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"Improving the Quality Versus Increasing the Quantity of Schooling"

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Improving the Quality Versus Increasing the Quantity of Schooling:

Evidence for Rural Pakistan

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Jere R. Behrman, David Ross and Richard Sabot*

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Abstract: *Interest in estimating the impact of school quality on earnings has increased. But most studies on this topic have important limitations, particularly in studies for developing countries. They tend to ignore behavioral decisions regarding schooling and individual and family background characteristics, use school quality measures aggregated to the regional level, and rely on crude indicators of teacher quality. These limitations may explain why the micro evidence of important school quality effects is scant. Moreover, the question of the relative rates of return, in terms of earnings, to improving school quality versus raising quantity has not been addressed. The data demands for estimating such rates of return are considerable. This paper presents a conceptual framework for undertaking such estimates, uses special data collected for this study, and makes estimates within a framework that controls for important individual and household choices, including the duration of schooling and subsequent participation in the wage labor market. Subject to qualifications because such an ambitious strategy stretches the limits of the even the special data that we collected, the estimates suggest that in rural Pakistan rates of return are much higher for investing in primary school quality or quantity than for investing in middle schools and, at the primary school level, somewhat higher for expanding low-quality schools (predominantly for girls) than for increasing quality in existing schools. More generally, the methods adopted here permit a more satisfactory assessment in developing economies than previously of the rates of return to improving school quality versus increasing quantity and their implications for educational policy.*

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Estimation of the impact of time spent in school on earnings and other outcomes has been a major area of research. But time spent in school is an input, not an output of schooling. School quality also is likely to influence such outputs as cognitive and other skills and the earnings they yield. There may be important tradeoffs between increasing time spent in school (higher school quantity) and improving school quality.

Three separate, but related, literatures address dimensions of the school quality-cognitive achievement-earnings nexus and continue to attract much scholarly and policy interest (see, for example, the Symposium on School Quality and Educational Outcomes introduced by Moffitt 1996, and Card and Krueger 1996).

First, there is a fairly large literature on the impact of school quality on earnings. However, the studies in this literature usually rely on crude proxies as measures of school quality, ignore human capital endowments and inputs provided in the home, and treat all aspects of schooling, even time in school, as predetermined. The estimated impact of school quantity and quality may be biased if home characteristics and ability affect earnings through choice of time devoted to schooling. Bias also can result if indicators of school quality do not include such direct measures of teachers' quality as their cognitive skills, even though how much a teacher knows is recognized as critical to how much a child learns. Perhaps as a result, many micro studies do not find much of an impact of school quality on earnings, or find negative effects of school attributes about as frequently as they find positive effects. Many studies also suffer from measurement error resulting from aggregation: Despite considerable within-geographical area variation in school inputs, they use the average of school characteristics for school districts or states rather than school characteristics for the schools actually attended by the individuals studied.[1]

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[1] Studies of the impact of school quality on earnings include Akin and Garfinkel (1977), Anderson, Shugart and Tollison (1991), Behrman and Birdsall (1983), Behrman, Birdsall and Kaplan (1996), Behrman, Rosenzweig and Taubman (1996), Betts (1995, 1996a,b), Card and Krueger (1992a,b), Daniere and Meechling (1970), Grogger (1996a,b), Heckman, Layne-Farrar, and Todd (1996), James, Alsalam, Conaty and To (1989), Johnson and Stafford (1973), Jud and Walker (1977), Link and Ratledge (1975a,b), Link, Ratledge, and Lewis (1976, 1980), Margo (1986), Morgan and Sirageldin (1968), Nechyba (1990), Reed and Miller (1970), Ribich and Murphy (1975), Rizzuto and Wachtel (1980), Solmon (1973), Solmon and Wachtel (1975), Wales (1973), Wachtel (1976), Weisbrod and Karpoff (1968), Welch (1966, 1973a,b), and Wolfle (1973). Virtually all of the existing studies of the impact of school quality on earnings treat schooling as predetermined (Behrman, Rosenzweig and Taubman 1996 is an exception in which schooling is posited to respond to individual and family endowments). All of the aggregate studies and many of the micro studies of the impact of school quality on earnings ignore family and individual characteristics (exceptions among the micro studies include Akin and Garfinkel 1977, Altonji 1988, Altonji and Dunn 1996a,b, Behrman, Rosenzweig, Taubman 1996, Link and Ratledge 1975a,b Solmon 1973, Taubman 1975, Wachtel 1976). Betts (1995) is an example of a study that uses school-level characteristics and does not find much impact. Examples of studies of the impact of school quality on earnings that use schooling measures defined for districts or states include Behrman and Birdsall (1983), Behrman, Birdsall and Kaplan (1996), Card and Krueger (1992a,b), Ribich and Murphy (1975), Rizzuto and Wachtel (1980), Wachtel (1976) and Welch (1966, 1973a,b).

Second, there are several studies of the impact of cognitive achievement on earnings. These studies find significantly positive effects of cognitive achievement that are generally more robust than are estimates of the effects of the impact of time in school on earnings (e.g., Alderman et al. 1996a, Boissiere, Knight and Sabot 1985, Glewwe 1996, Moll 1996, Murnane, Willet and Levy 1995).[2] The results in this literature highlight the importance of measuring the determinants of cognitive achievement, not only time in school, to assess the full impact of schooling on earnings.

Third, there is a large literature on education production functions with cognitive achievement or other test scores or grades as outputs and individual and school characteristics as inputs. Hanushek (1986, 1989, 1995), Hanushek, Rivkin and Taylor (1996) and Harbison and Hanushek (1992) survey this literature. These studies generally do not consider inputs into cognitive achievement other than those provided in schools and do not control for any behavioral choices, not even time spent in school. They obtain results that are very mixed across studies, with about as many significantly negative as significantly positive coefficients for various school inputs.

Virtually none of the studies in these three related literatures presents estimates of the rates of return to improving school quality versus increasing school quantity. We are aware of only two studies that present such estimates.[3] Behrman and Birdsall (1983) use a single aggregate measure of school quality (average teachers' schooling in a region) and do not control for choices regarding schooling nor for individual inputs into cognitive achievement. They interpret their estimates to mean that the social rates of return to improving school quality in Brazil are at least as great as are the rates of return to increasing school quantity at a given quality level. Glewwe (1996) uses three quality indicators (textbooks, blackboards, leakless roofs) that represent aspects of material inputs and physical conditions but not the quality of teachers or student exposure to them. His estimates suggest much higher rates of return to these three school quality indicators than to school quantity in Ghana.

In this paper, we integrate these three literatures by considering investments in education as a sequence: first,

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Almost all of the studies of school quality on earnings, furthermore, focus on the characteristics or inputs associated with one level of schooling (college or high school or grade school) even for individuals who have passed through a number of schooling levels (exceptions include Behrman, Rosenzweig and Taubman 1996 and Wachtel 1976).

[2] The first three of these studies explore the impact of control for the choices underlying development of cognitive skills in their analysis, with mixed results. These studies all use micro data. Hanushek and Kimko (2000) present related evidence using aggregate country-level data.

[3] Hanushek, Gomes-Neto and Harbison (1996) in the literature on education production functions estimate the rate of return to reducing grade repetition through improving school quality, but do not consider rates of return in terms of earnings nor the quality-quantity tradeoff.

cognitive achievement is produced by an education production function with inputs including individual and school characteristics and time in school (determined by behavioral choices); second, wages are determined by cognitive achievement and other human resource investments, all of which are treated as reflecting past choices. Estimates of the education production and earnings functions, together with estimates of costs of inputs into the production of cognitive achievement, enable us to estimate the rates of return to increasing school quantity versus improving school quality.

We use an unusually rich micro data set for rural Pakistan, specially designed for this purpose, that includes linked information on individuals, households and schools attended. The individual data include cognitive achievement and ability in addition to time spent in school and, for those who have completed school, actual labor market experience, earnings, and health indicators. The household data include parental schooling and household income, as well as prices and indicators of alternatives to wage employment that are important for identifying schooling attainment and labor force participation decisions. The school data include measures of school quality, including the cognitive achievement of teachers, that have not been considered in previous studies of the impact of school quality on earnings.

This study, while still subject to some data limitations and limited precision due in part to sample size, is an advance over the existing literature on the impact of schooling quantity and quality on earnings. Our data enable us to estimate and compare rates of return to improving the quality of schooling (holding quantity constant) and increasing the quantity of schooling (holding quality constant) within a more comprehensive and rigorous framework than previously used.

Which investment strategy -- improving quality versus increasing quantity -- is preferable depends on their relative costs and benefits. In rural Pakistan at the time that the data that we use were collected, primary schools were not universally available in the sense of being close enough to a particular community that some members of that community attended them -- particularly for girls (Table 1), school quality generally was low, the school-age population was expanding rapidly, public-sector budgets were tight, and wage employment opportunities were limited but expanding.[4] In such a context critical schooling investment strategy questions facing policy makers are: Should

[4] See Behrman and Schneider (1993), Birdsall, Ross and Sabot (1993) and Sather and Lloyd (1994) for discussions of the limited schooling in Pakistan relative to other countries at a similar time and level of development and of the pressure of high fertility rates on schooling in Pakistan. In part because of the limited schooling in this country, there have been a considerable number of studies of various aspects of the determinants of schooling in Pakistan (some recent examples are Alderman, Orazem and Paternao 2001, Lloyd, Mete and Sather 2002, Sathar, et al. 2002; Sawada and Lokshin 2001).

the quality of primary schools be improved even if that implies postponing the expansion of enrollments? Is universal access to primary school a worthy goal even at the expense of lowering the quality of primary-school education? Should access to middle school be increased for those completing primary school? The answers depend on the rate of return of improving quality (for given quantity of schooling) relative to the return to increasing quantity (holding quality fixed). Policy makers have urgent needs to answer similar questions in many other countries.

