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ABSTRACT

This paper explores the demand for child schooling in Pakistan, using the "Pakistan Integrated Household Survey" (1991). There have been few such studies for Pakistan, a country with relatively low enrollment rates and education levels, high illiteracy, and a large disparity between male and female education. This study focuses on two potential sources of bias in the estimation of the demand for schooling. First, studies which do not distinguish between currently enrolled children and those who have completed their schooling subject their estimates to a form of censoring bias. Second, studies which exclude samples for children who have left the household may introduce sample selection bias if the decisions to leave home and to attend school are related. This study finds evidence of both "censoring" and "sample selection" bias in the demand for child schooling in Pakistan, and shows that the sample chosen for the estimation of schooling demand can alter the results. While the majority of educational resources in Pakistan are earmarked for improving access to primary schools, the money would be better spent increasing access to boys' and girls' middle and secondary schools. Includes 26 notes. (Contains 65 references, 11 tables, and 5 figures.) (Author/BT)

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CENTER DISCUSSION PAPER NO. 794

MEASURING THE DETERMINANTS OF SCHOOL COMPLETION IN PAKISTAN: ANALYSIS OF CENSORING AND SELECTION BIAS

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Measuring the Determinants of School Completion in Pakistan:

Analysis of Censoring and Selection Bias

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Abstract

This paper explores the demand for child schooling in Pakistan, using the *Pakistan Integrated Household Survey* (1991). There have been few such studies for Pakistan, a country with relatively low enrollment rates and education levels, high illiteracy, and large disparity between male and female education. Additionally, this study focuses on two potential sources of bias in the estimation of the demand for schooling. First, studies which do not distinguish between currently enrolled children and those who have completed their schooling subject their estimates to a form of censoring bias. Second, studies which exclude children who have left the household from their samples may introduce sample selection bias if the decisions to leave home and to attend school are related. This study finds evidence of both "censoring" and "sample selection" bias in the demand for child schooling in Pakistan.

JEL classification: I2, C24

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1. Introduction

A diverse literature has emphasized the importance of education for both economic and social development. For example, school completion has long been identified as an important determinant of earnings, with private and social rates of return in excess of most other investment opportunities. In developing countries, the social rate of return to education has been estimated to be about 27% for primary school and 16% for secondary school, with private rates of return even higher (Psacharopoulos and Woodhall, 1985). The positive effect of education on agricultural production has also been well documented in the literature, and is particularly relevant to low-income countries in which farming is much of the economy. A summary of the findings of 31 studies from developing countries concludes that four years of primary education increases the productivity of farmers by approximately 8.7 percent (Lockheed, Jamison and Lau, 1980). In addition to the income-enhancing effects of education, evidence also suggests an important role for schooling in social development. Numerous studies have quantified the significant influence that women's schooling in particular, has on fertility reduction, child mortality, and family nutrition (for example, Cochrane, 1979; Haveman and Wolfe, 1984).

Given the documented role of education as a catalyst for economic and social development, improving our understanding of the determinants of schooling is important. An understanding of the factors which influence educational attainment would enable policy makers to adopt strategies to improve the allocation of resources, with the objectives of increasing school completion and reducing the inequality in attainment. For decades, researchers have attempted to isolate and quantify the impact of individual characteristics, family background, local labor markets, migration opportunities, and the quality and availability of schools on schooling outcomes. This paper explores these determinants of schooling attainment in the context of Pakistan, using the *Pakistan Integrated Household Survey* (1991). There have been few such studies for Pakistan, a country with relatively low enrollment rates and education levels, high illiteracy, and large disparity between male and female education.

Most previous work on the determinants of education does not distinguish between currently enrolled children and those who have completed their schooling, thereby subjecting their estimates to a form of censoring bias. Additionally, many studies have excluded from their analyses children who have left the household. If the decisions to leave home and to attend school are related, then such studies may be subject to sample selection bias. The censoring and sample selection bias could be different for boys and girls who leave school at different ages and leave home for different reasons. This study will examine the "censoring" and "sample selection" bias for boys and girls separately.

The outline of this paper is as follows. Section 2a introduces the reader to the theoretical background of the demand for schooling and Section 2b describes the data used in the analysis. Section 2c specifies an empirical model which accounts for right-censoring and then uses the model to estimate the schooling demand for all children in the household, both those living at home and away. This section contains the preferred estimation, having corrected for censoring and included all living children. Section 3a returns to the censoring bias of enrolled children. Estimates with and without proper treatment of the right-censored schooling spells are compared in order to quantify the censoring bias. Section 3b addresses the sample selection bias that arises in most previous studies when only home-resident children are analyzed. Section 4 concludes.

2. *Measuring School Completion*

2a. Theoretical Background

The theoretical approach underlying most empirical studies of schooling attainment is the human capital model developed by Schultz (1960, 1963), Becker (1964) and Mincer (1974). Education is viewed as not only a consumption activity but also as an investment good. In this lifetime optimizing framework, an individual evaluates the direct and indirect costs of education and compares such costs with his or her expected return to schooling. Investment in education ceases when the marginal cost and marginal benefit are equal. By embedding human capital within Becker's (1981) household production model, one obtains a theoretical basis for evaluating the derived demand determinants of investments in schooling. In Becker's (1981) model, altruistic parents maximize household utility for which quantity and quality of children, leisure, and market goods are arguments. The household is constrained by both money and time and the relevant production functions. Since education improves child quality, time spent by children in school and direct monetary outlays for education enter the production function for child quality. The reduced form demand determinants of quantity of schooling are given by:

$$S^* = F(W, P_m, P_n, V, X, Z) \qquad (1)$$

where S^* is the completed years of constant-quality schooling for a member of a particular cohort for his or her lifetime; W is a vector of wages for current household members as well as future expected earnings (conditional on schooling); P_m is a vector of market input prices (which should include the cost of borrowing for investment in human capital) and P_n is a vector of non-market prices such as travel time to school; V is nonearned household income, X describes individual and family-specific characteristics and Z represents community characteristics other than P_m and P_n.

2b. Data

Until recently, education in Pakistan had been a low priority of the national government. In 1960, public expenditure on education was only 1.1 percent of GNP; by 1992 the figure had climbed to 2.7 percent (ul Haq, 1997).[1] With such few resources devoted to education, the literacy and school attainment of the Pakistani population is not surprisingly, quite low. In 1993, only 36 percent of the adults over 15 were literate and the population over 25 had a mean attainment of only 1.9 years. In 1993, less than one-half of all primary age children were enrolled in primary school (ul Haq, 1997). Behind these national averages are substantial disparities in literacy and attainment between both men and women and rural and urban areas. For example, among people over 25 in 1992, women averaged only .7 years of school, compared to 2.9 years for men. Similarly, only 7 percent of females in rural areas were literate in 1981, compared to 35 percent in urban areas (Blood, 1995). The government of Pakistan has begun to recognize the need to mobilize resources to finance education (the Planning Commission of Pakistan in 1988).

[1] While 2.7% of GNP is certainly an improvement, note that more than 30 percent of GNP was spent on defense in 1993 and in 1990, Pakistan ranked fourth in the world in its ratio of military expenditures to health and education expenditures (Blood, 1995). On average, 4.4 percent of GNP was earmarked for education in developing countries in 1988, further highlighting Pakistan's poor investment in schooling.

Studies which focus on the factors which influence a student's final schooling level may help direct the allocation of such resources. This study is a step in that direction.

The data used in the analysis are from the *Pakistan Integrated Household Survey (1991)* or PIHS, a joint project of the World Bank and the Pakistan Federal Bureau of Statistics. Individuals from approximately 4800 households residing in 150 urban and 150 rural communities were surveyed about household composition, education, employment, health, time-use etc. Males and females were surveyed separately by male and female interviewers, respectively. In addition, community surveys were administered directly to groups of local council members and "knowledgeable individuals" in the nearest schools, health facilities and local markets. Shopkeepers were surveyed about the prices of their products, and health care workers and school officials were questioned about the characteristics of their respective facilities.

One unusual aspect of the survey is the maternal history section which provides information about the age, sex and education of all living children, and whether they currently reside in the mother's household. Such information is rare among surveys and I exploit it to examine the selection bias associated with exclusion of non-home resident children. By linking these children to their parent and household files, information about the family and community of each non-resident child is obtained.[2] Table 1 contains the

(Women in Pakistan, 1989).

[2] One shortcoming is that the survey does not ask whether the non-resident children are currently enrolled in school (and thus it is unknown whether these children should be treated as right-censored observations). In order to accommodate this shortcoming, enrollment status was predicted for the non-home resident children in the maternity file using individuals ages 5-25 from the main survey who had no parental links but claimed their mother was alive (In Appendix A, see Table A.1 for summary statistics of both samples and Table A.2 for prediction results).

summary statistics for the full sample of living children (column (a)) and also disaggregates the full sample into the non-home resident and home resident children (columns (b) and (c)).[3] On average, individuals in the full sample (a) have completed 3 years of school, yet 40% of the sample are still enrolled. 94% currently reside in the mother's household. At the mean, mothers report less than one full year of schooling, compared to fathers who have completed about 3.5 years. For the average child, the mean distance to primary school is 1.4 km., yet it is over 4 km. to middle and secondary schools. The average male wage is 1.7 times the average female wage in the full sample.

Schooling demands are analyzed separately for boys and girls. Analyzing the sample separately by sex is particularly important in Pakistan where evidence suggests that females receive less education than males (*e.g.* Bilquees and Hamid, 1989; Women in Pakistan, 1989; Burney and Irfan, 1991; Hamid, 1993; Sathar and Lloyd, 1993; Blood, 1995). Table 2 illustrates the gender disparity evident in the PIHS where enrollment rates and education level are disaggregated by sex, rural residence and province. Boys have consistently higher mean enrollment rates and school attainment, although the differences between boys and girls are most pronounced in rural areas and in the Northwest Frontier and Balochistan Provinces. For example, in the rural Northwest Frontier, 67% of the boys ages 5-14 are enrolled in school, compared to only 29% of girls in that age group; boys ages 15-25 have attained 5.6 years of schooling compared to .66 years for girls ages 15-25.

[3] Appendix C also contains a correlation matrix of the variables for the full sample.

Several factors may help explain the large gender disparity in education. Since cultural mores discourage women's participation in the labor market (especially if the job entails women working alongside men), job opportunities for women are limited in Pakistan. This may reduce the market returns to education for females (Blood, 1995; Women in Pakistan, 1989).[4] Furthermore, in rural Pakistan, the opportunity cost of sending daughters to school may be greater than for sons, as females are typically responsible for caring for younger children, gathering wood, collecting water, tending livestock and processing agricultural produce (Women in Pakistan, 1989). Daughters also join their husband's household at marriage and thus the expected benefit of educating daughters may be small relative to the expected benefit of educating sons who help provide for parents in old age (Women in Pakistan, 1989). Also, because Muslim culture encourages protection of young girls from exposure to the opposite sex once puberty is reached, the lack of all-girl schools with female teachers may be a significant deterrent to girls' continuation into middle and secondary school. Special transportation or a chaperone must often be arranged for daughters in middle and secondary schools, thereby adding to the costs of sending girls to school (Women in Pakistan, 1989). Since the household's decision to educate daughters appears to be quite different from the decision to educate sons, estimations of the demand for schooling are done separately for 7,298 (home and non-home resident) boys and 5,975 (home and non-home resident) girls ages 5-25.

The theoretical approach provides some guidance for the selection of variables to be included in an analysis of schooling attainment. The individual characteristics

[4] Note however, that two studies (Ashraf and Ashraf, 1993, 1996) found higher wage returns to education for females (relative to males) in Pakistan, which may signify a premium paid to educated females who are

included in the analysis are *age* and *age squared* which control for differences in potential attainment by age as well as changes across birth cohorts, allowing for non-linearities in the relationship between age and schooling.

Family characteristics are also important potential determinants of school attainment. If families are credit constrained, current income may influence a family's capacity to invest in child schooling (see for example, Jacoby (1994) or Lillard and Kilburn (1995)). Since family labor supply choices are determined jointly with child schooling decisions, current income is endogenous. *The value of land and property owned by the household* is specified to proxy the permanent income available for education outlays. *Mother's and father's education levels* are also included to account for genetic ability of children as well as the complementary home learning that may reduce the cost of schooling in households with better educated parents. Parent's education may also serve as a predictor of the parent's market earnings potential that could be invested in schooling. Furthermore, mothers with more education may have increased bargaining power in the household and may choose to allocate more resources toward children and their human capital than would their husbands (Thomas, 1990, 1994).[5] A dummy variable for *Muslim* is also included in the estimations (the alternative is Christian or other). Many communities have Muslim schools and it may be that the small minority of non-Muslims (3% of the sample) are limited in their school choice or perhaps place different value on education.

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willing to work in Pakistan.

[5] An interesting study by Behrman et al. (1997a) in green revolution India finds a significant effect of mother's education on the home teaching of her children, which is robust to income or bargaining power effects.

