 ***
	(0.0491)	(0.0901)
EDUCF2	0.0383	1.2039 ***
	(0.0539)	(0.0971)
RURAL	0.051	0.0376
	(0.0409)	(0.0688)
LNHHEXPH	0.019	0.3543 ***
	(0.0504)	(0.0672)
YEARB2	0.1885 ***	0.4554 ***
	(0.0508)	(0.0945)
YEARB3	0.5144 ***	1.6553 ***
	(0.0569)	(0.1201)

Child Survival

	Non-first born	**First born**
CONSTANT	4.2543 ***	36.8985 ***
	(1.1645)	(5.0459)
Duration 0 – 1	-2.2319 ***	-0.2883
	(0.2788)	(1.3489)
Duration 1 – 2	-0.5352 *	1.268
	(0.2864)	(0.9689)
Duration 2 – 5	-0.6935 ***	-0.7619 ***
	(0.0815)	(0.1876)
Duration 5 +	0.1548 ***	0.5152 ***

	(0.0489)	(0.1004)
BOY	0.079	2.0417 ***
	(0.0644)	(0.3664)
NEXT	-0.6088 ***	-9.0374 ***
	(0.0640)	(0.7333)
POLDF	-0.0759	
	(0.1066)	
PREV	-0.7276 ***	
	(0.0328)	
AGEM1	0.0301	1.0429 **
	(0.0937)	(0.4459)
AGEM3	0.1878 *	-0.9131
	(0.1017)	(2.1872)
AGEF1	0.0538	4.1128 ***
	(0.0944)	(0.4950)
AGEF3	-0.153	3.4837 ***
	(0.1107)	(0.6676)
EDUCM1	0.2928 *	-1.1065 **
	(0.1704)	(0.5534)
EDUCM2	0.0089	-1.1131
	(0.2239)	(1.4068)
EDUCF1	-0.0771	-1.4660 ***
	(0.1376)	(0.4121)
EDUCF2	-0.2441	-2.5407 ***
	(0.1594)	(0.4652)
RURAL	-0.2665 *	-0.024
	(0.1564)	(0.4536)
LNHHEXPH	-0.3305 **	-3.2590 ***
	(0.1365)	(0.5473)
DWATER1	0.105	-1.0811 **
	(0.1337)	(0.4902)
DRAIN1	-0.1991	-1.5036 **
	(0.1555)	(0.7161)
DISPOS2	-0.4000 ***	-2.3191 ***
	(0.1199)	(0.4369)
TOILTYP5	0.0173	1.5236 ***
	(0.1571)	(0.4673)
PRENAT	0.3235 **	1.3383 ***
	(0.1386)	(0.4937)
YEARB2	-0.3659 ***	0.5756
	(0.1291)	(0.3691)
YEARB3	-0.7141 ***	-3.8820 ***
	(0.1501)	(0.4922)
Heterogeneity and Correlation Terms:		
	Non-first born	**First Born**
σ_ε	0.5098 ***	2.6286 ***
	(0.0195)	(0.0951)
σ_u	1.2368 ***	9.7168 ***
	(0.0669)	(0.8470)
ρ	-0.6261 ***	-0.9381 ***
	(0.0591)	(0.0059)
Ln-L	-13543	-3641.94

Notes: Asymptotic standard errors in parentheses; Significance: '*'=10%; '**'=5%; '***'=1%.

Table A1: First Stage Regression of Log Household Expenditure (Pakistan only)

AGEHD	0.0133***
	(0.0032)
AGEHD2	-0.0001***
	(0.0000)
SEXHD1	0.0212
	(0.0583)
MARHD	-0.0012
	(0.0112)
EDUCHD1	0.1089***
	(0.0141)
EDUCHD2	0.1901***
	(0.0156)
EDUCHD3	0.2778***
	(0.0259)
TOTCHILD	0.0273***
	(0.0030)
TOTADTM	0.0855***
	(0.0065)
TOTADTF	0.0465***
	(0.0071)
RURAL	0.0474***
	(0.0169)
DOMIC1	-0.0144
	(0.0146)
WALLS1	0.0620***
	(0.0144)
FLOOR1	-0.0673***
	(0.0168)
ROOF3	-0.0445***
	(0.0124)
WINDOWS1	-0.0403***
	(0.0127)
NUMROOMS	0.1068***
	(0.0055)
DWATER1	-0.0636***
	(0.0152)
DRAIN1	0.1204***
	(0.0188)
DISPOS2	-0.0165
	(0.0130)
TOILTYP5	-0.1152***
	(0.0177)
PHONE	-0.3963***
	(0.0336)
CONSTANT	7.4081***
	(0.1204)

Notes:
Standard errors in parentheses;
Significance: '*'=10%; '**'=5%; '***'=1%.