Section 1 presents a simple analytic framework with which we assess the relative rates of return to improving the quality and increasing the quantity of schooling. Section 2 describes the data that we use in the analysis. As noted, our data set links information on individuals and households with information on the schools attended by household members. One questionnaire and a set of tests were administered to surveyed households. Another questionnaire and the same set of tests were administered to teachers in surveyed schools. Our data permit us to go beyond the previous literature and estimate relative returns to changes in the quality and quantity of schooling.

Section 3 presents estimates of three key sets of relations: cognitive achievement production functions with endogenous time in school and school quality inputs; a hedonic relation for costs for school quality inputs; and earnings functions dependent on endogenous human resources (cognitive achievement, experience, and health) with control for wage market participation. The cognitive achievement production function estimates indicate that teachers' quality and the student/teacher ratio, in addition to time spent in school, are particularly important in determining student cognitive achievement. The cost estimates indicate that per-pupil costs rise with school quality. The earnings function estimates indicate that increasing quantity and improving quality, by raising cognitive achievement, yield a payoff in the form of higher wages.

Section 4 uses these estimates to simulate the rates of returns to alternative investment strategies. The social rate of return of 2.8 percent to enabling graduates of low-quality primary school to complete middle school is low compared to the social rate of return of 13.0 percent to improving the quality of primary schools or to the 18.2 percent return to increasing access to low-quality primary schools. From an efficiency perspective, at the margin resources are better allocated to primary schools than to middle schools and to increasing access to primary schools than to improving quality of primary schools. The social rates of return to investing in primary schools are high in comparison to other widely available investments. Our results further suggest that pursuit of at least some widespread equity goals does not conflict with greater efficiency in schooling investments: those who are relatively disadvantaged -- particularly girls -- are likely to be the beneficiaries of investments in primary schooling in general, and of expanded access to primary school in particular.

Section 1. Conceptual Framework

Both the quantity and the quality of schooling received are assumed to be determinants of a child's cognitive achievement, which in turn is presumed to be a determinant of that child's subsequent productivity and wage earnings.[5] For our sample, all schools were public and over 98 percent of those who attended schools attended schools in their own or nearby villages.[6] Our analysis focuses on primary school (generally kindergarten plus five grades) and middle school (grades 6-8) because relatively few children continued beyond middle school.

We calculate the social rates of return (i) to attending a low-quality primary school where no school has been available, (ii) to middle schooling for a graduate of a low-quality primary school and (iii) to augmenting the quality of primary schooling based on (a) the estimated lifetime earnings profiles for these three options[7] and (b) the estimated total public and private cost of each option. A major component of the private cost is the opportunity cost of time of the student, which we assume is the same for a given level of schooling independent of the quality of that schooling. For example, we assume that a student who attends an improved quality primary school would not have been in the labor market, but rather would have attended a low-quality primary school, so there is no opportunity cost of time associated with investing in quality improvement for such students.[8] The zero opportunity cost of improving quality is likely to have an important influence on the rate of return to that alternative relative to the rate of return to increasing quantity.

To estimate rates of return to improving quality and to increasing quantity we require measures of each of

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[5] Increased cognitive achievement generally is thought to be a major product of schooling. There may be other products as well (e.g., increased discipline), but we do not have measures of them, so we proceed as if cognitive achievement is the key output of schooling (and/or is highly correlated with other products).

[6] Subsequent to our sample there has been an expansion of private schools in Pakistan, including in rural areas (e.g., Lloyd, Mete and Sathar 2002, Sather, et al. 2002).

[7] As in most of the previous literature on school quality, we include in our analysis only the returns that are captured in earnings (and not effects on health, nutrition, fertility, and enjoyment of leisure time). For Pakistan there is some recent work that considers the impact of school quality on fertility (Sathar, et al. 2002).

[8] If improved school quality induces increases in primary or post-primary enrollments as is suggested in some studies (e.g., Glewwe and Jacoby 1994, Lloyd, Mete and Sather 2002), we underestimate the opportunity cost of time and the returns for such quality improvements by our focus on students who just complete primary school or just complete middle school. This results in an underestimate of the private returns to quality improvements because the private returns for such students must outweigh the private costs for them to be induced to attend more schooling, though it is possible that the incremental social costs of publicly-provided inputs outweigh the private gains. The effects on primary school enrollments are likely to be small in the context that we study because over 90 percent of the children of primary school age already attended primary school if such schools were available in their villages

the various components of benefits and costs. Our estimates emerge from relations (1)-(4) below plus estimates of the opportunity cost of time. The availability and quality of local schools is assumed to be determined by district and higher level decisions, but not in direct response to household demands and village characteristics.[9] Cognitive achievement is determined by time in school (schooling attainment), school quality, and individual characteristics in a cognitive achievement production function (relation 1). Schooling attainment is determined simultaneously with cognitive achievement by a reduced-form demand relation (relation 2). Schooling attainment is identified in the cognitive achievement production function by its dependence on out-of-pocket costs (P) and family background characteristics (F). The data do not include the prices of the individual inputs into school quality, but only total school expenditures. Costs per student at each school therefore are estimated to depend upon schooling attainment, school quality, and (to allow for unobserved heterogeneity) by gender[10] and region (relation 3). Wage earnings in relation (4) depend in part on the output of schooling, i.e., cognitive achievement, which is identified by variables that determined previous schooling decisions (P, F, QS).

(1) $CA = CA(SA,QS,A,G,RA,R)$,

(2) $SA = SA(QS,A,G,RA,F,R,P)$,

(3) $SC = SC(SA,QS,G,R)$

(4) $E = E(CA,EX,G,R)$,

where A is age; E is wage earnings; EX is post-schooling work experience; F is a vector of family background characteristics including parental education and household income; CA is cognitive achievement; G is gender; P is a vector of prices faced by households including school fees, transportation costs and costs of books and of other supplies for schooling; QS is a vector of quality characteristics of schools attended; R is region; RA is reasoning ability; SA is schooling attainment; and SC is school costs.

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[9] Rosenzweig and Wolpin (1986), Behrman and Birdsall (1988), Pitt, Rosenzweig and Gibbons (1993), and Gershberg and Schuerman (2001) suggest that governmental decisions regarding the supply of public schools and other services may respond to local demands for schooling. In Alderman, Behrman, Ross and Sabot (1996b), we assess whether or not a sample village has a primary school depends on average village household income, strength of linkages between the village and regional government, and other village characteristics. With district controls included, none of these possible determinants has a statistically significant effect. School supply decisions by higher-level governments appear to be taken without reference to indicators of village-level demands. This suggests that as long as we include district controls, the use of school availability as a predetermined control in our analysis causes neither omitted variable nor selectivity bias.

[10] Almost all schools in rural Pakistan, and all schools in our sample, were single sex in 1989.

Section 2. Data

The data requirements for the estimation of the key parameters in the conceptual framework in Section 1 are substantial: individual data on ability, school attainment, cognitive achievement, wage earnings, labor force experience and alternatives to wage labor force participation; household data on parental education, income and prices faced by the household; school data on student/teacher ratios, teacher quality, and other school inputs. A major reason that previous studies have not adopted the estimation strategy that we utilize, in fact, is that the data demands are considerable and most data sets used for related studies have major data shortcomings. We have collected data that permit us to estimate fairly satisfactorily the key parameters in the conceptual framework though, as discussed below, even the data that we collected for this purpose have limitations. for example with regard to sample sizes and the precision of some of the estimates that we obtain.

We, under the auspices of the Pakistan Ministry of Food and Agriculture, administered a multipurpose survey to a panel of 800+ rural households containing over 7,000 individuals drawn randomly from villages in three relatively poor districts -- Attock in the Punjab, Dir in the North West Frontier Province (NWFP), and Badin in the Sind -- and one relatively prosperous district -- Faisalabad in the Punjab.[11] We developed human capital modules that were administered in the spring of 1989. These modules contain inter alia measures for individual respondents of the variables needed to estimate our model: i.e., family background, school availability, educational attainment, reasoning ability and cognitive achievement. A separate questionnaire to yield indicators of school quality and costs was administered to teachers in the schools attended by sample members. We now describe the data critical for estimating relations (1)-(4).

Cognitive Achievement (Relation 1) and Schooling Attainment (Relation 2)

For the estimation of the schooling attainment functions (relation 2), we focus on the 670 respondents between age 10 and 25 who had an opportunity to attend one of our sample schools and for whom we have measures of all relevant variables.[12] Of these, 221 respondents completed at least four years of school and have all

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[11] The only province not represented, Baluchistan, has a small proportion of the rural population.

[12] As noted below, respondents under 10 years of age did not take our test of reasoning ability; respondents with less than four years of school did not take the reading or math test. Current school characteristics are an imperfect measure of school quality for respondents who attended primary school in earlier years. Because the probability that a school was available is higher for our younger respondents and because a number of rural Pakistanis start school late, our sample has a higher number of respondents still in primary school than one would expect in a similar age cohort in most other countries. In fact 57% of the sample was still in school and 76% was in school or within five years of leaving school, so school characteristics at the time of the survey are a good approximation to

the variables necessary for the estimation of the cognitive achievement production function (relation 1). Table 2 presents descriptive statistics for the variables used in our analysis. (The greater representation of boys than girls reflects in part the differences in single-sex school availability described in Table 1.)

Cognitive achievement: Our measure of the dependent variable in relation (1) was generated by administering (in the regional language) to every person in our sample more than 10 years old, and with at least four years of schooling, tests of literacy and numeracy specially designed by the Educational Testing Service.[13] The tests appear appropriate for the population sampled: the distribution of the cognitive skill test scores is not truncated, exhibits substantial variance and appears to be normally distributed. Because there is a difference between the influence of school quality on the acquisition of literacy and numeracy, we report separate production estimates for each.