Community characteristics also affect the cost and quality of school services available to a child. An *urban-rural* indicator is included to control for the likelihood that individuals in rural areas have access to fewer schools and less qualified teachers, and may have higher opportunity costs due to farm employment opportunities or child labor needs at home. Preliminary evidence of the urban/rural disparity in enrollments and school attainment is presented in Table 2. With the exception of boys in Balochistan, enrollment rates are higher in urban areas for both sexes. Schooling levels are also consistently higher in urban regions relative to rural areas. The urban/rural disparity is also larger for girls than boys. *Distances to nearest primary*, *middle* and *secondary schools* in the community approximate the price of schooling.[6] The primary and middle school distance variables differ by sex; for girls, only the distance to the closest all-girls school is used, while for boys, the minimum distance to either an all-boys or co-educational school is included.[7] Secondary schools are not distinguished by sex in the survey. One additional community variable, a dummy for *no sewage disposal,* controls for community infrastructure. Lack of sewage disposal may also indicate hygiene practices in the area which affect one's health, a complement to learning and school attendance.[8]

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[6] If families "vote with their feet" and migrate to communities whose school characteristics best represent their preferences for schooling, then such community-defined school variables may not be exogenous (Rosenzweig and Wolpin 1988; Schultz 1988b). The survey reveals that 43.1% of adults in urban Pakistan and 31.8% of adults in rural Pakistan are living in places other than their birthplace.

[7] This is also done by Sathar and Lloyd (1993) in their estimation of the determinants of primary schooling in Pakistan. They contend that for girls, genuine access to school is equivalent to the existence of a single-sex school.

[8] See Behrman and Deolalikar (1988) for a survey of some evidence of the complementarity of schooling and health

Wages should also affect schooling outcomes, although the direction of the effect is unclear. Higher wages imply greater resources for current education expenditure as well as higher expected future earnings, thus increasing the demand for child schooling. On the other hand, higher wage rates may lead parents to substitute their time away from home to the labor market, reducing the complementarity of children's home and school learning, and thereby lowering children's final attainment. If higher wages are also paid to young workers, children may be drop out of school and enter the labor market at earlier ages, further depressing final school attainment. Only 7% of women ages 10-45 report a wage in the PIHS and thus *average female wage* was estimated for each of the four provinces to ensure adequate sample size. *Average male wage* was estimated for each of the 103 strata or regions.[9]

Province indicators control for the differences in geography, culture and people of Pakistan. Provincial governments are responsible for the organization and support of their own education system, and some of this variation may be captured by the provincial dummies. Pakistan is a federation of four provinces primarily defined by the four dominant languages of the country. *Punjab*, the omitted category, is the wealthiest province, characterized by fertile, irrigated land and developed urban centers. About 58% of the population lives in Punjab, although it contains only 26% of Pakistan's land area (Ahmad and Qureshi,1990). Its landed elite predominate in the upper echelons of the military and civil service and form a majority of the central government (Blood,1995). In

[9] Each household is assigned a male and female average wage that excludes that specific household from the calculation to ensure exogeneity of the wage variables.

terms of expenditure on education, 12.8% of Punjab's current capital budget in 1990-91 was allocated toward education, most of which was earmarked for building new or upgrading existing school buildings (Ahmad and Qureshi,1990). *Sind* is a province marked by both desert and fertile plains. The fertile regions are inhabited by big landowners and tenant cultivators as opposed to Punjab which consists of more small farmers. 18% of the Sind current capital budget was earmarked for education in 1990-91, of which 44% was specifically set aside for improving primary education (Ahmad and Qureshi, 1990). The *Northwest Frontier* province is a mountainous region with very small areas available for cultivation, animal grazing or forestry. It is inhabited by ethnically diverse tribal societies who are not well represented in the federal government. Feuding among tribes and violence is not uncommon in the province. One notable characteristic of the Northwest Frontier is the common practice of *purdah*, where women are restricted to private, family compounds in order to ensure purity of wives, mothers, and daughters and thus a man's honor (Blood,1995). With respect to education in particular, the Northwest Frontier allocated 22.46% of its 1990-91 current capital budget to education (Ahmad and Qureshi, 1990). USAID has also identified the Northwest Frontier province as one of the areas in Pakistan in need of more schools. It has initiated a special primary educational development program in which 3330 new primary schools will be built in the province between 1990-2000 (Ahmad and Qureshi, 1990). *Balochistan* is a large mountainous desert region that is sparsely populated by nomadic tribes. The land is "inhospitable" and geologists have likened the landscape to Mars (Blood, 1995). The province is often referred to as underdeveloped or backward (i.e. Ahmad and Qureshi, 1990). Only 8.3% of the Balochistan current capital budget was allocated to education in 1990-91, the lowest of all four provinces (Ahmad and Qureshi, 1990). Estimates of the educational expenditure per individual ages 5-24 suggests that the Northwest Frontier province spends the most with.08 rupees/school-age child, followed by Sind (.06), Punjab (.04) and finally Balochistan (.03).[10] Educational outcomes in all four provinces from the PIHS 1991 are illustrated in Table 2. In general, Punjab exhibits the highest enrollment rates and mean education levels, while Balochistan has the lowest.

2c. Model Specification and Empirical estimation

Ideally, a researcher analyzing the determinants of schooling would like to account for the final schooling level an individual attains and know the environment each lived in when the sequence of schooling decisions were made. Unfortunately, most surveys provide little information about where the adults in the sample grew up. The factors which influence adult schooling are therefore unknown (e.g. family income, community wages, distances to school, etc.). Research that concentrates on the determinants of child schooling has two advantages. First, using children as the unit of observation permits the use of information about the current parental, household and community characteristics, and thus the environment in which the schooling decisions are made. Second, because many developing countries are experiencing rapid expansions and structural change in their education systems, birth cohort differences are evident and the study of current child schooling is most relevant to policy. To use the current generation

[10] To approximate province-specific population levels for 1990-91, data from the last available Pakistan census (1981) was adjusted by the population growth rate for each province from 1972-81 (Pakistan Statistical Yearbook, 1994; Statistical Pocketbook of Pakistan, 1995).

of children in an analysis of schooling requires that both the censoring of final schooling for enrolled children and the selection problem arising from sampling home-resident children be addressed.

Further limitations are imposed by the data. First, surveys measure schooling by the "years of education attained". While the desired level of schooling may be continuous, the researcher only observes education level in discrete (non-negative) year intervals. Second, there is often a large mass point at zero years of schooling and similar probability spikes at primary and secondary completion levels where matriculation to the next level is impeded by fees or entrance examinations.[11] Ordinary least squares (OLS) estimation is thus inappropriate due to the non-negative restriction, the discreteness and the probability spikes of the schooling variable. Most studies have however used OLS to estimate the determinants of schooling (for example, Barros and Lam, 1992; Birdsall, 1980;1982;1985; Chernichovsky, 1985; Behrman and Wolfe, 1987; Handa, 1996; Jamison and Lockheed, 1987; Knight and Shi, 1996; Parish and Willis, 1993; Wolfe and Behrman, 1984;1986; Case and Deaton, 1996). One recent study by Tansel (1997) accommodates the spike at zero by estimating a probit for primary, and two-limit Tobits for secondary and higher education, but the Tobit specification fails to account for the discreteness of observed schooling in the continuous observed range. Lastly, (to be developed further in Section 3a), the model employed should account for the right-censored observations of enrolled students. The estimation strategy that best deals with the non-negative restriction, the discreteness, the spikes and the right-censoring is the censored ordered probit model proposed by King and Lillard (1983;1987) and

[11] In the PIHS 54% of 15-20 year old girls and 24% of 15-20 year old boys in Pakistan have never attended school. Figure 1 suggests that in Pakistan, the distribution of completed schooling has probability spikes at

subsequently used by Glewwe and Jacoby (1992), Alderman et al (1995) and Behrman et al. (1997).

The censored ordered probit framework is estimated in the following way:

Define S^* as the desired level of schooling, a continuous variable which depends linearly upon the observed regressors, x, and a residual term, ε: [12]

$$S^* = \beta' x + \varepsilon \qquad (2)$$

In practice, we do not observe desired schooling S^*. For those individuals who have finished schooling (*uncensored observations*), we observe a discrete level of completed education, S, where

$$\begin{aligned} S &= 0 \quad \text{if} \quad S^* \leq \mu_0 \\ &= 1 \quad \text{if} \quad \mu < S^* = \mu_1, \\ &= 2 \quad \text{if} \quad \mu_1 < S^* = \mu_2, \\ &\;\;\vdots \\ &= J \quad \text{if} \quad \mu_{j-1} = S^*. \end{aligned} \qquad (3)$$

Thus, the μ's are threshold parameters which denote a transition from one year of schooling to the next. For example, the probability that a non-enrolled individual is observed to have completed two years of school (S=2) is the probability that the value of the latent schooling attainment function, S*, lies between μ_1 and μ_2. Under the assumption that ε is distributed normally, we have

$$\begin{aligned} \text{Prob}(S=0) &= \Phi(\mu_0 - \beta' x) \\ \text{Prob}(S=1) &= \Phi(\mu_1 - \beta' x) - \Phi(\mu_0 - \beta' x) \\ \text{Prob}(S=2) &= \Phi(\mu_2 - \beta' x) - \Phi(\mu_1 - \beta' x) \\ &\;\;\vdots \\ \text{Prob}(S=J) &= 1 - \Phi(\mu_{j-1} - \beta' x). \end{aligned} \qquad (4)$$

The likelihood function for uncensored observations, L_u, is thus

years 5 and 10 (primary and secondary completion).

$$L_u = \Phi(\mu_s - \beta' x) \qquad \text{for } S = 0 \qquad (5)$$

$$L_u = \Phi(\mu_s - \beta' x) - \Phi(\mu_{s-1} - \beta' x) \qquad \text{for } S = 1...J-1$$

$$L_u = 1 - \Phi(\mu_{s-1} - \beta' x) \qquad \text{for } S = J$$

For individuals still enrolled (*censored observations*), the number of completed years of schooling is unknown but desired level of schooling, S^*, is greater than observed years S; hence,

$$S^* > \mu_{s-1} \text{ which implies that } \varepsilon > \mu_{s-1} - \beta' x \text{ for } S = 0 \ldots J$$ [13]

Thus, the likelihood of the censored observations, L_c, is thus the probability that the error, ε, exceeds $\mu_{s-1} - \beta' x$ and is calculated as:

$$L_c = 1 - \Phi(\mu_{s-1} - \beta' x) \qquad (6)$$

Multiplying all the likelihood expressions, for both the uncensored and censored observations, gives us the likelihood for the sample:

$$L = \Pi\, L_u\, \Pi\, L_c. \qquad (7)$$

Thus, the ordered choice aspect of the model accommodates the non-negative restriction, the probability spikes and the discreteness of schooling, and by allowing the enrolled students to enter the likelihood function separately from those who have completed their schooling, the model allows for the right-censoring issue.

Empirical Estimations

Table 3 presents the censored ordered probit estimates for all 5-25 year old, home and non-home resident boys (column (a)) and girls (column (b)). As Table 3 suggests, the signs of most of the regressors are as predicted. In column (a), *older* boys attain significantly more schooling but at a decreasing rate, higher *mother's and father's*

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[12] For ease of presentation, subscripts denoting the individual have been omitted.
[13] For S=0, μ_{-1} is equivalent to $-\infty$.

education significantly increases the education of their sons, as does higher *household landholdings and property*. Being *Muslim* significantly increases final attainment of boys, relative to adhering to Christianity or other religious beliefs. Having *no sewage disposal* system in the community is significantly associated with less schooling. The *distance to the nearest primary school* bears no relation to boys' years of schooling but the *distances to middle and secondary school* are significantly and negatively related to educational attainment. The *average female wage* reduces boys' school attainment while the *average male wage* is positively and significantly related to their schooling level. Lastly, relative to Punjab, boys living in the *Northwest Frontier* or *Balochistan* have significantly higher schooling levels.

Many of the above patterns are evident in the girls sample as well (column (b), Table 3). *Older* girls attain significantly more education, at a decreasing rate. *Both mother's and father's education* are important factors in increasing their daughter's education. *The value of land and property* has a significant and positive effect on girls' schooling, as does *Muslim* status and the *average male wage*. *Rural residence* has the expected negative and significant influence on female attainment, as do *no sewage disposal* in the community and *distances to middle and secondary school*. Like boys, *distance to primary school* does not appear to affect girls' schooling.

A few differences between the results for girls and boys deserve emphasis. For example, while positive and significant for both, the effect of *mother's education* is greater for girls than for boys. Furthermore, for girls, the magnitude of *mother's education* is greater than for *father's education*, while the reverse is true for boys. *Rural residence* significantly decreases girls' attainment as expected, but recall it has no effect on boys' attainment. *The lack of sewage disposal* in the community is less associated with the schooling of boys compared to that of girls, although the coefficient is significant and negative in both samples. The *average female wage* has no effect on girls' schooling while it is a significant and negative determinant of boys' schooling. Furthermore, the wealth effect on attainment is much larger for girls; the magnitudes of the coefficients for *land and property* and the *average male wage* are two to three times higher in the girls' sample than the boys'. Lastly, while none of the province indicators are significant in the girls' sample, living in the *Northwest Frontier or Balochistan* province (relative to Punjab) is positively associated with schooling attainment for boys.