APPENDIX

Table A2: Definition of regression variables

Variable	India	Pakistan
Parental characteristics		
AGEM1	Age Spline: if the mother is less than 20 years old at the time of birth.	
AGEM2	Age Spline: if the mother is between 20-22 years old at the time of birth.	
AGEM3	Age Spline: if the mother is above 22 years old at the time of birth.	
AGEF1	Age Spline: if the father is less than 24 years old at the time of birth.	
AGEF2	Age Spline: if the father is between 24-28 years old at the time of birth.	
AGEF3	Age Spline: if the father is above 28 years old at the time of birth.	
AGEM1		= 1 if the mother is less than 20 years old at the time of birth.
AGEM3		= 1 if the mother is above 22 years old at the time of birth.
AGEF1		= 1 if the father is less than 24 years old at the time of birth.
AGEF3		= 1 if the father is above 28 years old at the time of birth.
EDUCM1	= 1 if highest education attained by mother is primary school.	= 1 if highest education attained by mother is primary school.
EDUCM2	= 1 if highest education attained by mother is more than primary school.	= 1 if highest education attained by mother is more than primary school.
EDUCF1		= 1 if highest education attained by father is primary school.
EDUCF2		= 1 if highest education attained by father is more than primary school.
LITDAD	=1 if the father is literate	
EVERUSE	=1 if ever used contraception	
REPROB	1 if mother had any reproductive problems.	
PRENAT		= 1 if ever had pre-natal check
Child & Sibling Characteristics		
BOY		= 1 if child is a boy.
POLDF	Proportion of Elder siblings that are females. Not defined for first child.	Proportion of Elder siblings that are females. Not defined for first child.
SURV	Years lived before dying. Equals Age if alive at time of survey	Years lived before dying. Equals Age if alive at time of survey
NEXT	Duration between two successive children. Equals Age if last child.	Duration between two successive children. Equals Age if last child.
INEXTBOY	Interaction between NEXT and Boy.	
PREV		Prior duration between two successive children. Not defined for first child.
YEARB2	= 1 if the child is born between 1970 and 1980.	= 1 if the child is born between 1970 and 1980.
YEARB3	= 1 if the child is born between 1980 and 1990 .	= 1 if the child is born after 1980
YEARB4	= 1 if the child is born after 1990.	
Other Household Characteristics		
HEADMALE	=1 if the head is male	
HINDU	= 1 if comes from a Hindu Family.	
SIKH	= 1 if comes from a Sikh Family.	
PCASSET	Composite Indicator of Assets.	

LNHHEXPH		Predicted Value of Log Household Expenditure from Stage 1 regression.
AGEHD		Age of Household Head.
AGEHD2		Age of Household Head Squared.
HEADMALE		= 1 if Household Head is Male.
MARHD		= 1 if Household Head is Married.
EDUCHD1		= 1 if Highest education of Household Head is Primary School.
EDUCHD2		= 1 if Highest education of Household Head is Middle School.
EDUCHD3		= 1 if Highest education of Household Head is High School or More.
TOTCHILD		Total Number of Children in the Household.
TOTADTM		Total Number of Adult Males in the Household.
TOTADTF		Total Number of Adult Females in the Household.
DWATER	=1 if have access to safe drinking water	
MODTOILT	=1 if have access to modern toilet	
DWATER1		
DRAIN1		
TOILTYP5		
DISPOS2		
DOMIC1		= 1 if household lives in a single family home.
WALLS1		= 1 if walls of house are stones-cement bonded.
Community characteristics		
RURAL	= 1 if household resides in a rural area.	= 1 if household resides in a rural area.