School attainment: The dependent variable of relation (2) is an individual and household choice variable, the result of balancing the cost of an additional year of schooling against the present value of the increase in expected future benefits due to the added cognitive achievement from another year of schooling. We report in Table 2 the mean level of current schooling (for those still in school) or completed schooling for all respondents for whom a school was available (the schooling-attainment sample) and who completed at least four years of school (the production function sample).

School quality: We consider three components of school quality: student-teacher ratio, teacher quality in reading and math instruction, and school environment (physical characteristics that enhance learning). The latter two are not directly observed in the data. However, our school survey contains a number of inputs into each. We chose

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the school characteristics that they experienced. Using an upper bound at age 25 balances imprecision resulting from such measurement error against the imprecision of a small sample. Setting the upper bound at age 20 reduces the sample size by 14% but leaves the production function estimates qualitatively unchanged though more imprecisely estimated

[13] Tests were administered only to those with at least four years of schooling. The scores of a subsample of the uneducated who were given the tests confirmed the appropriateness of assigning this group zero scores. Respondents with one to three years of school and qualified respondents who failed to take the test are kept in the sample for the estimates of the schooling attainment relations, but are treated as missing for the cognitive skills production function estimates. These tests have been used successfully in economic research in East and West Africa (see Boissiere, Knight and Sabot 1985, Knight and Sabot 1990, Glewwe 1996, Glewwe and Jacoby 1993, 1994, 1995). We assume that tests administered several years after the completion of school accurately measure cognitive skills at the time of termination of school for the minority of the sample which has completed school (see the previous note). Exploratory estimates indicate that time and experience subsequent to schooling neither augment nor depreciate significantly cognitive skills. Therefore, we do not include age in the estimates that are presented in Table A.6. For further consideration of this variable and of alternative specifications of the cognitive achievement production function, see Behrman, Khan, Ross and Sabot (1997).

those for inclusion that seemed plausible a priori based on the schooling literature for developing countries. The teacher characteristics are average teacher reading and math scores based on the same cognitive achievement tests used for respondents in the household survey, average teacher reasoning ability, average teacher schooling attainment, average teacher experience (years in teaching), fraction of teachers born in village (who are alleged to be more effective ceteris paribus), fraction of teachers who attended teacher training institutes, and fraction of teachers with in-service training. The school environment is measured by dummy variables that are 1 if classroom instruction is in same language spoken at home, if there is sectioning based on ability, if there is a boundary wall, if the school has electricity, if the school has its own water supply, if there are toilets for teachers, and if there are toilets for students. Regional dummy variables represent school quality differences not captured by these measures.

Household characteristics: Household characteristics can affect the demand for schooling. We include measures of parental schooling and household income. The low level of schooling attainment for parents (in our sample none of the mothers from the district of Badin had completed primary school) in comparison with the schooling for their children suggests the progress that Pakistan has made in expanding the rural educational system. We use predicted rather than observed household income in relation (2). Pakistani rural incomes vary substantially from year to year; therefore, current income may be a poor indicator of a household's permanent income or of the income at the time the schooling decision was made. Predicting income on the basis of parents' assets and other characteristics yields an unbiased measure of past family income.[14]

Individual characteristics: Age plays an obvious role in the schooling attainment relation. We include it in the cognitive achievement production functions as a partial control for cohort effects, the possibility that school quality may have changed over time, and to allow for the possibility that children who start school later or who repeat grades have different cognitive skills for the same level of schooling attainment.[15]

[14] To obtain predicted income, we first regressed current household income on parental characteristics including education, employment, and acreage farmed, if any. We then used the parameters of this equation together with measures of the corresponding variables for the respondent's parents to obtain a measure of the parents' permanent income in 1989 rupees. Similar procedures have been used in a number of studies for developing countries. Behrman and Knowles (1999), for example, cite some such studies and report estimates for Vietnam that indicate a much higher association between parental income and various dimensions of school success if such a measure is used than if current income is used.

[15] For example, nutrition in the womb, in infancy and in early childhood is thought to affect importantly cognitive development (Martorell 1999). Several recent studies find important effects of pre-school nutrition, including in Pakistan, on age of starting school and other aspects of school success (e.g., Alderman, Behrman, Levy and Menon 2001; Glewwe and Jacoby 1995; Glewwe, Jacoby and King 2001; Glewwe and King 2001).

We administered Raven's (1956) Coloured Progressive Matrices (CPM), a non-writing test of reasoning ability that involves the matching of patterns, to everybody in the sample 10 years of age or older. This test has been used to control for ability in a number of economic studies (e.g., Boissiere, Knight and Sabot 1985, Knight and Sabot 1990, Glewwe 1996, Glewwe and Jacoby 1993, 1994, 1995) and in the epidemiological literature (e.g., Nokes et al. 1992a,b). The test is designed so that formal schooling does not influence performance, though performance may reflect early childhood environment as well as innate capacity. The distribution of the Raven's test scores is not truncated at either tail, exhibits substantial variance and appears to be normally distributed. Though this test was designed to be gender neutral (Raven 1956, Court 1983), there is a significant gender difference in the distributions of these scores for our sample, as well as significant regional differences.[16] Therefore, we control separately for gender and region in our estimates, so that gender and regional effects are not attributed to the ability scores. Our results are not much altered by dropping the Raven's test from the specification.

Schooling prices: The data set includes expenditures on books and school supplies. These expenditures are dependent not only on prices, but also on households' preferences and income. To obtain the exogenous price component, we estimated educational expenditure functions and then used these functions to estimate exogenous prices. These functions include a vector of household characteristics, dummy variables for district, level of schooling, gender, and whether the school was located in the village or a nearby town. The household variables were then held constant to predict the exogenous components of these prices. Because of the high correlation among costs for books, clothing, and other fees, we include only textbook prices in our estimates.

School Costs (Relation 3)

We lack price data for individual school-related cognitive achievement inputs, but have total school cost data. Therefore, we derive estimates of primary and middle school cost per student and how primary school cost varies with quality from our sample of 75 primary schools and 36 middle schools (Table 3). We formulate a hedonic function (relation 3) in which primary school cost per student is a quadratic function of number of teachers, number of students, the school quality indices, along with gender and regional dummies. For each school, we calculate average variable cost as the sum of teacher pay per student and recurring nonsalary annual expense per student. We lack data on the annual amortized capital costs attributable to each student, but the physical characteristics of the

[16] We examine in detail the distributions of the Raven's scores in our sample in Alderman, Behrman, Khan, Ross and Sabot (1993) and of the gender gap in particular in Alderman, Behrman, Ross and Sabot (1992, 1996b). Our exploration of the gender gap in Raven's scores tentatively suggests that it is due to early childhood acculturation that is not otherwise related to the variables in the present analysis.

primary schools in our sample suggest that these costs are small. We also calculate, from the household survey, annual out-of-pocket expenses for each child currently in school (Table 7, Panel 2).

Earnings Function (Relation 4)

We use monthly earnings from wage employment for 1941 respondents 15 years of age and older (Table 4). Although the nonagricultural wage labor market has expanded dramatically in rural Pakistan, it remains much smaller than in high income countries. Just over 25 percent of men and fewer than 5 percent of women in our sample list nonagricultural wage labor as the primary activity. In equilibrium, if hours of work in the wage market are flexible and there are not substantial structural impediments, individuals who participate in the wage market obtain the same return at the margin from participating in that market as they would in own-farm or household activities. We have evidence of some mobility between nonagricultural wage employment and other activities in our sample: First, 8 percent of respondents not engaged in wage labor at the time of the survey report past spells of wage labor employment. Second, average wage experience for wage workers at the time of the survey represents less than 60 percent of their average total work experience.

Though our focus is on the impact of cognitive achievement on earnings, we include other human resources in order to control for their effects: total work experience, wage labor work experience, schooling attainment, reasoning ability and anthropometric indicators of health and nutrition status.[17] Total work experience is the difference between current age and the age at the completion of schooling or 15, the standard measure of potential post-schooling work experience used by Mincer (1974) and others. However, we include only experience obtained when individuals are at least 15 years old, as in Behrman and Birdsall (1983), under the assumption that labor performed by children younger than 15 does not have a direct effect on their subsequent adult human capital stock.[18] The total experience measure is important if general maturity or work of any type -- not just wage work -- enhances productivity. Wage labor experience is the total of all spells of wage employment based on recall data. Actual wage

[17] A number of studies have explored the impact of anthropometric measures on wages and productivity in developing countries. Strauss and Thomas (1998) provide a fairly recent survey.

[18] While most studies of earnings functions ignore experience prior to the termination of schooling, among the studies that do include such experience there is some controversy regarding whether such experience has impact on post-schooling earnings. In a recent study, for example, Hotz, et al. (2002) find that what appears to be significant effects for males in the United States with some estimates is not significant in their preferred estimates with control for such factors as unobserved heterogeneity. There may be indirect effects in our case if such child labor is associated with schooling attainment so that the estimated impact of schooling attainment includes the correlated impact of child labor. Very few children in the sample who are younger than 15 have wage market experience.

work experience may be rewarded in the labor market differently than total experience. Most studies of wage determination have measures akin to total work experience (often measured potential experience measured as age - years of schooling - six), but not to wage labor experience.