Figure 1 shows the distribution of schooling attainment in Pakistan for individuals ages 15-20, by sex. Note the increased frequencies at years 1, 5 and 10 years. Furthermore, although not shown in Figure 1, 54% of females and 24% of males in this age group have zero years of education, adding another spike in the distribution. Such non-linearities suggest that the above censored ordered probit specification is an improvement over the typical OLS (linear) specification. Figures 2a and 2b plot the estimated thresholds (μ's) from the censored ordered probit model for boys and girls (from columns (a) and (b) in Table 3). The thresholds increase in a non-linear fashion, with steeper ascents at the end of primary school (year 5) and the end of secondary school (year 10). The non-linearity is particularly evident in the girls sample, justifying the use of the non-linear ordered choice framework.

Comparison to previous work on schooling in Pakistan

Some of the results above may be compared to previous studies of educational outcomes in Pakistan. The significant positive association between household income and schooling outcomes has appeared in several studies; for example, a series of studies using the International Food Policy Research Institute (IFPRI) 1989 survey of four rural regions in Pakistan found evidence of the positive impact of household income on schooling attainment (Alderman et al., 1995, 1996; Behrman et al., 1997) as did the studies by Burney and Irfan (1991) which utilized the 1979 Population, Labor Force and Migration national survey and by Sathar and Lloyd (1993) which employed the PIHS 1991.

The relationship between parental education and child schooling is less conclusive in previous studies of Pakistan. While I found a positive and significant effect for both mother's and father's education on both boys' and girls' education, King et al (1986), using the 1979-80 Asian Marriage surveys, found a clear positive effect of father's education on both sexes, but no significant effect of mother's education on boys' schooling and a significant effect for girls only in the middle class, urban sub-sample. This is similar to several studies which used the 1989 IFPRI survey of rural Pakistan. Alderman et al (1995;1996) and Behrman et al (1997) found no effect of mother's primary schooling on child school attainment, although the sample of mothers reporting any primary education was small. Two of the IFPRI studies found a significant and positive association between father's schooling and children's education (Alderman et al 1995, Behrman et al, 1997) but a third found no significant association when child's attainment was conditioned on starting school (Alderman et al, 1996). Burney and Irfan (1991), using the 1979 Population, Labor Force and Migration survey, found a positive and significant effect of both parent's education on school enrollments and in general found father's education to have a greater effect. Lastly, Sathar and Lloyd (1993), using the PIHS 1991, showed that whether a mother ever attended school was a positive and significant predictor of children's primary school completion while father's literacy was unrelated.

The effects of school supply characteristics are similarly inconsistent across previous studies. Recall that this study found no effect of primary school distance but a negative and significant effect of middle and secondary school distances on both boys' and girls' schooling. In contrast, Alderman et al (1996) found that the distance to primary school had a surprising positive association with school attainment for those who began school, yet the distance to middle school was unrelated. Sathar and Lloyd (1993) found that having a public school less than one kilometer away was unrelated to primary school completion and had a significant and positive effect on primary school attendance for rural girls only. Burney and Irfan (1991) found that the presence of a school in the village had no effect on the probability of enrolling in school. On the other hand, results from Alderman et al. (1995, 1996) and Sabot (1992) suggest a significant role of school supply on cognitive achievement, perhaps the most important product of schooling. Using the rural IFPRI survey of 1989, Alderman et al (1995) in particular show that at least 40 percent of the gender and regional gaps in literacy and numeracy tests are associated with gender and regional disparities in local school availability.

3. *Empirical Issues: Censoring and Sample Selection*

The estimation described in Section 2c accounts for right-censoring of enrolled children and includes children who have already left the home. It is considered the preferred framework. The following sections explore the implications of neglecting these issues in terms of both censoring and sample selection bias in the estimation of the demand for child schooling.

3a. Censoring of final attainment for enrolled children

Children who are still enrolled in school pose a potential problem for researchers since for these children, final attainment is unknown but is greater or equal to current completed years. Several techniques have been used previously to deal with these right-censored observations. One approach is to define the samples to include only those above the age of likely school completion, thus limiting samples to older populations and throwing away many younger observations (Alderman et al, 1996; Beller and Sin Chung, 1992; Knight and Shi, 1996; Lazear, 1977; Leibowitz, 1974;Tansel, 1997).[14] The elimination of these observations may be less satisfactory for low-income countries experiencing rapid change in enrollments and attainment. For example, in Pakistan, the mean education of females ages 15-20 is 3.53 years, while for the female cohort ages 25-30 it is only 2.03 years, implying that mean education increased nearly 75% in one decade (PIHS 1991). Also, since many household surveys do not inquire about the childhood environment of adults, as the minimum age for included observations rises,

[14] Lazear (1977) and Knight and Shi (1996) may have introduced some selection bias in their respective samples. Lazear used a sample of 1969 US individuals aged 17-27, but excluded those who were attending school during the survey or two years previous, an exclusion based on endogenous schooling choice. Knight and Shi (1996) restricted their China sample to individuals age 16 to 30 who completed their education, similarly eliminating most of the individuals who are likely to attain the highest levels of education.

selective migration out of the parental home may introduce bias in the schooling demand equation (discussed in Section 3b).[15]

Studies that include younger children commonly attempt to control for incomplete schooling by incorporating age and perhaps age squared as covariates in an ordinary least squares regression of schooling attainment (for example, Anderson et al. 1995; Birdsall, 1985; Behrman and Wolfe, 1987; Handa, 1996, Case and Deaton, 1996). While age may explain much of the difference in attainment between young, enrolled children and older individuals who have completed schooling, it does not eliminate the censoring problem since it does not distinguish between completers and non-completers.[16] The usefulness of age as a control for incomplete schooling is further complicated in low-income countries where frequent late entry, repetition and sporadic school attendance reduce the power of age as a predictor of attainment. Research on the determinants of repetition, late entry and sporadic attendance is sparse, but some evidence suggests the frequency of such occurrences may be substantial in some low income countries In 1985, the median repetition rates of primary students were about 16% in low income countries and 11% in lower middle income countries. Furthermore, the median difference between the student-years needed per graduate and the years in the primary school system in low-income countries is a striking *four* years(where the average primary school cycle in developing

[15] If we consider a migrant as anyone that has moved away from their birthplace, then the average age at which males (ages 15-25) migrate is 11 years and the average age at which females (ages 15-25) migrate is thirteen years. Approximately 18% of individuals ages 15-25 claimed to be migrants. Overall, 35% of adults in Pakistan claim to be migrants.

[16] Consider an analysis on two twelve year old children, one who is enrolled and one who has already dropped out. Age as a control does not eliminate the censoring issue since both children are still treated identically in the estimation.

countries is six years), suggesting the widespread existence of repetition in these countries (Lockheed and Verspoor, 1991).

Evidence from the PIHS suggests that repetition and late enrollment are frequent in Pakistan. Table 4 illustrates the percentage of all currently enrolled children in each grade level, by age in Pakistan. Highlighted are the grade levels for which a student of a given age is considered to be "on time". Students falling in categories to the left of those highlighted are considered "lagging behind".[17] As is clear from Table 4, late entry and repetition appear to be commonplace in this Pakistani sample - by age eight, 66% of those enrolled in the sample are below their expected grade. Clearer evidence of late entry is presented in Figure 3, which displays the proportion enrolled by age and sex. If all individuals entered at the same age but dropped out at different levels, we would expect to see maximum enrollment at age 6, with a gradual decline thereafter. Instead, enrollment rates increase up to age 11 for males and age 9 for females which suggests that late entry is not uncommon. Thus relying on age as a control for differences in expected enrollment level may have weak justification.

Another method to deal with unobserved completed schooling has been to standardize by constructing an 'age and sex specific schooling index'. For example, "the ratio of child schooling to the mean schooling of children in the relevant age-sex group" has been used as the dependent variable in attainment regressions by both Birdsall (1982) and Wolfe and Behrman (1986). A closely related schooling index is used by Wolfe and

[17] Note, I have considered students to be "on-time" for two grade levels at each age group to account for children who may have birthdays at the end of the school year. For example, children who were 4 at the start of the school year would not be enrolled in grade one, but at the time of the survey they may have already turned five. Having zero years of school is still "on-time" for these children.

Behrman (1984) in which child's schooling is normalized by "eligible years of schooling" rather than "mean schooling of age/sex cohort". In a similar vein, Jamison and Lockheed (1987) use deviations from mean cohort schooling as the dependent variable in their regression analysis. However, similar to controlling for age as a covariate, for enrolled students, each of these measures reflects lagging behind or surpassing one's classmates in attainment, rather than incomplete schooling spells. Furthermore, lags at younger ages depress the ratio-form indices more than lags at older ages. Again, the common occurrence of repetition and late entry suggests that these relative schooling measures may be a particularly poor choice in low-income countries.

Another approach to the measurement of schooling attainment is done by Barros and Lam (1993) in which the Brazilian census sample was limited to 14 year olds, an age group that is required to attend school. Their goal was to estimate the determinants of schooling attainment of 14 year olds, rather than final attainment. However, it is not clear whether this indicator of schooling is a good predictor of completed schooling, nor whether this outcome even enters the household utility function.

Chernichovsky (1985) addressed the censoring issue by separately estimating the determinants of schooling for enrolled and non-enrolled 6-18 year olds in Botswana, but without correcting for the selection bias in either set of estimates.

As mentioned in Section 2c, King and Lillard's (1983; 1987) ordered multinomial choice model allows complete and incomplete spells to contribute separately to the likelihood function and consistent and unbiased estimates of the coefficients are achieved. Their technique which has the most attractive properties, to my knowledge has been used in only a few previous studies (Alderman et al, 1995; Behrman et al, 1997; Glewwe and Jacoby, 1992).

The implications of failing to properly distinguish between completers and enrollees are known for OLS estimation, which is the most common form of analysis in previous studies. It can be shown that if the independent variables are normally distributed, then not accounting for censored observations and applying OLS introduces a proportional downward bias in all variable coefficients. Consider the following true model for completed schooling in years, S^*, which is a linear function of some vector of individual *i's* characteristics, X_i:

$$S_i^* = \beta' X_i + \varepsilon_i, \text{ where } \varepsilon_i \sim N(0, \sigma^2). \tag{8}$$

For children who are no longer in school (and assuming no re-entry), final school attainment is equal to currently observed grade level ($S_i^* = S_i$). For children still enrolled in school, final attainment is not known ---only current grade, S_i, is observed. If we assume children finish the currently enrolled grade, then observed schooling is necessarily less than or equal to final level ($S_i \leq S_i^*$) for enrolled children. Thus, for those enrolled, final schooling is censored at the individual-specific censoring point, c_i. We have the following censored model:

$$\begin{aligned} \text{Completers: } S_i &= \beta' X_i + \varepsilon_I \quad \text{if } S_i^* < c_i \\ &= S_i^* \\ \text{Enrollees: } S_i &= c_i \quad \text{otherwise} \end{aligned} \tag{9}$$

A transformation of the variables allows us to use the results obtained by Greene (1981) to characterize the bias associated with failing to treat incomplete observations as censored. Define:

$$\underline{S}_i = c_i - S_i, \tag{10}$$

$$\underline{X}_i = \begin{bmatrix} X_i \\ c_i \end{bmatrix} \text{ and } \underline{\beta} = \begin{bmatrix} -\beta \\ 1 \end{bmatrix}$$

so that we have the familiar censored regression model or right-censored Tobit:

$$\text{Completers:} \quad \underline{S}_i = \underline{\beta}'\underline{X}_i + u_i \quad \text{if RHS} > 0 \tag{11}$$

$$\text{Enrollees:} \quad \underline{S}_i = 0 \quad \text{otherwise}$$

A closed form solution for the bias of OLS estimation of $\underline{S}_i$ on $\underline{X}_i$ for all observations is obtained under the assumption that the independent variables are distributed normally. Greene (1981) shows that when all observations (both enrolled and completed) are estimated together by OLS, we can expect that the

$$\text{plim } \underline{\beta}^{OLS} = \Phi(\underline{\beta}'\underline{X}_i/\sigma)\underline{\beta}. \tag{12}$$

Thus, sufficiently large values of $\underline{\beta}'\underline{X}_i/\sigma)$ imply Φ close to 1 and relatively small bias, as would occur if $\underline{S}_i > 0$ occurs frequently or, in other words, most children have completed schooling. Similarly, small values of $\underline{\beta}'\underline{X}_i/\sigma)$ imply Φ close to 0, and large downward bias, as $\underline{S}_i = 0$ occurs more frequently and most children are currently enrolled in school. The main result is that every element of $\underline{\beta}$ is estimated with the same proportional downward bias, and the magnitude of the bias grows with the frequency of censored observations.

In the present case, the assumption that the conditioning variables are distributed normally is unrealistic and thus, the expected attenuation bias might not be strictly proportional in practice. One can still examine the censoring bias by estimating the schooling equation using both OLS and a right-censored Tobit. I expect smaller coefficients in the OLS specification relative to the Tobit and more censoring bias in the estimates for males compared to females since a larger proportion of males are enrolled.[18]

[18] 51 percent of boys in the sample are still in school compared to only 34 percent of girls.

Table 5 contains OLS and right-censored Tobit estimates of the determinants of schooling for both home and non-home resident boys and girls, ages 5-25. Results in the table indicate that Greene's prediction regarding attenuation bias was generally correct for both samples. With the exception of a few coefficients which are insignificant, the OLS parameter estimates are closer to zero when compared to the Tobit coefficients. Marginal effects for the Tobit estimations are also included in Table 5. The marginal effects are obtained by scaling the Tobit coefficients by the probability that an observation is uncensored:

$$\frac{\partial E(S_i|X_i)}{\partial X_i} = \beta[\mathrm{Prob}(S_i^* < c_i)] = \beta\left[\Phi\left(\frac{c_i - \beta' X_i}{\sigma}\right)\right] \tag{13}$$

Since c_i, the censoring point, is only known for enrolled (or censored) individuals, the proportion of the sample still enrolled is used as a consistent estimator for the probability that an observation is uncensored.[19, 20]

$$\frac{\partial E(S_i|X_i)}{\partial X_i} = \beta\left(\frac{n}{N}\right) \tag{14}$$

where n is the number of individuals currently enrolled in school and N is the sample size.

[19] The fact that c_i is unknown for completers is not problematic for the empirical estimation of the Tobit coefficients. It is only necessary to define a dummy variable which indicates that an observation is censored (in this case, enrolled=1,0).

[20] Note that the latter approximation does not depend upon normality of the independent variables.

For the boys sample (column (a), Table 5), a comparison of the OLS and Tobit estimates reveals that, while positive and significant in both models, *mother's education* becomes noticeably more significant with a marginal effect almost four times as large with proper treatment of censored students.[21] The marginal effect of *the distance to middle school* also increases more than seven-fold with the censoring accounted for in the Tobit.

Column (b) in Table 5 contains the comparison of the OLS and right-censored Tobit estimates for the sample of girls. First, note that the dummies for the *Northwest Frontier* and *Balochistan provinces* lose significance in the Tobit specification. Also, as witnessed in the boys' sample, *mother's education* becomes noticeably more significant in the Tobit framework with a marginal effect more than double its counterpart in the OLS estimation.

Because the ordered choice specification is the preferred model, it is useful to compare the estimates of an ordered probit done with and without treating enrolled children as censored.[22] Table 6 presents results of ordered probit and censored ordered probit estimations of schooling attainment for boys and girls ages 5-25 (both home and non-home resident). In the boys' sample (column (a)), when censoring is accounted for in the censored ordered probit specification, a stronger effect of *mother's education* is again seen - the coefficient increases by a factor of four. The *average female wage rate, and the Northwest Frontier and Balochistan dummies* also become significant with proper treatment of censored observations in the ordered choice framework. There are no

[21] Since the cov(β^{OLS}, β^{Tobit}) is unknown, it is impossible to make a definitive statement regarding the significance of the difference between the two models.
[22] Since ordered probits do not fit a conditional mean, nothing can be said about the expected censoring bias in the ordered probit framework. The coefficients and marginal effects can still be compared across the

changes in significance across coefficients in the girls' sample (column (b)), yet the noticeably larger significance of *mother's education* in the censored model is again noted.

A comparison of the marginal effects between the two models is also insightful.[23] In both the ordered probit and the censored ordered probit, marginal effects of the independent variables are computed for each year of schooling. Table 7 displays the marginal effect of each independent variable on the probability of having zero and five years of education for both models and for boys and girls separately. For boys, at zero years of education, the marginal effects are generally similar across the two specifications, except perhaps for *mother's education*, *rural residence, the average female wage* and the provincial dummies. By year 5, however, large differences in magnitude and sign of the marginal effects appear. For girls, again the difference in the marginal effects of *mother's education* and the provincial dummies are seen as early as zero years of education. While the magnitudes of the marginal effects for 5 years of schooling begin to diverge in the girls sample, only *average female wage* changes sign.

A closer look at the differences in the marginal effects is possible. Recall in the boys' sample that the coefficient for *mother's education* increased by a factor of four when censoring was accounted for in the ordered probit specification.[24] Figure 4 shows

models.

[23] Again, since the $cov(\beta^{O.P}, \beta^{C.O.P.})$ is unknown, no definitive statement can be made regarding the significance of the difference between the two models.

[24] A similar four-fold increase in the marginal effect was observed with censoring accounted for in the OLS-Tobit comparison for boys.

the differences in the marginal effect of *mother's education* on boys' schooling for the ordered probit and censored ordered probit models. In the censored ordered probit, the marginal effect of *mother's education* on boys' schooling is much greater than in the ordered probit at zero years and years 10 and beyond.

Lastly, for a select group of conditioning variables, Table 8 summarizes the changes in the expected value locus for the OLS, Tobit and the ordered and censored ordered probit models. For the OLS and Tobit models, the change in expected schooling for a one unit change in the conditioning variable is given by the OLS coefficient and the Tobit marginal effect, respectively. For the ordered choice models, it is given by:

$$\frac{\partial E(S_i|X_i)}{\partial X_i} = \left(\frac{\partial(\Pr ob(S_i=0))}{\partial X_i}\right)*0+\left(\frac{\partial(\Pr ob(S_i=1))}{\partial X_i}\right)*1+\ldots+\left(\frac{\partial(\Pr ob(S_i=15))}{\partial X_i}\right)*15. \quad (15)$$

Several aspects of Table 8 deserve mention. First, the "censoring effect" can be seen as the difference in the changes in expected schooling predicted by changes in the conditioning variables between the OLS and Tobit estimates, and between the ordered and censored ordered probit models. For both boys and girls, the censoring effect appears to be stronger in the ordered choice comparison; for many of the covariates, the change in expected schooling nearly doubles when censoring is accounted for in the censored ordered probit. Another insight from Table 8, for both boys and girls, is the large difference in magnitude between the changes in expected value calculated by OLS and the censored ordered probit. For example, for boys, the change in the expected value of schooling induced by increasing *mother's education* by one year is 7 times as large in the censored ordered probit model as it is in the OLS framework. For girls it is nearly 3 times as large. Clearly, then, the choice of framework used to estimate schooling attainment has a large impact on the predictions of the model and the censoring effect appears to be non-trivial in this case, particularly in the ordered choice specification. The next section shows that the sample chosen for estimating the demand for schooling will also significantly influence one's results.

3b. Selection bias on children currently residing in the home

It is plausible that the decisions to attend school and to remain in the parental household are related. Table 9 reports probit estimates of the determinants of leaving home for boys and girls ages 5-25. For boys (column (a)*father's education, average male wage*, *distance to middle school*, and the*percentage of households which own land in the community* are significantly and negatively associated with leaving home*Rural family residence* significantly increase a male's probability of leaving home. For girls (column (b)), *age* significantly increases the probability of leaving home (at a decreasing rate), as do *percent of males in the community* and *distance to primary school.* Higher *mother's and father's education* as well as*family wealth* and *average male wages* in the community significantly reduce the likelihood of girls leaving home. Many of these factors are also significant determinants of educational attainment. Since the factors we observe influence both the decision to leave home and one's educational attainment, it seems likely that the unobservable determinants of both outcomes are also related. The close relationship between leaving home and educational attainment suggests that home-resident children may not be a random sample of all children. For example, if the least able or least motivated children (two unobserved characteristics) tend to leave home at an earlier age and are less likely to attend advanced schools, then the correlation between the errors in the home leaving and school attainment equations will lead to sample selection bias when schooling is estimated for home-resident children only. These biases may also differ by sex, if for example, only the less motivated boys who drop out of school stay at home, while the less motivated girls who drop out of school leave home and get married.

The following describes the potential bias introduced into the estimation of schooling demand when children not residing at home are excluded from the sample (Greene, 1993). Let h_i^* be a latent variable for residing at home and let w_i be the vector of independent variables determining child *i's* decision to stay at home so that:

$$h_i^* = \gamma' w_i + u_i. \qquad (16)$$

We observe the child staying at home, $h_i = 1$, if $h_i^* > 0$, otherwise we observe the child residing elsewhere, $h_i = 0$. If we assume that the error term u_i, is distributed normally with mean zero and unit variance then the probability that the child is observed living at home is given by

$$\text{Prob}(h_i = 1) = \Phi(\gamma' w_i), \qquad (17)$$

and the probability that the child is observed not living at home is given by.

$$\text{Prob}(h_i = 0) = 1 - \Phi(\gamma' w_i). \qquad (18)$$

Let S_i be the observed years of schooling which is a function of regressors X_i, and which is observed only if the child resides in the home. Thus we have

$$S_i = \beta' X_i + \varepsilon_i \qquad \text{observed only if } h_i = 1. \qquad (19)$$

Sample selection bias arises if we believe there exists some correlation among the errors, u_i and ε_i in equations (16) and (19). For example, if we assume that $(u_i, \varepsilon_i) \sim$ bivariate normal $(0, 0, 1, \sigma_\varepsilon, \rho)$ then ρ is a measure of the correlation among the errors. The correlation between the two errors will be positive, if for example, being highly motivated or having high genetic ability increases both the probability of staying home and one's educational attainment. We can now see the bias introduced by looking at the mean of the completed education distribution, conditional on the child residing in the home:

$$E\,(S_i | \, h_i = 1) = \beta' X_i + \rho\sigma_\varepsilon\lambda(\gamma' w_i) \qquad \text{where } \lambda = \frac{\phi(\gamma' w_i)}{\Phi(\gamma' w_i)} \tag{20}$$

and $\phi(.)$ and $\Phi(.)$ are the probability and cumulative density functions for the normal distribution. The conditional mean is thus higher than the unconditional mean if ρ is positive, and lower if ρ is negative. If not corrected, the effect of sample selection may be likened to omitted variable bias, where $\lambda(\gamma' w_i)$ can be viewed as the omitted variable. Redefining $\Psi = \rho\sigma_\varepsilon$ (noting that the sign of Ψ is determined by the sign of ρ) and simplifying $\lambda(\gamma' w_i)$ to λ, we have an unbiased specification of the regression model for the educational attainment of our selected sample:

$$S_i = \beta' X_i + \Psi\lambda + v_i. \tag{21}$$

However if we omit λ and simply regress X_i on S_i, the estimator becomes

$$b = \beta + (X'X)^{-1}X'\lambda\Psi + (X'X)^{-1}X'v. \tag{22}$$

Thus, even if the included regressors, X_i, are orthogonal to the error, v_i, the existence of a correlation between X_i and λ results in a biased estimate of β, with the direction of the bias determined by the sign of the second term in (22). Many of the same regressors are found in both w_i and X_i and because λ is a nonlinear transformation of $(\gamma' w_i)$, a non-zero correlation between X_i and λ is anticipated. Furthermore, the non-zero correlation in the error terms in (16) and (19) ($\rho \neq 0$) leads to a non-zero Ψ, further complicating the bias.

There are few discussions of this form of bias. Some studies had access to information on all living children and were not faced with the problem (Tansel, 1997; King and Lillard, 1983, Glewwe and Jacoby, 1992, for example). Most studies do not mention the possibility of bias nor whether their samples consisted of all children or only those in residence. Birdsall (1985) is an exception - she acknowledges the possibility of bias and drops children over the age of 15 to reduce the probability that some children have left the household. Her approach increases the censoring bias however, as it increases the proportion of the sample still enrolled. Behrman et al (1997), Birdsall (1980), Burney and Irfan (1991), Handa (1996), Knight and Shi (1996), and Case and Deaton (1996) use children resident in the household and do not correct for potential selection bias. Jamison and Lockheed (1987) use data on household children as well and re-define children to be any young relative of the household head (including grandchild, niece and nephew).[25]

The presence of selection bias can be detected in the PIHS using the data on all living, home and non-home resident children in the maternal history file. Figure 6 shows the proportion of children who have left the mother's household by sex and age. One can see that the potential for selection bias is greater for girls since by age sixteen, 20% have already left the home. Table 1 compares the summary statistics for children

[25] Such an all-encompassing definition of a household child may complicate the bias since the family's and head's characteristics are attached to both own children and those who have migrated to the relevant household. Furthermore, it is possible that households which "attract" foster children are over-represented in their sample.

who have left the home with those who are living with both parents. Children who have left home are significantly more likely to be female, older, less educated, have less educated and less wealthy parents, and are more likely to live in rural areas in which primary and middle schools are farther away. Average male and female wages are also significantly lower for children who have left home, and they are more likely to come from the Northwest Frontier province but less likely to come from Balochistan.