Section 3. Estimates of the Key Relationships

Cognitive Achievement Production Function (Relation 1) and School Attainment (Relation 2): To obtain estimates of the parameters of relations (1) and (2), we begin by assuming that the residuals of the cognitive achievement production and the schooling attainment reduced-form demand relation are normally distributed. Because it is relatively parsimonious and takes account of the interaction among the major inputs, we use a multiplicative (Cobb-Douglas) functional form -- with gender and regional dummies serving as shifters for the constant and with Teacher Quality = the teacher quality indicators multiplied by a vector of parameters. In effect, we are creating a teacher quality index as a linear combination of the appropriate variables, estimating the weights as part of the likelihood estimation.[19]

Because the precise parameterization of the schooling attainment function is less critical to our rate of return calculation, we assume that desired schooling attainment is a linear function of all the variables included in the cognitive achievement production function plus the family background and school price variables -- with the exception of age, which enters quadratically. We do not observe the latent continuous schooling attainment variable, SA^*. The probability that a respondent who has completed his or her schooling is observed as completing grade j is the probability that SA^* lies between threshold parameters τ_j and τ_{j+1}. This is the standard ordered probit model. However, our sample contains a number of students still in school, for whom we do not observe final schooling attainment.[20] The probability that a particular respondent who is still in school will have completed grade j is the probability that $SA^* > \tau_j$. The variance of the residual of the schooling attainment function is normalized to one. We obtain estimates of the coefficients of the cognitive achievement and schooling attainment functions by maximizing the bivariate normal likelihood function for both residuals using GAUSS. Table 5 gives parameter estimates for the reading and math cognitive achievement production functions. For both reading and math cognitive achievement, Wald statistics reject null hypotheses that all but the intercept coefficients are zero at the 1 percent significance level

[19] One of the index component weights is set to one to obtain estimates for the other weights.

[20] This does not cause a right-censoring problem (as explored in King and Lillard 1987) because we are interested not in the final schooling attainment but in schooling attainment at the time that the cognitive achievement test was taken.

for the entire model, and for the production functions.[21] All else equal, a 10 percent increase in schooling attainment raises reading and math scores by just over 4 percent. A 10 percent increase in the teacher quality indices raises the predicted reading test score by 2 percent and the math score by 1 percent.[22] Lowering the student-teacher ratio by 10 percent raises the predicted reading score by 2 percent and the predicted math score by 1 percent. All else equal, age has no effect on the reading score. However, a 10 percent increase in age lowers the math score by 3 percent. In other estimates, we found no evidence that cognitive achievement varies in a systematic way with years since leaving school. It may be that the age coefficient in the math production function reflects the higher age of weaker students who have been required to repeat grades or who started school when they were older. Or, it is possible that the quality of math instruction, but not reading instruction, has risen over the time period that our respondents were in school.

School Costs: The cognitive achievement production functions indicate that schools can influence cognitive achievement by altering teacher quality and the student teacher ratio. Table 6 presents parameter estimates for the regression of public annual recurring expenditures per pupil on number of students, teachers, and average teacher quality indices (using the weights estimated in the production function) entered quadratically as well as on gender and regional dummy variables. The individual coefficients are difficult to interpret because of the quadratics and interactions. But F-statistics reject insignificance at the 1 percent level for coefficients involving students (29.5, degrees of freedom = 5,56), teachers (37.8, df = 5,56), and teacher quality (5.5, df = 10,56), but not for the gender and regional dummy variables (1.3, df = 4,56). At sample means, public costs per pupil fall with an increase in students, and rise with increases in teachers, teacher reading quality, and teacher math quality.

We also regressed on these same variables out-of-pocket household expenditures on uniforms, fees, books

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[21] We also explored including family background and school environment variables directly in the cognitive achievement production functions in addition to their effects through school attainment (with identification of school attainment only through prices). But with this specification, a wide range of alternative estimates of the parameters of the family background and school environment indices are consistent with being at the top of the likelihood hill so that there is not convergence due to the statistical insignificance of the coefficients for these two indices. Therefore, we dropped them from the production functions (but left the component variables in the schooling attainment relation). This implies, for example, that we can not confidently identify the relative importance of teaching quality and school infrastructure in overall school quality even through our results that school quality is significant and important are robust to this and a number of other specification changes.

[22] The coefficient estimates for the terms in the teacher quality indices are sensitive to the exact specification, but those for the total impact of teacher quality are robust to such specification changes. Wald statistics for the null hypothesis that the teacher quality exponent and component coefficients are zero are 20.29 and 801.06 for reading and math respectively. Both are significant at the 1 percent level.

and other supplies for each respondent attending one of the sampled school at the time of the survey. Because the regression had no explanatory power, we conclude that private costs do not vary with school quality. As Panel 2 in Table 7 indicates, school costs per pupil are higher for middle school students than for primary school.

Wage Earnings Function: We estimate semilogarithmic earnings functions, as is almost standard in the literature and which form is supported by some well-known explorations of alternative functional forms (e.g., Heckman and Polachek 1974), with an additive dichotomous variable for gender.[23] Our data offer measures of a number of dimensions of human capital: cognitive achievement, actual wage market experience, total labor market experience, school attainment, reasoning ability, and anthropometric indicators of health and nutrition. But only cognitive achievement and the experience variables add significantly to earnings variance, so we limit our specification here to these human capital measures. These explorations also indicate no significant difference between the earnings impact of reading versus math cognitive achievement, so we include total cognitive achievement in our estimates here.

Earnings regressions frequently suffer from two major statistical problems. First, human capital stocks reflect past household investments, and hence are endogenous. If these investments in human capital are made in response to unobserved individual characteristics such as motivation and inherent robustness, the estimates of the human capital-productivity relationship may be subject to simultaneous or omitted variable biases. For example, if human capital investments are greater in children with greater motivation or whose parents are socially or politically well-connected, then the usual earnings function estimates capture not only the effects of human capital, but also the effects of these correlated factors. Depending on the direction of these correlations, the coefficients on the human capital variables can either be biased toward zero or biased upward. Second, Table 4 indicates substantial differences in characteristics between wage workers and all adults. Because these differences reflect individual decisions to participate in the wage market and wages are only observed for wage market participants, ordinary least squares coefficients may suffer from selectivity bias. To the extent that participation is positively related to the human capital indicators, the coefficients on the human capital variables in an ordinary least squares wage equation are likely to be biased downward. As noted in the introduction, the previous literature on the impact of school quality on earnings generally has ignored the endogeneity of human capital, though in some cases there are efforts to control for selective labor force participation.

We deal with endogeneity of human capital investments by using estimated instrumental variable values of

[23] Much of the previous literature on gender wage differentials has found that only a dichotomous variable is significant within a semilog specification. Because we have so few women wage earners in our sample (see Table 4) we have not explored whether interactions between gender and human capital might be significant.

our human capital variables, which yield consistent estimates. These instrumental variable estimates effectively purge the human capital variables of components such as unobserved abilities and physical robustness that, if not eliminated, may cause biases. To identify human capital variables in the current wage and wage market participation functions, we must have among our first-stage instruments predetermined variables that do not enter directly into the current earnings functions. Variables that affected the accumulation of these human capital stocks in the past (e.g., distance to schools when of school age, primary book costs, parental schooling, ability) serve this purpose. To construct these estimates we also use our knowledge that cognitive achievement, schooling attainment, and wage labor experience are truncated at zero for our sample, so they are related to the first-stage variables in a nonlinear manner. We do not instrument total experience: most respondents in the sample concluded school before they were 15 years old, so total experience primarily reflects age or maturity. The details of the estimation are discussed in the Appendix.

We deal with selectivity by joint maximum likelihood estimation of the wage relation and of current wage participation as a comparison between wages and the returns to alternative activities.[24] The returns to alternative time use, in turn, are affected by a set of variables that do not enter directly into the wage relation, so they permit identification of the selectivity control in the wage relation. These variables are the distance to workplace identified by market or town, the current number of males over age 16 in the household, and current rainfed and irrigated land held by the household (Table 4). The human capital variables themselves, of course, also enter into the wage participation determination because they affect the wages and possibly the returns to other uses of time. They are treated as endogenous for such estimates, in which case they are identified by their dependence on variables that are predetermined from the point of view of investments in children's human capital (such as schooling prices and parental schooling) that are assumed not to have <u>direct</u> effects on current wage labor force participation but only indirect effects through the human capital stocks.[25] The details of the estimation are discussed in the Appendix.

Table 8 gives the estimates of the log earnings function. Increased cognitive skills significantly raise monthly

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[24] The use of selectivity controls is designed to yield estimates that are consistent. In small samples, it is possible for efforts to control for selectivity to worsen the observed bias--particularly where the selectivity controls excluded from the relation of interest are weakly related to the selection decision and/or highly correlated with variables in the relation of interest (e.g., Mroz 1987, Newey et al. 1990). Because our excluded selectivity controls are significantly related to wage market participation, this is not a serious problem for our estimates.

[25] Schooling attainment, cognitive achievement, and height are determined early in the life cycle, prior to wage labor market participation and prior to adulthood (including the possibility of establishing a separate household), so the first-stage variables do not include the current variables that affect current wage labor participation. BMI and wage participation are determined by both longer-run (e.g., BMI through height) and current variables (e.g., BMI through weight), so the first-stage variables include both the earlier childhood variables and the current variables.

earnings. We reject the null hypothesis that the four experience coefficients are zero (Log-likelihood ratio chi-square = 19.71). We rely on the inverted U pattern of earnings implied by the individual coefficients despite the imprecision resulting from multicollinearity.[26]

Section 4. Rates of Return

Based on our cognitive achievement production function estimates (relation 1) and the sample means (Table 2), we derive the predicted cognitive achievement scores for three schooling investment alternatives (holding all other characteristics at their sample means): (1) enabling a child to complete a low-quality primary school (five years), where no school previously was available, (2) raising the quality of a primary school from low to high, and (3) enabling the graduate of a low-quality primary school to complete middle school (a total of eight years). A low- (high-) quality primary school is defined to be one with each of the teacher quality indices set to one-half standard deviation below (above) the sample mean and the student-teacher ratio set to one-half standard deviation above (below) the mean.

The top panel of Table 7 gives predictions of cognitive skills for these cases. The impact of quality differences on cognitive achievement is substantial relative to the effect of increasing schooling attainment. Raising the quality of primary school raises cognitive skills by 3.1 points (23.2-20.1) or 65 percent of the gain a student from a low-quality primary school would have realized from completing middle school.

Drawing on the regressions from Table 6, we calculate the public expenditures per pupil at each school quality level (the first line of the second panel of Table 7) and record (second line) annual private-out-of-pocket expenditures per pupil for primary and middle schools.

On the assumption that rural Pakistanis not in school typically enter the wage labor market at age 15, we use the estimated wage of a respondent with no experience as a measure of the opportunity cost of schooling for a 15-year old.[27] The last panel of Table 7 draws on the sample means and the estimates of relation (4) to estimate the

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[26] The rate of return calculations reported below do not change much when we reestimate the earnings function dropping the two wage experience terms.

[27] Our wage-relation sample includes one 13-year old and one 15-year old with no years of experience. Their wages and those of older teenagers with one or fewer years of experience average about 700 rupees higher than the predicted value for a respondent with no schooling but otherwise at the sample mean. Thus, this estimate may understate the opportunity cost of attending primary school and, hence, overstate the return to a low-quality

annual wage earnings of a 15-year old with no schooling or with five years of schooling at a low-quality or high-quality primary school. To represent the opportunity cost of younger children, we assume that there is zero opportunity cost to attending the first grade, but that the opportunity cost rises linearly until it reaches the market wage at age 15.[28]

The benefits of improving the quality versus increasing the quantity of schooling are represented by the discounted present values of the resulting increases in post-schooling lifetime (four and a half decades) earnings. We project the lifetime earnings trajectory using the estimates of relation (4) presented above, sample means for gender and region, predicted cognitive skills from Table 7, and by increasing total experience for each year. To predict increments to wage experience, we use the coefficients relating wage experience to total work experience presented in the Appendix.

With these components in hand, we perform the following simulation exercise. A student enters primary school at age 8 and attends school for five years. The level of cognitive skills, hence earnings, achieved and the annual cost borne depend on whether the student (a) attended a low-quality primary school or (b) a high-quality primary school. If the student leaves after primary school (at age 13), the student enters productive work at age 15 and works until age 60.[29] As a third option, a student attends three years of an average-quality middle school after attending a low-quality primary school. That student starts productive work at age 16 and works for 44 years.

Table 9 reports social and private returns[30] for the three schooling investment alternatives. The rates of return to the provision of middle school and low-quality primary school do not incorporate capital costs and are, therefore, overstated. The rates of return to improving quality are understated to the extent that improvements in quality reduce

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primary school.

[28] Appendix Table A1 explores the sensitivity of our estimates to this assumption by having opportunity costs fall linearly to zero at ages 7 or 9; the rates of return, in particular to low-quality primary school versus no school, increase as the age through which the opportunity cost is assumed to be zero is increased.

[29] The choice of age of retirement has no effect upon the relative ranking of returns. The impact of alternative assumptions regarding the value of work before age 15 in the simulation is explored in Appendix Table A.1.

[30] The private returns estimates subtract public expenditures from the costs before calculating the rates of return.

repetition rates, and hence recurrent costs.[31] All rates of return are understated to the extent that social benefits exceed private benefits or to the extent that there are private benefits (e.g., better health and nutrition, better information processing capacities for purchases and greater efficiency in household production) that are not included in these calculations.[32]

The social rate of return to enabling the graduate of a low-quality primary school to complete middle school -- 2.8 percent -- is low compared to improving school quality -- 13.0 percent -- or providing access to a low-quality primary school -- 18.2 percent. The relatively high rate of return to improving quality reflects the absence of any additional opportunity cost to the students and the absence of higher capital costs for students already enrolled in school. Because estimated private costs do not increase for higher as opposed to lower quality primary schools, the private returns to improving school quality are effectively infinite -- that is, there is an increase in expected labor market returns with the public sector covering all of the cost.

Section 5. Conclusions

While interest in estimating the impact of indicators of school quality on earnings has increased, most research on this topic has had important limitations: ignoring behavioral decisions regarding schooling; omitting individual and family background characteristics; using excessively aggregated school quality measures; and relying on crude indicators of teacher quality. These limitations may explain why the micro evidence of important school quality effects on earnings has been scant. Moreover, the question of the relative rates of return to improving school quality versus increasing school quantity hardly has been addressed.

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[31] A number of studies indicate that in various developing country contexts changes in grade repetition rates may be important means for affecting schooling success. Gomes-Neto and Hanushek (1994, 1996) and Hanushek, Gomes-Neto and Harbison (1996) present evidence that in Brazil the reduction of repetition and associated costs, induced by higher school quality, would exceed the cost of improving school quality. Behrman and Knowles (1999) report that in Vietnam the most important difference associated with parental income is the repetition rate. Behrman, Sengputa and Todd (2002) find that a major channel through which scholarships work in Mexico's well-known rural Progresa program is through reducing repetition.

[32] In equilibrium if hours of work in the wage market are flexible and if there are no transactions costs to participating in the wage market, individuals who participate in the wage market obtain the same return at the margin from participating in that market as they would in own-farm or household activities. But individuals who do not participate in the wage market must get at least as high returns at the margin in own-farm or household activities than they would in the wage market.

The data demands for estimating such rates of return are considerable. We developed a conceptual framework for undertaking such estimates, collected the necessary data for rural Pakistan, and made estimates with methods that overcome in part the major limitations noted. Despite our considerable efforts to obtain data especially for this study, however, one conclusion of the study is to reinforce how difficult it is to obtain sufficient data for the research strategy that we devised. Our results must be qualified, for example, because we are not able to identify confidently the weights of the individual components of school quality. Subject to such qualifications about some aspects of the study, we think that our estimates nevertheless have some important implications for schooling in rural Pakistan, which we now summarize .

In rural Pakistan, increasing the quantity of schooling a child receives raises his or her cognitive skills. Improving school quality has the same effect. Increasing the quantity of schooling -- by providing a primary education to children who otherwise would not go to school, or by providing a middle school education to children who otherwise would leave school upon the completion of primary school -- entails substantial costs. Similarly, social direct costs rise with the quality of primary schools. However, in this case, there is little or no change in the opportunity cost of student time -- a large component of the total cost of schooling.

Higher cognitive skills are rewarded with higher wages in rural Pakistan, presumably because more skilled workers are more productive. Because they are more skilled, graduates of even low-quality primary schools earn more than uneducated workers. In like manner, graduates of high-quality primary schools and graduates of middle schools who attended low-quality primary schools earn more than students who complete only low-quality primary schools.

Increasing the quantity and improving the quality of schooling are alternative means of increasing the productivity and earnings of the labor force. Our estimates of social rates of return indicate that improving the quality of primary schooling may be preferable to increasing access to middle schooling: the rate of return to improving the quality of primary schooling is substantially greater than the rate of return to increasing access to middle school, although it is somewhat lower than the rate of return to expanding enrollment in low-quality primary schools.[33]

In this context, it appears that productivity and equity concerns both point towards expanding primary

[33] Our estimates are based on micro data and thus subject to the Hoehn and Randall (1989) critique that they do not incorporate feedback effects and thus are likely to overstate the true returns. But the same critique applies to micro-based estimates of rates to return for other types of investments.

schools, even if they are of lower quality. And, because few boys now lack access to a primary school, girls will benefit disproportionately. More generally, the methods adopted here permit a more satisfactory assessment than previously of the rates of return to improving school quality versus increasing school quantity and their implications for educational policy.

Appendix

Table A.1 examines the sensitivity of the rate of return calculations presented in Table 9 to variations in opportunity costs.

Table A.2 presents estimates of relation (2), the schooling attainment function, used to control for selectivity into schooling and the simultaneous determination of cognitive achievement and years of schooling. Schooling attainment rises with father's education, family income, and reasoning ability, and the availability of middle school. It rises at a diminishing rate with age (the Wald statistic for the null that both age coefficients are zero is 24.11 for reading and 26.39 for math). Rising costs discourage schooling attainment. There are significant regional differences in schooling attainment, but ceteris paribus no differences by gender. We reject at the 5 percent (but not the 1 percent) significance level, the null hypothesis that none of he school quality variables has a significant effect on schooling attainment (27.49 for reading, 28.24 for math). Accepting that result, we find that the student-teacher ratio has no significant effect, the teacher quality variables have no significant effect (13.47 for reading, 13.97 for math), but that the school environment variables are jointly significant (20.14 and 19.05).

As noted in the text, in estimating relation (4), the wage earnings function, one must control for potential biases resulting from the endogeneity resulting from past and present investments in human capital and from selection into wage employment. The remainder of this appendix addresses our efforts to control for these two biases.

We deal with endogeneity of human capital by using estimated instrumental variable values of our human capital indicators. These instrumental variable estimates effectively purge the human capital variables of components such as unobserved abilities and physical robustness that, if not eliminated, may cause biases because such attributes may affect wages and therefore be included in the disturbance term of the wage relation. To construct these estimates we use not only variables that are predetermined from the point of view of the household, but our knowledge that three of these variables -- cognitive achievement, schooling attainment, and wage labor experience -- are truncated at zero for our sample for a variety of reasons (e.g., in the case of schooling, we observe no schooling when no school was locally available). We adopt estimation strategies that are consistent with these truncations, and therefore more efficient than if we were not to take the truncations into account. Height and Body Mass Index (BMI), in contrast, are not truncated. We do not instrument total experience because most respondents in the household sample concluded school before they were 15 years old so total experience primarily reflects age or maturity. As in relations (1) and (2), we treat ability as predetermined but find that alternative estimates in which this variable is constrained to have zero coefficient estimates do not differ significantly from those that we present in this paper.

Many (particularly older) Pakistanis had no school available when they were children, and thus had no schooling attainment and zero cognitive achievement. For those for whom a primary school was available,[34] we estimated (Table A.3) a probit equation relating the probability of attending school to the exogenous characteristics appearing in relation (2), excluding the school quality measures, because these are not available for respondents who did not attend one of the sampled schools or for respondents over age 25.[35] Village dummy variables (for villages with five or more respondents in the appropriate sample) proxy for school quality and other village level effects. We estimated separate probits for men and women younger than and older than 25 years. Significant determinants of the probability of starting school are age, family income (for the younger men), father's education (for women and older men), distance to primary school (for men and younger women), and primary book costs (for men). Conditional on starting school, we estimated also corresponding[36] ordered probits relating the level of schooling to exogenous characteristics. Age (women and younger men), family income (for younger men), father's education (for men), availability of middle school, distance to middle school (for men), and middle school book costs (for women and younger men) are significant determinants.