A test for selection bias in the estimation of schooling attainment of home-resident children is done by introducing an additional set of regressors which capture the effect of residing at home. In addition to the independent variables included in the previous estimations, a dummy variable for living at home (*home)* and its interaction with each of the covariates (e.g. *home*age*, *home*mother's education*, etc.) have been added to the OLS and censored ordered probit specifications:

$$S_i = \beta' X_i + \gamma' \mathit{home}_i + \delta' (\mathit{home}_i * X_i) + \varepsilon_i \qquad (23)$$

A likelihood ratio test of the joint significance of the "home terms" tests for the existence of selection bias. Under the null hypothesis, γ and δ are jointly not significantly different from zero, indicating no selection bias exists. Rejection of the null implies the presence of selection bias and therefore that estimation of the full sample of home and non-home resident children yields significantly different results from estimation on home resident children alone. While I consider the censored ordered probit the best specification, I also perform this exercise using OLS to see if the OLS estimates, which dominate the literature on schooling attainment, are also prone to selection bias.

Appendix B contains the results of the estimation of equation (23) using both OLS and censored ordered probit specifications, for boys (Table B.1) and girls (Table B.2) respectively. Table 10 presents the results of the likelihood ratio tests described earlier. Clearly, for both boys and girls, and for both models, the null hypothesis that the coefficients on all the "home" terms are jointly equal to zero is rejected. Thus, studies which omit children who have left the parent's household are subject to selection bias. If we assume that the models are estimated with the same level of precision for both boys and girls, then it appears that the selection bias is more pronounced in the girls' sample, as evident by the much larger likelihood ratio statistics. This was expected since leaving home before age 25 is a phenomenon that occurs much more frequently among females in Pakistan (see Figure 6).

4. *Conclusion*

When defining a sample for the estimation of the determinants of school attainment, a researcher faces several obstacles. Adults, whose childhood environments are rarely characterized in surveys, must be eliminated since the socioeconomic conditions at the time the schooling choices were made are unknown. Young children, while perhaps the most relevant sample for current policy insights, are often still enrolled in school and pose a problem of unknown final attainment. Older children begin to leave the parental household and thus the home-resident children recorded in most household surveys become a more select sample. The results of this study suggest that these problems are not trivial; the methodology employed and the sample one analyzes may change the results significantly.

Tables 11a and 11b summarize the effects of select conditioning variables on schooling outcomes estimated from the OLS, ordered probit and censored ordered probit specifications. One can think of the three models as building on each other in complexity; OLS is the simplest model, the ordered probit framework allows for the discreteness of the schooling variable and finally, the censored ordered probit model accounts for the right censoring of enrolled students. For each model, the *ceteris paribus* change in a conditioning variable required to move a child from zero to one year of school (Table 11a) or from five to six years of school (Table 11b) can be calculated. This provides a better indication of the effect of treating schooling years as discrete (by comparing OLS and ordered probit results) and of treating enrolled students as right-censored (by comparing ordered and censored ordered probit results)[26]. For example, according to the OLS and ordered probit estimates, it takes four additional years of father's education to move a boy into grade one while the censored ordered probit results indicate it would take less than half a year of father's schooling to accomplish the same transition. Moving a boy from grade 5 to grade 6 requires an additional four years of father's schooling in OLS, an additional 2.61 years in the ordered probit but less than one additional year in the censored ordered probit . For girls, a similar pattern exists where in general, the ordered probit results lie between the OLS and censored ordered probit specifications but the most pronounced differences exist between the ordered and censored ordered probit specifications, highlighting the non-trivial censoring effect. Furthermore, the censoring

[26] The change in x required to move a child from *year j* to *year j+1*, *ceteris paribus*, is equal to $1/\beta_x$ for OLS and $(\mu_{j+1}-\mu_j)/\beta_x$ for the ordered choice models.

effect appears to be smaller for the grade 6 transition than the grade 1 transition as expected, since more individuals are censored at lower grade levels.

This paper has also shown that the sample chosen for the estimation of schooling demand can alter one's results. Samples consisting of only home-resident children introduce significant bias in OLS and censored ordered probit estimates of the demand for girls' and boys' schooling. As expected, since more girls than boys leave home in Pakistan before age 25, the bias is more problematic in the girls sample.

The preferred framework, a censored ordered probit specification using a sample of all home and non-home resident children provides some insight into the demand for child schooling in Pakistan. Parental education is a significant determinant of both boys' and girls' schooling, with mother's education exerting a larger impact on daughters' education and father's education influencing more heavily the schooling of sons. Household wealth is also a major factor in determining children's schooling and its influence is greater for females. Lastly, while the majority of educational resources in Pakistan are earmarked for improving access to primary schools, this study suggests that money would be better spent increasing access to boys' and girls' middle and secondary schools; distance to primary school does not affect one's attainment whereas distances to middle and secondary schools are significant determinants of final schooling level.

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Table 1: Summary Statistics for samples of all living children (a), non-home resident children (b)and home-resident children (c) ages 5-25.

Variable	(a) Full Sample (n=13238) *Mean (Std. Dev.)*	(b) Non-home resident (n=843) *Mean (Std. Dev.)*		(c) Home-resident (n=12395) *Mean (Std. Dev.)*
Child / Household				
Sex (male = 1)	0.5494	0.2017	**	0.5731
	(0.50)	(0.40)		(0.49)
Age (years)	12.7676	19.6311	**	12.3008
	(5.71)	(3.94)		(5.51)
Age Squared	195.5885	400.8956	**	181.6253
	(163.59)	(141.63)		(155.43)
Education (years)	3.0487	1.7651	**	3.1360
	(3.74)	(3.34)		(3.75)
Enrolled [1] (currently in school = 1)	0.3986	0.0487	**	0.4164
	(0.49)	(0.22)		(0.49)
Home (currently living in mother's household=1)	0.9363	0.0000		1.0000
	(0.24)	(0.00)		(0.00)
Mother's Education (years)	0.9090	0.3203	**	0.9491
	(2.62)	(1.49)		(2.68)
Father's Education (years)	3.4700	2.0913	**	3.5660
	(4.35)	(3.56)		(4.39)
Value of land and property (rupees) / 100,000	1.4742	1.0869	**	1.4953
	(4.30)	(2.80)		(4.36)
Muslim	0.9682	0.9715		0.9680
	(0.18)	(0.17)		(0.18)
Community				
Rural Residence	0.5359	0.6299	**	0.5295
	(0.50)	(0.48)		(0.50)
No Sewage Disposal in Community	0.5728	0.6002	*	0.5710
	(0.49)	(0.49)		(0.49)
Distance to Primary School [2](km)	1.3994	2.1563	**	1.3479
	(6.24)	(8.79)		(6.02)
Distance to Middle School [2] (km)	4.7867	6.3887	**	4.6778
	(10.15)	(11.96)		(10.00)
Distance to Secondary School (km)	4.2415	4.7300		4.2084
	(8.45)	(9.75)		(8.36)
Average Female Wage in Province (rupees/montl	879.7230	868.7122	*	880.4718
	(199.40)	(174.98)		(200.94)
Average Male Wage in Strata (rupees/month)	1493.1700	1327.0320	**	1504.4690
	(713.96)	(399.69)		(729.08)
Punjab Province	0.4847	0.4875		0.4845
	(0.50)	(0.50)		(0.50)
Sind Province	0.2814	0.2764		0.2817
	(0.45)	(0.45)		(0.45)
Northwest Frontier Province	0.1605	0.2064	**	0.1574
	(0.37)	(0.40)		(0.36)
Balochistan Province	0.0734	0.0297	**	0.0764
	(0.26)	(0.17)		(0.27)

Source:PIHS 1991

[1] This variable is predicted for non-resident children (see Appendix A)

[2] For girls, the distance variable is based on the nearest girls' (primary or middle) school, while for boys it is based on the nearest boys' or co-ed (primary or middle) school.

** indicates the means of home and non-home resident children are significantly different at the .01 level

* indicates the means of home and non-home-resident children are significantly different at the .10 level

Table 2: Enrollment rates for home-resident children ages 5-14 and mean years of education for all living children ages 15-25, by sex, province and urban/rural residence.

Province		*% Enrolled Ages 5 - 14* [1]		*Mean Years of Education Ages 15-25* [2]	
		Boys	*Girls*	*Boys*	*Girls*
Punjab	urban	76.53%	71.47%	7.25	5.60
	rural	66.02%	38.96%	5.27	1.94
Sind	urban	66.76%	62.01%	6.94	5.24
	rural	53.12%	22.42%	4.41	0.75
NWFP	urban	78.19%	50.24%	6.45	3.47
	rural	66.87%	28.77%	5.57	0.66
Balochistan	urban	51.20%	32.48%	6.10	2.15
	rural	52.68%	20.54%	4.25	0.56
Average		63.92%	40.86%	5.78	2.55

Source:PIHS 1991

[1] based on home-resident children only

[2] based on both home and non-home resident children

Table 3: Censored ordered probit analysis of the determinants of years of school attainment for all living children ages 5-25, by sex.

	(a) *Boys*		(b) *Girls*	
Variables	*Coefficient*	*(T-Statistic)*	*Coefficient*	*(T-Statistic)*
Child / Household				
Age	0.3411	(25.44)	0.2442	(13.99)
Age Squared [1]	-0.0107	(-23.60)	-0.0088	(-14.19)
Mother's Education	0.0583	(6.89)	0.1195	(14.28)
Father's Education	0.1061	(24.21)	0.0966	(20.55)
Value of land and property / 100,000	0.0138	(6.56)	0.0306	(7.54)
Muslim	0.3833	(5.00)	0.3087	(2.50)
Community				
Rural	0.0651	(1.53)	-0.2469	(-4.81)
No sewage disposal	-0.0866	(-2.16)	-0.3741	(-7.75)
Dist to Primary	-0.0026	(-0.70)	-0.0014	(-0.57)
Dist to Middle	-0.0033	(-1.69)	-0.0069	(-3.57)
Dist to Secondary	-0.0124	(-6.57)	-0.0058	(-2.31)
Avg Female Wage	-0.0068	(-1.85)	-0.0013	(-0.29)
Avg Male Wage	0.0001	(3.47)	0.0003	(10.48)
Sind Province	0.1421	(0.81)	-0.2314	(-1.05)
NW Frontier Province	2.6365	(1.88)	0.0770	(0.04)
Balochistan Province	4.2450	(1.78)	-0.1188	(-0.04)
Constant	2.7921	(1.00)	-1.1577	(-0.33)
Threshold Parameters:				
$\mu 1$	0.0418	(8.35)	0.0315	(6.33)
$\mu 2$	0.1103	(13.45)	0.0759	(9.40)
$\mu 3$	0.1829	(17.37)	0.1444	(12.48)
$\mu 4$	0.2758	(21.54)	0.2462	(15.70)
$\mu 5$	0.4857	(29.23)	0.5212	(21.69)
$\mu 6$	0.5790	(32.17)	0.5770	(22.48)
$\mu 7$	0.7046	(35.54)	0.6275	(23.07)
$\mu 8$	0.8977	(39.84)	0.8155	(24.62)
$\mu 9$	1.0013	(41.82)	0.8743	(25.47)
$\mu 10$	1.4994	(47.01)	1.4121	(26.51)
$\mu 11$	1.5528	(46.89)	1.4291	(26.51)
$\mu 12$	1.8828	(41.29)	1.9609	(25.87)
$\mu 13$	2.0676	(39.29)	2.2195	(23.01)
$\mu 14$	2.9126	(18.73)		
Chi-squared(16)	17991.21		10652.08	
significance level	(0.0000)		(0.0000)	
# Obs	7298		5975	
Log-likelihood	-8082.051		-4902.729	

Source: PIHS, 1991

[1]A test that *age* and *age squared* are jointly different from zero is significant at the .01 level

Table 4: Proportion of students currently enrolled in each grade, by age

Grade / Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	# obs
5	**24**	**71**	3	1													341
6	14	**65**	**17**	2	1												566
7	8	50	**29**	**11**	2												743
8	3	33	30	**21**	**10**	2											823
9	1	17	22	23	**21**	**11**	3	1									669
10	1	10	14	19	28	**17**	**8**	1	1								730
11		3	8	15	18	22	**21**	**11**	2								532
12		3	6	9	14	20	21	**18**	**6**	2	1						736
13		1	1	5	8	15	22	21	**19**	**5**	1						419
14		1	1	2	6	11	10	19	21	**17**	**11**						446
15			1	1	2	3	9	16	24	19	**19**	**5**	1				365
16				1	1	3	5	8	12	20	34	**11**	**5**	1			332
17						1	2	5	8	12	29	20	**20**	**3**			234
18				1	1	2	4	3	8	11	17	14	24	**8**	**5**	0	237
19			1				1	4	1	9	15	16	31	11	**10**	**0**	91
20				1	1	1	1	4	2	3	10	9	31	13	21	2	146
21				2		2			2	2	11	6	14	26	35	3	66
22		1				1				3	11	8	14	18	31	11	71
23					3				3		3	10	3	38	34	3	29
24										3	7	10	10	34	17	17	29
25						7		4			7		7	26	30	19	27

Source: PIHS, 1991

Note: Proportions highlighted are those students considered to be "on time" for their age.

Table 5: Comparison of OLS and Tobit analyses of the determinants of years of school attainment, for all living children ages 5-25, by sex.

	(a) Boys			*(b) Girls*		
	(1) OLS	*(2) Right Censored Tobit*		*(3) OLS*	*(4) Right Censored Tobit*	
Variables	*Coefficient (T-Stat)*	*Coefficient (T-Stat)*	*Marginal Effect[2]*	*Coefficient (T-Stat)*	*Coefficient (T-Stat)*	*Marginal Effect[2]*
Child / Household						
Age	1.1191	1.4978	0.7309	0.6836	0.6831	0.4536
	(35.69)	(28.02)		(21.84)	(17.02)	
Age Squared [1]	-0.0267	-0.0454	-0.0222	-0.0180	-0.0217	-0.0144
	(-24.91)	(-25.01)		(-16.00)	(-15.15)	
Mother's Education	0.0373	0.2663	0.1300	0.1493	0.5042	0.3348
	(2.29)	(7.16)		(9.72)	(17.68)	
Father's Education	0.2513	0.4771	0.2328	0.1860	0.2832	0.1880
	(26.53)	(26.46)		(20.76)	(22.93)	
Value of land and property / 100,000	0.0351	0.0636	0.0311	0.0548	0.0743	0.0494
	(4.02)	(3.22)		(6.32)	(4.70)	
Muslim	0.9860	1.4706	0.7177	0.7735	0.8361	0.5552
	(5.36)	(4.88)		(3.69)	(3.07)	
Community						
Rural	0.0599	0.2501	0.1220	-0.7341	-0.8629	-0.5730
	(0.60)	(1.44)		(-7.77)	(-7.02)	
No sewage disp	-0.2018	-0.3203	-0.1563	-0.6518	-1.0404	-0.6908
	(-2.10)	(-1.94)		(-7.32)	(-8.98)	
Dist to Primary	-0.0012	-0.0073	-0.0036	-0.0020	0.0001	0.0001
	(-1.26)	(-0.48)		(-0.46)	(0.01)	
Dist to Middle	-0.0105	-0.1632	-0.0796	-0.0072	-0.0092	-0.0061
	(-2.25)	(-2.05)		(-2.22)	(-2.28)	
Dist to Secondary	-0.0255	-0.0426	-0.0208	-0.0019	-0.0046	-0.0031
	(-5.60)	(-5.69)		(-0.44)	(-0.86)	
Avg Female Wage	-0.0027	-0.0149	-0.0073	0.0081	0.0038	0.0025
	(-0.40)	(-1.31)		(1.41)	(0.50)	
Avg Male Wage	0.0002	0.0004	0.0002	0.0003	0.0008	0.0005
	(3.40)	(3.11)		(5.25)	(9.02)	
Sind Prov	-0.1354	0.0470	0.0229	-0.5881	-0.6803	-0.4517
	(-0.42)	(0.09)		(-2.10)	(-1.82)	
NW Frontier Prov	0.8402	5.9050	2.8816	-3.8585	-2.3177	-1.5390
	(0.33)	(1.36)		(-1.78)	(-0.80)	
Balochistan Prov	1.2930	9.0794	4.4307	-6.2878	-4.3970	-2.9196
	(0.30)	(1.23)		(-1.70)	(-0.89)	
Constant	-5.1467	3.9526	1.9289	-10.1163	-6.0586	-4.0229
	(-1.00)	(0.46)		(-2.32)	(-1.04)	
Sigma		4.4153			3.0609	
		(79.44)			(85.83)	
F statistic(16) (OLS)	361.99			242.60		
significance level	(0.0000)			(0.0000)		
# Obs	7298	7298		5975	5975	
Log-likelihood	-18216.82	-12220.27		-14027.63	-11284.21	

Source: PIHS, 1991

[1]A test that *age* and *age squared* are jointly different from zero is significant at the .01 level.

[2] Marginal Effects are calculated by scaling the parameters by the proportion uncensored. For boys, .49 are uncensored while for girls .66 are uncensored.

Table 6: Comparison of ordered probit and censored ordered probit analyses of the determinants of years of school attainment for all living children ages 5-25, by sex.

	(a) *Boys*				(b) *Girls*			
	(1) Ordered Probit		*(2) Censored Ordered Probit*		*(3) Ordered Probit*		*(4) Censored Ordered Probit*	
Variables	*Coef*	*(T-Stat)*	*Coef*	*(T-Stat)*	*Coef*	*(T-Stat)*	*Coef*	*(T-Stat)*
Child/Household								
Age	0.4356	(33.56)	0.3411	(25.44)	0.3328	(19.47)	0.2442	(13.99)
Age Squared [1]	-0.0110	(-26.87)	-0.0107	(-23.60)	-0.0095	(-16.63)	-0.0088	(-14.19)
Mother's Educ	0.0126	(1.74)	0.0583	(6.89)	0.0411	(5.73)	0.1195	(14.28)
Father's Educ	0.0900	(22.17)	0.1061	(24.21)	0.0876	(20.81)	0.0966	(20.55)
Value of land and property / 100,000	0.0094	(4.18)	0.0138	(6.56)	0.0124	(4.73)	0.0306	(7.54)
Muslim	0.4116	(6.90)	0.3833	(5.00)	0.3688	(3.26)	0.3087	(2.50)
Community								
Rural	0.0221	(0.61)	0.0651	(1.53)	-0.2997	(-6.51)	-0.2469	(-4.81)
No sewage disp	-0.0892	(-2.60)	-0.0866	(-2.16)	-0.3188	(-7.41)	-0.3741	(-7.75)
Dist to Primary	-0.0040	(-1.29)	-0.0026	(-0.70)	-0.0024	(-1.07)	-0.0014	(-0.57)
Dist to Middle	-0.0036	(-2.12)	-0.0033	(-1.69)	-0.0077	(-4.39)	-0.0069	(-3.57)
Dist to Secondary	-0.0121	(-8.06)	-0.0124	(-6.57)	-0.0055	(-2.53)	-0.0058	(-2.31)
Avg Fem Wage	-0.0019	(-0.66)	-0.0068	(-1.85)	0.0015	(0.41)	-0.0013	(-0.29)
Avg Male Wage	0.0001	(2.80)	0.0001	(3.47)	0.0002	(6.22)	0.0003	(10.48)
Sind Province	-0.0459	(-0.33)	0.1421	(0.81)	-0.2739	(-1.52)	-0.2314	(-1.05)
NW Frontier	0.6671	(0.60)	2.6365	(1.88)	-1.0559	(-0.75)	0.0770	(0.04)
Balochistan	1.0474	(0.55)	4.2450	(1.78)	-1.6928	(-0.70)	-0.1188	(-0.04)
Constant	-1.9102	(-0.86)	2.7921	(1.00)	-4.0242	(-1.42)	-1.1577	(-0.33)
Thresholds:								
$\mu 1$	0.3621	(29.01)	0.0418	(8.35)	0.2925	(22.01)	0.0315	(6.33)
$\mu 2$	0.6199	(39.08)	0.1103	(13.45)	0.5123	(28.98)	0.0759	(9.40)
$\mu 3$	0.8459	(46.71)	0.1829	(17.37)	0.7221	(34.42)	0.1444	(12.48)
$\mu 4$	1.0916	(54.52)	0.2758	(21.54)	0.9405	(39.36)	0.2462	(15.70)
$\mu 5$	1.3953	(63.57)	0.4857	(29.23)	1.2612	(44.68)	0.5212	(21.69)
$\mu 6$	1.6278	(68.89)	0.5790	(32.17)	1.4380	(46.97)	0.5770	(22.48)
$\mu 7$	1.8510	(73.28)	0.7046	(35.54)	1.6337	(48.59)	0.6275	(23.07)
$\mu 8$	2.1201	(77.58)	0.8977	(39.84)	1.8654	(49.78)	0.8155	(24.62)
$\mu 9$	2.3177	(80.19)	1.0013	(41.82)	2.0384	(50.89)	0.8743	(25.47)
$\mu 10$	2.8260	(82.31)	1.4994	(47.01)	2.4954	(48.16)	1.4121	(26.51)
$\mu 11$	2.9848	(83.03)	1.5528	(46.89)	2.6126	(48.02)	1.4291	(26.51)
$\mu 12$	3.4238	(75.57)	1.8828	(41.29)	3.0634	(43.47)	1.9609	(25.87)
$\mu 13$	3.7542	(72.03)	2.0676	(39.29)	3.4044	(40.98)	2.2195	(23.01)
$\mu 14$	4.6100	(40.77)	2.9126	(18.73)				
Chi-squared(16)	3940.707		17991.21		2741.967		10652.08	
significance level	(0.0000)		(0.0000)		(0.0000)		(0.0000)	
# Obs	7298		7298		5975		5975	
Log-likelihood	-15107.3		-8082.051		-8857.787		-4902.73	

Source: PIHS, 1991

[1]A test that *age* and *age squared* are jointly different from zero is significant at the .01 level.

Table 7: Marginal effects on the probability of attaining zero and five years of schooling for ordered probit and censored ordered probit estimations, for all living children ages 5-25, by sex.

	(a) *Boys*				(b) *Girls*			
	Education=0		*Education=5*		*Education=0*		*Education=5*	
Variables	*Ordered Probit*	*Censored Ordered Probit*	*Ordered Probit*	*Censored Ordered Probit*	*Ordered Probit*	*Censored Ordered Probit*	*Ordered Probit*	*Censored Ordered Probit*
Child/Household								
Age	-0.1341	-0.1087	0.0238	-0.0079	-0.1307	-0.0969	0.0239	0.0116
Age Squared	0.0034	0.0034	-0.0006	0.0002	0.0038	0.0035	-0.0007	-0.0004
Mother's Educ	-0.0039	-0.0186	0.0007	-0.0013	-0.0161	-0.0474	0.0030	0.0057
Father's Educ	-0.0277	-0.0338	0.0049	-0.0025	-0.0344	-0.0383	0.0063	0.0046
Value of land and property / 100,000	-0.0029	-0.0044	0.0005	-0.0003	-0.0049	-0.0121	0.0009	0.0014
Muslim	-0.1268	-0.1221	0.0225	-0.0089	-0.1449	-0.1224	0.0265	0.0146
Community								
Rural	-0.0068	-0.0207	0.0012	-0.0015	0.1177	0.0979	-0.0222	-0.0117
No sewage disp	0.0275	0.0276	-0.0049	0.0020	0.1252	0.1484	-0.0229	-0.0177
Dist to Primary	0.0012	0.0008	-0.0002	0.0001	0.0009	0.0006	-0.0002	-0.0001
Dist to Middle	0.0011	0.0010	-0.0002	0.0001	0.0030	0.0027	-0.0006	-0.0003
Dist to Secondary	0.0038	0.0040	-0.0007	0.0003	0.0022	0.0023	-0.0004	-0.0003
Avg Fem Wage	0.0006	0.0022	-0.0001	0.0002	-0.0006	0.0005	0.0001	-0.0001
Avg Male Wage	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0001	0.0000	0.0000
Sind Province	0.0141	-0.0453	-0.0025	-0.0033	0.1076	0.0918	-0.0197	-0.0110
NW Frontier	-0.2054	-0.8400	0.0365	-0.0610	0.4148	-0.0305	-0.0759	0.0036
Balochistan	-0.3225	-1.3524	0.0573	-0.0983	0.6650	0.0471	-0.1217	-0.0056
Constant	0.5882	-0.8895	-0.1046	-0.0646	1.5808	0.4592	-0.2892	-0.0549

[1] Calculations based on results reported in Table 1.6.

Table 8: Change in expected schooling for a unit change in select variables for OLS, Tobit, ordered probit, and censored ordered probit specifications, by sex.

Boys

Variable	*OLS*[1]	*Right-Censored Tobit*[1]	*Ordered Probit*[2]	*Censored Ordered Probit*[2]
Mother's Education	0.0373	0.1300	0.0394	0.2673
Father's Education	0.2513	0.2328	0.2678	0.4854
Value of land and property / 100,000	0.0351	0.0311	0.0280	0.0632
No Sewage Disposal	-0.2018	-0.1563	-0.2662	-0.3974
Distance to Middle	-0.0105	-0.0796	-0.0093	-0.0145
Distance to Secondary	-0.0255	-0.0208	-0.0384	-0.0574

Girls

Variable	*OLS*[1]	*Right-Censored Tobit*[1]	*Ordered Probit*[2]	*Censored Ordered Probit*[2]
Mother's Education	0.1493	0.3348	0.0615	0.4446
Father's Education	0.1860	0.1880	0.1708	0.3607
Value of land and property / 100,000	0.0548	0.0494	0.0241	0.1126
Rural	-0.7341	-0.5730	-0.5932	-0.9185
No Sewage Disposal	-0.6518	-0.6908	-0.6316	-1.3902
Distance to Middle	-0.0072	-0.0061	-0.0144	-0.0246
Distance to Secondary	-0.0019	-0.0031	-0.0105	-0.0224

[1] Results based on Table 1.5

[2] Results based on Table 1.6. The changes in expected schooling for the ordered choice models are obtained by multiplying the year of education by the marginal effect for that year, and then summing across all years.