From the ordered probits we derive estimates of schooling attainment for those who have completed school. For children still in school, instrumenting years of schooling is a bit more complicated because current schooling will be less than expected completed schooling in most cases. We begin by estimating a tobit equation[37] relating age at

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[34] In Alderman, Behrman, Ross and Sabot (1996b) we explore whether the availability of schools in our sample responds to observed village-level characteristics. We find that the allocation of schools across villages appears neither to favor higher income villages (which would seem to have more political power), nor poorer ones (which might be favored if equity considerations were weighed heavily). Therefore, in these estimates we consider the availability of local schools to be given from the point of view of individual households.

[35] These characteristics in principle are the same for all of the outcomes that were determined in childhood (though perhaps different for adult labor force experience and BMI). Regional dummy variables were dropped to the extent they were perfect linear combinations of the village level dummy variables. Similarly, we dropped the dummy variable for mother's education; every respondent in the sample whose mother completed primary school attended school. The same problem led us to drop this dummy variable from the starting age tobit.

[36] Because of the small number of older women who started school, we did not attempt to obtain separate estimates by age cohort.

[37] Estimation results for the age and wage experience tobits and for the BMI regressions are available from David Ross.

the start of school to the same exogenous characteristics as in the ordered probit (Table A.5). Although we can reject the null hypothesis that all the explanatory variable coefficients are zero, the equation has low explanatory power. Nevertheless, by subtracting this predicted age from the current age, we derive predicted current years of schooling for those still in school. Instrumented years of schooling is then the minimum of current years of schooling predicted in this fashion and years of schooling as predicted by the ordered probit.

To create an instrument for cognitive skills, we build upon our previous explorations (Behrman, Khan, Ross, and Sabot 1997) to specify that cognitive achievement depends upon individual characteristics (ability, age, gender), parental household characteristics (parental income and schooling), and district and village characteristics (including school quality). Because we have found in these previous studies that there are differences between the determinants of cognitive achievement in reading and in mathematics, we also estimate the first-stage relations separately for reading and mathematics.

For the 221 respondents attending a sampled school, our instrument for cognitive skills is derived from the estimates of relation (1) presented in the text. Where school quality data were not available -- because the respondent did not attend one of the surveyed schools or was older than 25 -- cognitive skills are instrumented using regressions of math and reading test scores on the same set of exogenous characteristics used above. To control for cohort effects, we estimated the regressions (Table A.6) separately for those 25 and younger and those over 25. The inverse of the Mills' ratio controls for selectivity into grade 4--below which our tests of literacy and numeracy were not given. Gender-specific village dummy variables account for quality differences. These village dummy variables account for most of the explained variation in cognitive skills. Other significant determinants are ability, household income (reading score only, for the younger cohort), and father's education (for the older cohort).

Health status arguably (like our other human capital indicators) may not be independent of the disturbance term in the wage relation. Individuals who inherently are more robust, for example, may have better health indicators and command higher wage rates because they are more energetic. Haddad and Bouis (1991) treated shorter-run anthropometric indicators such as BMI as endogenously determined in wage relations, but not height. Yet investments in the health of children (as reflected in their adult height), as well as in their schooling, may respond to unobserved attributes (e.g., inherent robustness and energy) that are persistent and affect their adult wages. If so, then even such long-run indicators of human resources such as height should be treated as endogenous in wage estimates.

To obtain an instrumented value for height, the first stage relations include the same predetermined childhood variables as for the schooling-cognitive achievement system, but for height there is no need to be concerned about truncation. By far the best fit is obtained for younger men. Beyond the village level dummy variables, family income (younger men) and age cohort are significant determinants. Height, like schooling and cognitive achievement, is basically determined for this sample in childhood. However, an individual's body mass index and wage labor market experience are influenced not only by predetermined childhood variables, but also by predetermined variables to which the individual is exposed as an adult. BMI, for example, reflects not only the childhood determinants of height, but also the adult determinants of weight. Wage labor force participation, likewise, reflects both investments made while a child (e.g., schooling) and therefore the predetermined variables from childhood, but also the determinants of the relative returns to participating in the wage market versus other time uses as an adult. Therefore, the body mass index and wage labor market experience are instrumented by regressions on a set of variables relating to current household characteristics (i.e. those variables other than the individual's human capital that enter into the wage selectivity relation discussed below) as well as childhood characteristics (Table A.7). BMI is not truncated, but wage labor market experience is, so a tobit is used to allow for the sample truncation for respondents who have never held a wage job. Significant determinants of BMI are work experience (proxying for age), number of males over age 16 in the household (for women), household irrigated and rain-fed acreage, father's education, and whether father had been a wage worker (men). Significant determinants of wage labor experience are total work experience, whether father was a wage worker, household irrigated and rain-fed acreage, father's education, and availability of middle school.

We deal with selective wage market participation, by maximum likelihood estimates (estimated jointly with relation (4)) of current wage participation based on a comparison of the wages obtained versus the returns to alternatives. The returns to alternative time use, in turn, are affected in part by a set of variables (e.g., the distance to workplaces, the current number of males over age 16 in the household, and current rainfed and irrigated land held by the household) that do not enter directly into the wage relation, so they permit identification of the selectivity control in the wage relations. The human capital variables themselves, of course, also enter into the wage participation determination because they affect the wages and possibly the returns to other uses of time. As was the wage relation, the selectivity equation is susceptible to bias resulting from the endogeneity of the human capital variables. The instruments for these variables are identified in the selectivity relation by their dependence on variables that affected the accumulation of these human capital stocks in the past (e.g., distance to schools when of school age, primary book costs, parental schooling, ability) but that are assumed not to have direct effects on current wage labor force participation (but only indirect effects through the human capital stocks). Table A.8 presents coefficients for the selectivity controls estimated simultaneously with the earnings function presented in the text.

Table A.9, finally gives the estimated weights in the teacher quality index, which were estimated jointly with the cognitive achievement production functions in Table 8 and the schooling attainment functions in Table A.2.

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Table 1
School Availability for the 10-25 Age Cohort

	Boys	Girls	All Children
Primary	98%	565%	78%
Middle	89	46	69

Table 2 Sample Means and Standard Deviations
For Schooling Attainment and Cognitive Achievement Production Functions
Respondents 10-25 Years of Age with Primary School Available (Standard Deviations in Parentheses)

	Primary School Available (Attainment Sample)	Attended Primary School (Cognitive Achievement Sample)
Individual & Family Characteristics		
Female	34%	26%
Attock	27%	33%
Faisalabad	47%	51%
Dir	12%	7%
Badin	14%	9%
Reading Score		13.3
		(7.0)
Math Score		12.1
		(6.7)
Schooling Attainment	4.1	7.3
	(3.5)	(2.3)
Reasoning Ability (Ravens Score)	19.4	22.7
	(6.9)	(7.2)
Family Income (1000 rupees)	24.2	25.5
	(8.7)	(9.0)
Mother Primary or More	6%	11%
Father Middle or More	20%	31%
Primary School Book Cost Proxy	55.5	53.4
	(19.5)	(19.4)
Middle School Book Cost Proxy	216	216
	(74.4)	(68.9)
Middle School Available	92%	95%
School Characteristics		
Teacher Reading Score		19.7
		(5.2)
Teacher Math Score		18.0
		(7.9)
Teacher Reasoning Ability		27.0
		(6.4)
Teacher Schooling Attainment		10.3
		(2.6)
Teacher Experience		10.2
		(4.5)
Student/Teacher Ratio		57.6
		(37.9)
Teachers Born Here		22%
Teacher Training		96%
In-Service Training		26%
Instruction in Language Spoken at Home		18%
Sectioning Based on Ability		5%
Boundary Wall		33%
Electricity		27%
Own Water Supply		58.%
Toilets for Teachers		21%
Toilets for Students		15%
N	670	221

Table 3
Sample Means and Standard Deviations
For Public School Cost Per Pupil Estimates
And for Selected Primary School Characteristics

Primary School	
Annual Recurring Expenditure Per Pupil	496
	(434)
Students	225
	(227)
Teachers	5.0
	(4.6)
Teacher Reading Quality Index	14.2
	(5.3)
Teacher Math Quality Index	17.3
	(4.9)
Female	28%
Faisalabad	17%
Dir	33%
Badin	17%
N	75
Middle School	
Annual Recurring Expenditure Per Pupil	846
	(645)
N	36

(Standard deviations in parentheses)

Table 4
Sample Means and Standard Deviations
For Wage Earnings Function

	All	Wage Workers
Individual Characteristics		
Wage worker	11%	
Log (wage)		6.75
		(0.66)
Cognitive skills	4.3	13.9
	(10.8)	(16.7)
Years of schooling	1.3	4.4
	(3.2)	(5.0)
Ability	16.8	21.3
	(6.4)	(6.4)
Total experience	25.1	21.6
	(15.6)	(13.6)
Wage experience	2.3	13.0
	(6.8)	(11.0)
BMI (Body Mass Index)	20.4	20.1
	(1.9)	(2.)
Height (meters)	1.59	1.67
	(0.10)	(0.06)
Father was a wage worker	13%	16%
Female	54%	6%
Region		
Attock	20%	31%
Faisalabad	18%	20%
Dir	24%	19%
Badin	39%	30%
Household Characteristics		
Distance to work	19.4	17.2
	(10.8)	(20.8)
Males over 16	3.3	2.9
	(1.9)	(1.7)
Net transfers (000 rupees)	5.2	5.0
	(15.6)	(18.6)
Rain fed acres	2.7	2.9
	(9.5)	(11.0)
Irrigated acres	6.1	2.3
	(15.1)	(6.2)
N	1941	207