Table 9: Probit analysis of leaving mother's household for all living children ages 5-25, by sex.

Dependent Variable: AWAY, (Not living in mother's household=1)

	(a) Boys		(b) Girls	
Variables	*Coefficient*	*(T-statistic)*	*Coefficient*	*(T-statistic)*
Child/Household				
Age	0.0481	(1.28)	0.2766	(6.31)
Age Squared [1]	0.0010	(0.86)	-0.0024	(-1.87)
Mother's education	0.0159	(0.77)	-0.0374	(-2.02)
Father's education	-0.0231	(-2.13)	-0.0318	(-3.81)
Value of land and property / 100,000	0.0011	(0.09)	-0.0281	(-2.09)
Community				
Rural	0.3189	(2.66)	0.0655	(0.66)
Percent Males in Community	-0.2797	(-0.63)	0.7243	(2.12)
Distance to Primary School	0.0045	(0.50)	0.0087	(2.52)
Distance to Middle School	-0.0094	(-1.65)	-0.0012	(-0.44)
Distance to Secondary	0.0020	(0.50)	0.0038	(1.07)
Average Female Wage	-0.0054	(-0.32)	-0.0114	(-1.14)
Average Male Wage	-0.0004	(-3.04)	-0.0002	(-3.34)
Percent Households Own Land	-0.0063	(-3.46)	0.0006	(0.45)
Sind Province	0.1973	(0.25)	0.7197	(1.52)
Northwest Frontier Province	1.6742	(0.27)	4.6348	(1.22)
Balochistan Province	2.5793	(0.24)	7.1883	(1.11)
Constant	1.8402	(0.15)	3.6861	(0.49)
Chi-squared (16)	253.16		1655.24	
significance level	(0.0000)		(0.0000)	
# observations	7316		5993	
Log-likelihood	-680.9704		-1271.4657	

Source: PIHS, 1991

[1]A test that *age* and *age squared* are jointly different from zero is significant at the .01 level.

Table 10: Likelihood ratio tests of joint significance of "Home-resident" variables, by sex.

Boys

Model	*OLS (column (1) in Table 1.5)* Rhs = β'x	*OLS (column (1) in Table 1B.1)* Rhs=β'x + γ*home* + δ'(*home**x)	*Censored Ordered Probit (column (2) in Table 1.6)* Rhs = β'x	*Censored Ordered Probit (column (2) in Table 1B.1)* Rhs=β'x + γ*home* + δ'(*home**x)
Log-Likelihood	-18216.8167	-18141.0324	-8082.051	-8044.419
LR Test Statistic (Chi-squared(17))	151.5686		75.26	
Significance level	p=.0000		p=.0000	

Girls

Model	*OLS (column (3) in Table 1.5)* Rhs = β'x	*OLS (column (1) in Table 1B.2)* Rhs=β'x + γ*home* + δ'(*home**x)	*Censored Ordered Probit (column (4) in Table 1.6)* Rhs = β'x	*Censored Ordered Probit (column (2) in Table 1B.2)* Rhs=β'x + γ*home* + δ'(*home**x)
Log likelihood	-14027.6301	-13825.8915	-4902.729	-4829.032
LR Test Statistic (Chi-squared(17))	403.4772		147.394	
Significance level	p=.0000		p=.0000	

Table 11a: Change in select independent variables required to move a child from grade 0 to grade 1 for OLS, ordered probit, and censored ordered probit specifications[1]

	Boys				Girls			
Δx_i needed to enter grade 1	*Mean (std dev)**	*OLS*	*Ord Prob* [2]	*Cens Ord Prob* [2]	*Mean (std dev)**	*OLS*	*Ord Prob* [2]	*Cens Ord Prob* [2]
Mother's education (yrs)	.29 (1.42)	26.85	23.14	0.72	.22 (1.29)	6.69	7.12	0.26
Father's education (yrs)	1.69 (3.18)	3.98	4.02	0.39	2.02 (3.32)	5.38	3.34	0.33
Land and Property/100,000	.87 (3.90)	28.46	38.48	3.03	.84 (2.35)	18.25	23.63	1.03
Dist to Middle (km)	4.06 (8.88)	-95.27	-102.87	-12.71	8.62 (13.47)	-138.89	-38.04	-4.57
Dist to Secondary (km)	5.77 (10.12)	-39.26	-29.01	-3.36	5.29 (9.35)	*insig*	-53.18	-5.44

*means and standard deviations are calculated for individuals with zero years of education

Table 11b: Change in select independent variables required to move a child from grade 5 to grade 6 for OLS, ordered probit, and censored ordered probit specifications[1]

	Boys				Girls			
Δx_i needed to continue from grade 5 to grade 6	*Mean (std dev)**	*OLS*	*Ord Prob* [2]	*Cens Ord Prob* [2]	*Mean (std dev)**	*OLS*	*Ord Prob* [2]	*Cens Ord Prob* [2]
Mother's education (yrs)	.73 (2.44)	26.85	18.45	1.60	1.34 (2.95)	6.69	4.30	0.47
Father's education (yrs)	3.36 (4.14)	3.98	2.61	0.88	4.80 (4.62)	5.38	2.02	0.58
Land and Property/100,000	1.35 (4.17)	28.46	24.72	6.77	1.52 (3.21)	18.25	14.28	1.82
Dist to Middle (km)	3.08 (7.65)	-95.27	-65.27	-28.27	4.50 (10.50)	-138.89	-22.99	-8.08
Dist to Secondary (km)	3.05 (6.62)	-39.26	-18.63	-7.50	2.81 (6.47)	*insig*	-31.98	-10.71

*means and standard deviations are calculated for individuals with five years of education

1 Calculations are based on results from Tables 1.5 and 1.6

2 The change in x required to move a child from year j to year j+1, ceteris paribus, is equal to $1/\beta_x$ for OLS and $(\mu_{j+1}-\mu_j)/\beta_x$ for the ordered choice models.

Figure 1: Distribution of schooling for individuals ages 15-20, by sex

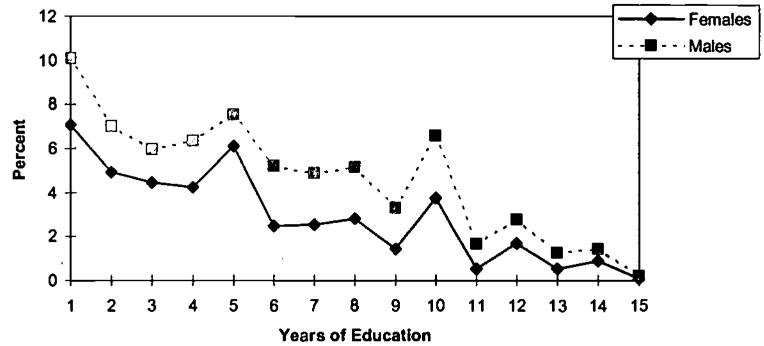


Figure 2a: Estimated thresholds from censored ordered probit analysis for *Boys* (taken from Table 3, col (a))

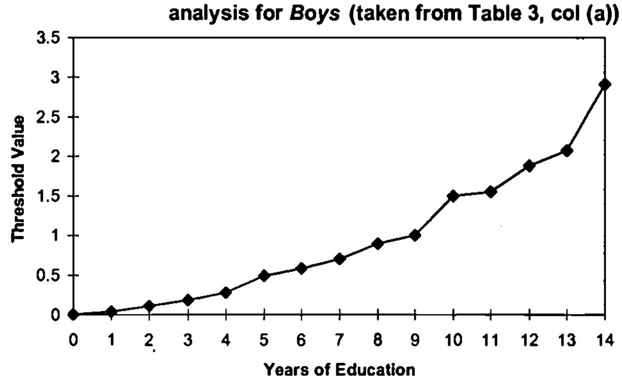
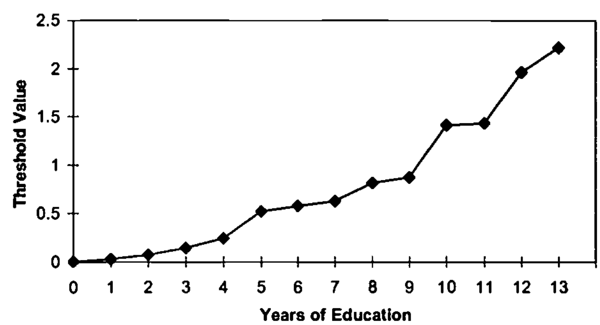
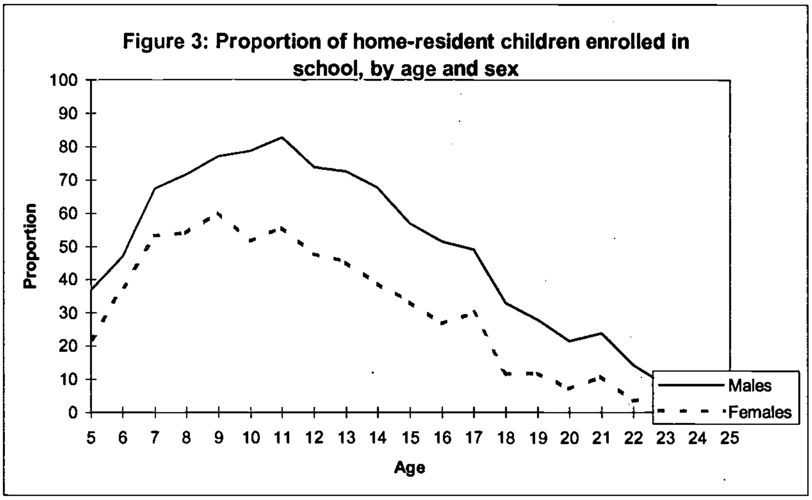


Figure 2b: Estimated thresholds from censored ordered probit analysis for *Girls* (taken from Table 3, col (b))



Source: PIHS, 1991.



Source: PIHS, 1991.

Figure 4 : Comparison of marginal effect of *mother's education* for ordered probit and censored ordered probit specification for *boys*

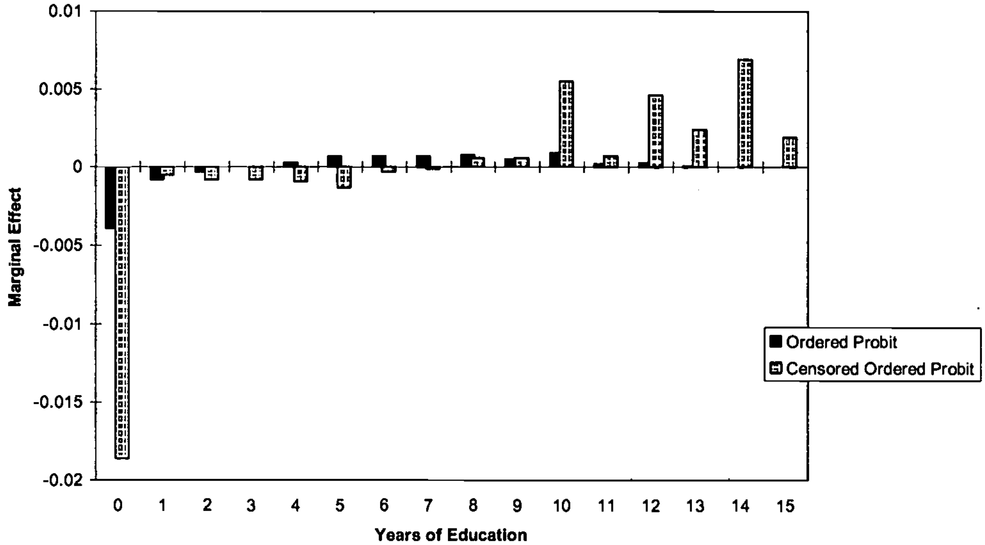
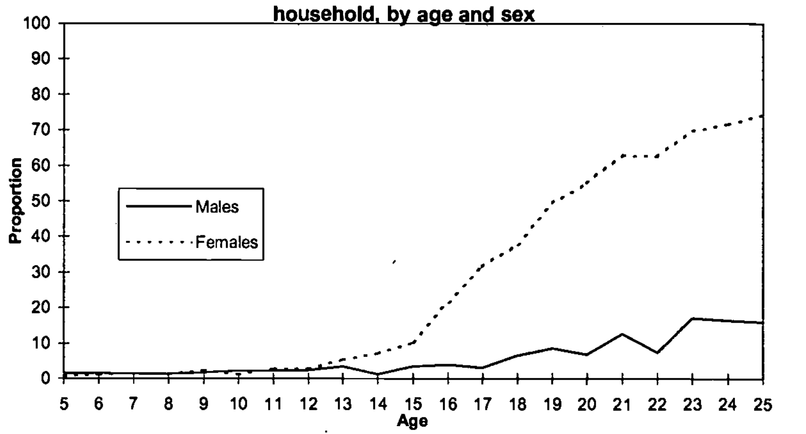


Figure 5: Proportion of children who have left mother's household, by age and sex



Source: PIHS, 1991.

Appendix A.

Table A.1: Summary statistics for non-home resident children with and without links to parent's household.

Variable	*(a)Non-home resident children without ties to parents from main sample n=1582* Mean *(Std. Dev.)*	*(b)Non-home resident children with ties to parents through maternity file n=843* Mean *(Std. Dev.)*
Child/Household		
Sex (male=1)	0.1485	0.2017
	(0.36)	(0.40)
Age (years)	20.7541	19.6311
	(4.17)	(3.94)
Education (years)	1.9152	1.7651
	(3.52)	(3.34)
Enrolled (currently in school)	0.0636	0.0487
	(0.24)	(0.22)
Mother Literate	0.0575	0.0657
	(0.24)	0.25
Father Literate	0.2484	0.2998
	(0.43)	(0.46)
Value of Land and Property (rupees) / 100,000	1.4355	1.0390
	(4.18)	(2.83)
Community		
Rural Residence	0.5784	0.6299
	(0.49)	(0.48)
Distance to Primary (km)	2.7933	2.1563
	(9.91)	(8.79)
Distance to Middle (km)	6.6213	6.3887
	(11.59)	(11.96)
Distance to Secondary (km)	4.4277	4.7300
	(8.24)	(9.75)
Average Female Wage (rupees/month)	887.8906	868.7122
	(206.27)	(174.98)
Average Male Wage (rupees/month)	1505.0770	1327.0320
	(765.27)	(399.69)
Punjab Province	0.4437	0.4875
	(0.50)	(0.50)
Sind Province	0.3123	0.2764
	(0.46)	(0.45)
Northwest Frontier Province	0.1618	0.2064
	(0.37)	(0.40)
Balochistan Province	0.0822	0.0297
	(0.27)	(0.17)

Source: PIHS, 1991.

Note: The individuals in column (a) are used to predict enrollment rates for individuals in column (b)

Table A.2: Probit results for probability of enrollment for non-home resident boys and girls ages 5-25 (without parental links from main sample and with a living mother), by sex.

Dependent Variable: Currently enrolled in school

	(a) Boys		(b) Girls	
Variables	*Coefficient*	*(T-statistic)*	*Coefficient*	*(T-statistic)*
Child/Household				
Age	-0.1972	(-7.62)	-0.2628	(-8.62)
Mother Literate	1.1224	(2.37)	0.9106	(2.72)
Father Literate	1.1178	(3.48)	1.1274	(3.89)
Value of land and property/100,000	-0.0394	(-1.14)	-0.0156	(-0.41)
Community				
Sind	-1.5142	(-0.19)	-0.1846	(-0.42)
NWFP	-10.5069	(-0.16)	-2.6817	(-1.01)
Baloch	-19.1123	(-0.18)	-4.3188	(-0.90)
Rural	0.5052	(1.37)	0.0994	(0.30)
Distance to Primary	0.0262	(0.56)	-0.4338	(-1.63)
Distance to Middle	-0.0409	(-1.29)	0.0058	(0.35)
Distance to Secondary	-0.0323	(-0.85)	-0.0412	(-1.28)
Average Female Wage	0.0273	(0.16)	0.0057	(0.82)
Average Male Wage	0.0003	(1.85)	0.0004	(2.63)
Constant	-18.8968	(-0.15)	-2.6583	(-0.50)
# obs	237		1349	
Chi-squared(13)	143.66	(p=0.0000)	216.52	(p=0.0000)
Log-likelihood	-62.2621		-68.3698	
Correlation between actual and predicted enrollment	0.687		0.544	

Source: PIHS, 1991.

Appendix B.

Table B.1: OLS and censored ordered probit analysis of the determinants of schooling attainment with "home-resident" interactions, for all living *boys* ages 5-25.

	(a) Boys			
	(1) Ordinary Least Squares		*(2) Censored Ordered Probit*[1]	
Variables	*Coefficient*	*T-Statistic*	*Coefficient*	*T-Statistic*
Child/Household/Comm				
Age	0.0605	(2.17)	-0.0128	(-0.42)
Age Squared	-0.0001	(-1.62)	0.0002	(0.23)
Mother's education	-0.0413	(-0.22)	-0.0135	(0.18)
Father's education	0.5870	(8.51)	0.1763	(6.26)
Value of land and property / 100,000	-0.0085	(-0.07)	0.1475	(0.16)
Muslim	1.0020	(0.78)	33.8962	(0.00)
Rural	0.8738	(1.27)	0.3152	(0.77)
No Sewage Disposal	0.3668	(0.62)	-0.1439	(-0.35)
Distance to Primary School	-0.0374	(-0.74)	-0.0103	(0.44)
Distance to Middle School	0.0157	(0.44)	0.0027	(0.16)
Distance to Secondary	0.0311	(1.37)	-0.0006	(0.05)
Average Female Wage	-0.0005	(-1.98)	-0.0111	(-0.70)
Average Male Wage	0.0042	(3.97)	0.0002	(2.33)
Sind Province	20.6300	(1.85)	4.2900	(0.58)
Northwest Frontier Province	176.1812	(1.97)	41.6683	(0.69)
Balochistan Province	299.6053	(1.97)	32.2752	(0.00)
Home	-346.1683	(-1.94)	-46.7214	(0.00)
Interactions				
Home*Age	0.0505	(1.80)	0.0472	(1.87)
Home*Age Squared	-0.0001	(-1.54)	-0.0012	(-1.89)
Home*Mother's education	0.0811	(0.43)	0.0719	(0.35)
Home*Father's education	-0.3445	(-4.95)	-0.0723	(-2.92)
Home*((Land & property) / 100,000)	0.0425	(0.36)	-0.1340	(1.19)
Home*Muslim	-0.0461	(-0.04)	-33.5226	(0.00)
Home*Rural	-0.7619	(-1.10)	-0.2371	(-0.49)
Home*No Sewage Disposal	-0.6048	(-1.01)	0.0534	(0.11)
Home*Dist Primary	0.0272	(0.53)	0.0077	(-0.44)
Home*Dist Middle	-0.0281	(-0.78)	-0.0064	(-0.37)
Home*Dist Secondary	-0.0570	(-2.46)	-0.0119	(-0.65)
Home*Average Fem Wage	0.0462	(1.97)	0.0104	(0.66)
Home*Average Male Wage	-0.0004	(-3.79)	-0.0001	(-2.26)
Home*Sind Province	-20.7461	(-1.86)	-4.1391	(-0.58)
Home*Northwest Frontier Province	-175.3528	(-1.96)	-39.0297	(-0.66)
Home*Balochistan Province	-298.3481	(-1.96)	-28.0336	(0.00)
Constant	341.1031	(1.91)	49.5078	(0.00)
F/Chi squared (33)	183.39		18066.48	
significance level	(0.0000)		(0.0000)	
# observations	7298		7298	
Log-Likelihood	-18141.0324		-8044.419	

Source: PIHS, 1991.

[1] For ease of presentation, the estimated thresholds have been omitted from the table.

Table B.2: OLS and censored ordered probit analysis of the determinants of schooling attainment with "home-resident" interactions, for all living *girls* ages 5-25.

	(b) Girls			
	(1) Ordinary Least Squares		*(2) Censored Ordered Probit[1]*	
Variables	*Coefficient*	*T-Statistic*	*Coefficient*	*T-Statistic*
Child/Household/Comm				
Age	-0.0184	(-0.09)	-0.3013	(-2.30)
Age Squared	0.0019	(0.38)	0.0082	(2.32)
Mother's education	0.6631	(8.17)	0.1358	(3.45)
Father's education	0.1870	(6.09)	0.0747	(3.91)
Value of land and property / 100,000	0.1733	(3.38)	0.0565	(2.35)
Muslim	0.4471	(0.75)	0.5852	(0.99)
Rural	-0.6697	(-2.49)	-0.3341	(-1.65)
No Sewage Disposal	-0.3899	(-1.66)	-0.1209	(-0.64)
Distance to Primary School	-0.0052	(-0.50)	-0.0023	(-0.21)
Distance to Middle School	-0.0071	(-0.84)	-0.0116	(-1.19)
Distance to Secondary	-0.0012	(-0.11)	-0.0087	(-0.84)
Average Female Wage	-0.0340	(-0.50)	-0.0081	(-0.20)
Average Male Wage	0.0008	(2.70)	0.0004	(2.21)
Sind Province	1.6133	(0.51)	0.1928	(0.10)
Northwest Frontier Province	12.1315	(0.47)	2.5424	(0.16)
Balochistan Province	20.7507	(0.47)	0.9574	(0.00)
Home	-33.5837	(-0.65)	-8.1764	(-0.26)
Interactions				
Home*Age	0.0604	(3.18)	0.0571	(4.31)
Home*Age Squared	-0.0139	(-2.66)	-0.0180	(-4.81)
Home*Mother's education	-0.5287	(-6.40)	-0.0179	(-0.45)
Home*Father's education	-0.0125	(-0.39)	0.0229	(1.16)
Home*((Land & property)/100,000)	-0.1289	(-2.48)	-0.0289	(-1.18)
Home*Muslim	0.3319	(0.53)	-0.2972	(-0.49)
Home*Rural	0.0434	(0.15)	0.1229	(0.59)
Home*No Sewage Disposal	-0.3317	(-1.32)	-0.2943	(-1.50)
Home*Dist Primary	0.0060	(0.52)	0.0018	(0.17)
Home*Dist Middle	-0.0014	(-0.15)	0.0045	(0.45)
Home*Dist Secondary	0.0022	(0.17)	0.0035	(0.33)
Home*Average Fem Wage	0.0004	(0.59)	0.0066	(0.16)
Home*Average Male Wage	-0.0005	(-1.79)	-0.0001	(-0.70)
Home*Sind Province	-2.0886	(-0.65)	-0.4156	(-0.22)
Home*Northwest Frontier Province	-15.0523	(-0.58)	-2.3705	(-0.15)
Home*Balochistan Province	-25.7406	(-0.59)	-0.9743	(0.00)
Constant	25.4371	(0.49)	6.9927	(0.23)
F/Chi squared (33)	138.06		10799.48	
significance level	(0.0000)		(0.0000)	
# observations	5975		5975	
Log-Likelihood	-13825.8915		-4829.032	

Source: PIHS, 1991

[1] For ease of presentation, the estimated thresholds have been omitted from the table.

Appendix C. Correlation Matrix

	Educ	Enrolled	Home	Mother's educ	Father's educ	Land & Property	Rural	No waste disposal	Dist to Prim	Dist to Middle	Dist to Sec	Avg fem wage	Avg male wage	Punjab	Sind	NWFP	Baloch
Education	1																
Enrolled	0.375	1															
Home	0.090	0.200	1														
Mother's education	0.243	0.263	0.059	1													
Father's education	0.329	0.334	0.083	0.509	1												
Land & Property	0.197	0.121	0.027	0.340	0.265	1											
Rural	-0.216	-0.159	-0.050	-0.267	-0.237	-0.149	1										
No waste disposal	-0.224	-0.155	-0.015	-0.273	-0.236	-0.149	0.640	1									
Dist to Primary	-0.085	-0.068	-0.032	-0.036	-0.056	-0.034	0.080	0.071	1								
Dist to Middle	-0.159	-0.133	-0.041	-0.100	-0.088	-0.074	0.303	0.180	0.313	1							
Dist to Secondary	-0.136	-0.118	-0.015	-0.105	-0.134	-0.075	0.289	0.205	0.206	0.297	1						
Avg fem wage	-0.113	-0.057	0.014	-0.105	-0.128	0.013	-0.028	0.156	0.091	0.123	0.073	1					
Avg male wage	0.180	0.144	0.061	0.305	0.237	0.265	-0.389	-0.258	-0.022	-0.113	-0.142	0.203	1				
Punjab	0.092	0.058	-0.001	0.035	0.070	0.010	0.051	-0.033	-0.073	-0.131	-0.031	-0.592	-0.139	1			
Sind	-0.002	-0.021	0.003	0.064	0.030	-0.046	-0.053	-0.137	0.043	0.054	0.012	-0.234	0.050	-0.607	1		
NWFP	-0.069	-0.019	-0.033	-0.082	-0.057	0.065	0.036	0.169	-0.062	0.033	-0.080	0.567	-0.098	-0.424	-0.273	1	
Baloch	-0.075	-0.048	0.044	-0.062	-0.106	-0.031	-0.057	0.061	0.154	0.112	0.150	0.742	0.318	-0.274	-0.176	-0.123	1

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