(Standard deviations in parentheses)

Table 5. Cognitive Achievement Production Function Estimates		
	Reading	Mathematics
Elasticities of		
Reasoning ability	0.328 (3.18)	0.263 (2.64)
Schooling attainment	0.426 (3.32)	0.442 (4.48)
Student-teacher ratio	-0.213 (2.15)	-0.181 (2.42)
Teacher quality	0.211 (2.55)	0.113 (0.73)
Age	-0.008 (0.06)	-0.342 (2.50)
Constant and additive terms	7.389	29.134
Female	1.404 (1.46)	-0.814 (1.29)
Faisalabad	1.439 (1.58)	2.434 (1.38)
Dir	-2.991 (1.51)	0.226 (0.31)
Badin	2.721 (1.32)	-0.225 (0.23)
sigma	5.431 (17.71)	5.488 (19.78)
rho	-0.053 (0.33)	-0.122 (0.95)

Notes: These are maximum likelihood estimates for the Cobb-Douglas cognitive achievement production functions together with the teacher quality indices (reported in Appendix Table A.9) and the schooling attainment selectivity (reported in Appendix Table A.2) for N=221. Sigma is the standard error of the production function. Rho is the correlation coefficient for the production and attainment function residuals. Absolute values of t-statistics are in parentheses.

Table 6 Public Recurring Annual Expenditures Per Pupil

Students	-3.204
	(2.68)
$Students^2$	0.004
	(6.58)
Teachers	166.412
	(2.76)
$Teachers^2$	-2.966
	(1.59)
Teacher Reading Quality Index (TRQ)	-9.721
	(0.22)
TRQ^2	-1.300
	(0.37)
Teacher Math Quality Index (TMQ)	-18.651
	(0.26)
TMQ^2	0.242
	(0.05)
Students x Teachers	-0.213
	(4.84)
Students x TRQ	-0.198
	(1.43)
Teachers x TRQ	17.609
	(2.49)
Students x TMQ	0.136
	(0.90)
Teachers x TMQ	-12.404
	(1.74)
TRQ x TMQ	1.744
	(0.25)
Female	30.468
	(.34)
Faisalabad	-136.902
	(1.69)
Dir	-129.723
	(1.58)
Badin	-150.028
	(1.44)
Constant	667.092
R^2	.784
F(18,56)	15.93
N	75

(t-statistics in parentheses)

Table 7
Predicting Cognitive Skills and Schooling Costs
For Student at Sample Mean

	Low-Quality	High Quality	Average
1.Predicted Cognitive Skills	Primary	Primary	Middle
Reading	10.5	12.2	12.9
Math	9.6	11.0	12.0
Total	20.1	23.2	24.9
	Low-Quality	High-Quality	Average
2. Schooling Costs (rupees/year)	Primary	Primary	Middle
Public Recurring Expense/Pupil	239	712	846
Private Out-of-Pocket	297	297	633
	With	With Low-	With High-
3. Opportunity Cost at Age 15	No School	Quality Primary	Quality Primary
	4088	5920	6269

Table 8. Log Earnings Functions	
Cognitive Skills	0.018 (3.58)
Total Experience	0.020 (1.38)
Total Experience^2	-0.0005 (1.79)
Wage Experience	0.269 (1.05)
Wage Experience^2	-0.032 (0.60)
Female	-0.772 (2.31)
Faisalabad	-0.201 (1.46)
Dir	-0.128 (0.83)
Badin	0.081 (0.59)
Constant	6.153
Sigma	0.064 (9.03)
rho	0.0466 (1.90)

Notes: Estimates for the selectivity control are in the Appendix. Absolute values of t statistics are in parentheses to the right of the point estimates.

Table 9
Rates of Return to Alternative Schooling Investments
For Student at Sample Means

	Social	Private
Low-Quality Primary vs. No School	18.2	20.5
Middle after Low-Quality Primary	2.8	3.5
High-Quality vs. Low-Quality Primary	13.0	*

Assuming linear extrapolation of age 15 opportunity cost to zero at age 8 (starting year of primary school).

*Effectively infinite (see text)

Table A.1
Sensitivity to Opportunity Cost Assumption of
Rates of Return to Alternative Schooling Investments
For Student at Sample Means

	Social		Private	
	(1)	(2)	(1)	(2)
Low-Quality Primary vs. No School	15.6	24.2	17.1	30.8
Middle after Low-Quality Primary	2.7	2.9	3.4	3.6
High-Quality vs. Low-Quality Primary	13.0	13.2	*	*

(1) Assuming linear extrapolation of age 15 opportunity cost to zero at age 7.
(2) Assuming linear extrapolation of age 15 opportunity cost to zero at age 9.

*Effective infinite (see text)

Table A.2
Schooling Attainment Function
Jointly Estimated with Cognitive Achievement Production Functions in Table 5

	Reading	Math
Female	-0.397	-0.3581
	(1.14)	(0.93)
Faisalabad	1.174	1.154
	(4.34)	(4.15)
Dir	-3.394	-3.289
	(4.52)	(4.33)
Badin	-2.670	-2.586
	(4.52)	(4.06)
Mother Primary or More	0.316	0.328
	(0.63)	(0.65)
Father Middle or More	0.331	0.348
	(1.91)	(2.00)
Family Income	0.035	0.034
	(4.81)	(4.58)
Age	.037	0.034
	(0.780)	(0.71)
Age^2	-.00002	-0.00002
	(1.78)	(1.75)
Reasoning Ability	0.058	0.059
	(6.46)	(6.51)
Student-Teacher Ratio	-0.002	-0.001
	(0.75)	(0.43)
Teacher Experience	0.006	0.012
	(0.36)	(0.72)
Teacher Reading/Math Score	-0.003	0.005
	(0.13)	(0.32)
Teacher Schooling Attainment	0.045	0.020
	(0.46)	(0.18)
Teacher Reasoning Ability	0.006	0.007
	(0.28)	(0.34)
Teacher Born Here	-0.186	-0.198
	(0.90)	(0.97)
Teacher Training	-2.593	-2.53
	(3.18)	(3.29)
In Service Training	0.031	0.032
	(0.14)	(0.14)
Instruction in Language Spoken at Home	1.001	0.963
	(2.00)	(1.80)
Sectioning based on Ability	-0.975	-0.984
	(3.88)	(3.89)
Boundary Wall	-0.315	-0.313
	(0.88)	(0.91)
Own Water Supply	0.248	0.277
	(1.28)	(1.41)
Toilets for Teachers	0.894	0.934
	(3.09)	(3.04)
Toilets for Students	-0.488	-0.504
	(1.73)	(1.73)
Electricity	-0.492	-0.512
	(2.26)	(2.10)
Distance to Primary School	-0.005	-0.005
	(1.41)	(1.55)
Primary Book Cost Proxy	-0.025	-0.025
	(5.09)	(5.05)
Middle Book Cost Proxy	-0.020	-0.020
	(5.48)	(5.42)
Middle School Available	4.850	4.819
	(5.22)	(5.14)
Selectivity Threshold 1	-7.445	-7.356
Selectivity Threshold 2	-6.288	-6.209
Selectivity Threshold 3	5.580	-5.500
Wald Statistic (dof)	405.17 (44)	1283.14 (44)
N	670	670

(t-statistics in parentheses)

Table A.3
Probability of Attending School Probits by Gender and Age

	Men	Woman	Men	Woman
	Age = 25	Age = 25	Age > 25	Age > 25
Reasoning Ability	0.057	-0.037	0.055	-0.010
	(1.12)	(0.25)	(0.94)	(0.04)
Reasoning Ability^2	0.0006	0.003	0.0006	-0.002
	(0.47)	(0.77)	(0.40)	(0.37)
Age	0.287	0.276	0.124	-0.315
	(4.09)	(0.99)	(3.16)	(1.86)
Age^2	-0.010	-0.004	-0.001	0.003
	(4.81)	(0.57)	(3.09)	(1.60)
Family Income	0.031	0.031	0.005	0.088
	(4.11)	(1.04)	(0.48)	(1.87)
Father Primary or More	0.119	-0.513	0.734	1.100
	(0.56)	(1.06)	(2.48)	(2.13)
Father Middle or More	0.113	1.323	0.314	0.914
	(0.35)	(2.21)	(0.62)	(1.10)
Middle Available	0.321	3.919	-0.242	9.366
	(0.45)	(0.03)	(0.25)	(0.03)
Distance to Primary	-0.042	-0.405	-0.061	-0.234
	(4.72)	(5.52)	(5.83)	(0.02)
Distance to Middle	0.024	0.373	0.028	0.322
	(2.58)	(4.42)	(2.47)	(0.02)
Primary Book Cost	-0.060	-0.051	-0.053	-0.075
	(9.48)	(1.41)	(5.23)	(0.009)
Middle Book Cost	-0.099	-0.034	-0.006	0.011
	(0.37)	(0.001)	(1.32)	(0.35)
Attock	1.379	7.472	1.671	7.121
	(1.73)	(0.03)	(3.57)	(0.06)
Faisalabad	1.051	0.475	1.417	5.270
	(3.29)	(0.27)	(3.36)	(0.03)
Dir	-0.996	4.218	0.597	3.343
	(2.09)	(0.07)	(0.87)	(0.02)
Log-Likelihood	-446.8	-263.6	-410.6	-77.5
N	745	384	593	121

(t-statistics in parentheses)
(village dummy variables suppressed)

Table A.4
Schooling Attainment Ordered Probits by Age and Gender

	Men	Men	Women
	Age = 25	Age > 25	
Reasoning Ability	0.051	0.140	-0.036
	(1.28)	(2.09)	(0.45)
$(\text{Reasoning Ability})^2$	0.0001	-0.002	0.002
	(0.29)	(1.04)	(1.03)
Age	0.398	-0.004	0.120
	(4.24)	(0.09)	(4.14)
Age^2	-0.006	-0.0003	-0.002
	(2.39)	(0.16)	(3.04)
Income	0.016	0.018	0.013
	(2.35)	(1.60)	(0.96)
Mother Primary or More	0.063	0.142	0.375
	(0.19)	(0.19)	(0.79)
Father Primary of More	0.039	0.215	-0.207
	(0.26)	(0.90)	(0.76)
Father Middle or More	0.305	0.667	0.305
	(1.49)	(1.60)	(1.04)
Middle Available	3.010	2.344	3.257
	(4.99)	(2.64)	(2.11)
Distance to Primary	0.022	0.017	0.025
	(4.48)	(1.70)	(2.41)
Distance to Middle	-0.008	-0.019	-0.023
	(1.69)	(2.41)	(1.19)
Primary Book Cost	0.002	-0.001	-0.010
	(0.33)	(0.22)	(1.15)
Middle Book Cost	-0.011	-0.005	-0.013
	(4.99)	(1.42)	(1.91)
Constant	-2.467	1.096	1.207
Grade 4 Threshold	0.000	0.000	0.000
Grade 5 Threshold	0.611	0.354	0.636
Grade 6 Threshold	1.386	1.534	1.760
Grade 7 Threshold	1.820	1.685	1.978
Grade 8 Threshold	2.262	1.809	2.182
Matric Threshold	3.095	2.432	2.723
FA/FSc Threshold	3.969	3.207	3.347
BA/BSc Threshold	5.167	3.668	3.764
Wald Statistic (df)	290.17 (52)	1140.33 (46)	179.7 (33)
N	531	285	255

(t-statistics in parentheses)
(village dummy variables suppressed)

Table A.5
Age at start of School Tobit and Height Regressions

	Age Starting School		Height			
	Men	Women	Men	Women	Men	Woman
	(Age 10-25)		10-25	10-25	Age > 25	Age > 25
Reasoning Ability	0.071	0.539	0.013	0.003	-0.001	0.000002
	(0.39)	(1.81)	(2.77)	(0.83)	(0.46)	(0.001)
(Reasoning Ability)^2	0.003	-0.013	-0.000	-0.00004	0.00003	-0.00001
	(0.72)	(1.74)	(2.34)	(0.43)	(1.11)	(0.08)
Age	1.142	0.708	0.105	0.007	-0.0004	-0.001
	(3.78)	(1.74)	(13.87)	(0.17)	(0.44)	(0.42)
Age^2	-0.039	-0.023	-0.002	-0.0001	0.0002	-0.000001
	(4.45)	(1.84)	(10.23)	(0.43)	(0.29)	(0.01)
Income	0.067	-0.011	0.001	0.001	0.001	0.001
	(2.65)	(0.26)	(1.72)	(0.97)	(1.81)	(0.97)
Mother Primary			0.020	-0.018	-0.058	0.009
			(0.46)	(0.25)	(2.60)	(0.24)
Father Primary	0.043	0.659	0.005	0.011	0.001	0.004
	(0.07)	(0.92)	(0.25)	(0.78)	(0.10)	(0.31)
Father Middle or More	0.276	1.769	-0.047	0.013	-0.007	-0.011
	(0.34)	(1.69)	(1.67)	(0.76)	(0.51)	(0.65)
Distance to Primary	0.010	-0.403	0.001	-0.0004	0.000	-0.002
	(0.49)	(11.37)	(2.46)	(0.44)	(0.96)	(1.26)
Distance to Middle	-0.063	-0.026	-0.001	0.004	-0.0002	-0.0003
	(2.96)	(1.37)	(1.19)	(1.30)	(1.07)	(0.47)
Middle Available	-3.155	4.974	0.221	0.030	-0.032	-0.064
	(1.48)	(1.25)	(4.37)	(0.28)	(1.11)	(0.62)
Primary Book Cost	-0.101	-0.023	-0.000	0.001	-0.0002	0.001
	(6.52)	(0.96)	(0.83)	(2.30)	(0.46)	(1.26)
Middle Book Cost	-0.015	-0.030	0.001	-0.001	-0.0003	0.0003
	(1.64)	(1.75)	(5.64)	(1.68)	(0.72)	(0.59)
Attock			-0.105	1.381		
			(1.95)	(2.95)		
Dir				1.412		
				(3.07)		
Badin				1.322		
				(2.83)		
Constant	2.013	5.845				
SER	5.248	5.074				
	(28.99)	(17.92)				
Rbar^2			0.505	0.259	0.113	0.142
N	745	383	379	244	792	682

(t-statistics in parentheses; village dummy variables suppressed)

Table A.6
Cognitive Skills Regressions
Math and Reading by Age

	Math	Reading	Math	Reading
	Age = 25	Age = 25	Age > 25	Age > 25
Reasoning Ability	-0.491	0.021	-0.432	0.665
	(1.49)	(0.06)	(0.74)	(1.02)
$(\text{Reasoning Ability})^2$	0.016	0.006	0.015	-0.008
	(2.33)	(0.77)	(1.26)	(0.63)
Age	0.205	0.342	0.450	-0.359
	(0.35)	(0.52)	(1.12)	(0.79)
Age^2	-0.003	-0.003	-0.005	0.005
	(0.21)	(0.18)	(1.00)	(0.98)
Household Income	0.033	0.162	0.053	0.017
	(0.85)	(3.69)	(0.85)	(0.24)
Mother Primary or More	-1.301	0.377	-5.913	3.225
	(0.95)	(0.24)	(1.75)	(0.86)
Father Primary or More	0.348	0.195	-0.717	0.046
	(0.35)	(0.17)	(0.48)	(0.03)
Father Middle or More	0.493	-0.042	5.545	5.364
	(0.44)	(0.03)	(3.34)	(2.81)
Middle Available	4.179	3.111	0.295	7.424
	(1.35)	(0.89)	(0.06)	(1.22)
Distance to Primary	0.050	0.035	0.012	-0.042
	(1.38)	(0.85)	(0.14)	(0.43)
Distance to Middle	-0.001	-0.024	0.014	0.013
	(0.04)	(0.65)	(0.26)	(0.20)
Primary Book Cost	-0.009	-0.002	0.002	-0.071
	(0.22)	(0.05)	(0.03)	(1.20)
Middle Book Cost	-0.019	-0.003	-0.007	-0.027
	(1.48)	(0.18)	(0.37)	(1.20)
Female	3.941	6.534	-8.152	-1.427
	(1.21)	(1.78)	(2.58)	(0.40)
Dir	5.857	0.658	2.655	-3.341
	(1.47)	(0.15)	(0.74)	(0.83)
Badin	-0.972	0.909	-5.334	-0.390
	(0.30)	(0.25)	(1.77)	(0.11)
Female, Faisalabad	-3.770	-1.536	-2.221	2.244
	(1.10)	(0.40)	(0.36)	(0.32)
Female, Dir	-4.392	-6.718	6.407	5.987
	(1.07)	(1.45)	(1.11)	(1.85)
Female, Badin	-7.169	-7.525	4.718	5.115
	(1.35)	(1.26)	(1.94)	(1.30)
Constant	13.791	3.436	0.866	11.401
	(1.75)	(0.39)	(0.08)	(0.95)
IMR	-0.356	0.491	0.966	5.663
	(0.64)	(0.78)	(0.24)	(1.34)
Rbar^2	.245	.237	.254	.081
N	316	316	157	157

(t-statistics in parentheses; village dummy variables suppressed)

Table A.7
Wage Experience Tobit and BMI Regressions

	Wage Experience	BMI Regression	
	Tobit	Men	Women
Reasoning Ability	0.441	0.141	0.016
	(0.90)	(0.81)	(0.16)
(Reasoning Ability)^2	0.002	-0.002	0.00003
	(0.05)	(1.32)	(0.01)
Total Work Experience	0.670	0.077	0.165
	(5.21)	(4.20)	(4.32)
Work Experience^2	-0.007	-0.0009	-0.003
	(3.62)	(2.84)	(3.23)
Female	-29.44		
	(12.89)		
Father Wage Worker	4.558	-0.873	0.393
	(2.48)	(2.71)	(1.16)
Distance to Work	-0.012	0.009	-0.010
	(0.28)	(1.18)	(0.64)
Males over 16	-0.350	0.110	0.061
	(1.03)	(2.09)	(0.89)
Net Transfers (000 rupees)	0.015	-0.004	0.012
	(0.40)	(0.59)	(1.56)
Rain Fed Acres–Attock	-0.077	0.110	0.051
	(1.12)	(1.00)	(2.77)
Irrigated Acres–Attock	1.683	-0.050	0.574
	(0.99)	(0.15)	(1.32)
Irrigated Acres—Faisalabad	-0.552	0.042	0.051
	(2.62)	(1.55)	(1.36)
Rain Fed Acres–Dir	-0.199	-0.044	0.050
	(1.14)	(1.59)	(1.64)
Irrigated Acres–Dir	0.094	0.104	0.143
	(0.44)	(3.04)	(3.35)
Irrigated Acres–Badin	-0.161	0.031	0.004
	(2.16)	(3.75)	(0.40)
Income	-0.087	-0.109	0.661
	(0.82)	(0.70)	(0.02)
Mother Primary	0.814	-0.407	-1.770
	(0.16)	(0.51)	(1.23)
Father Primary	3.063	0.774	0.657
	(1.53)	(2.23)	(1.64)
Father Middle or More	-6.150	0.607	-0.175
	(1.92)	(1.14)	(0.31)
Distance to Primary	-0.102	0.003	0.086
	(1.25)	(0.25)	(2.49)
Distance to Middle	-0.013	0.002	0.058
	(0.19)	(0.16)	(0.46)
Middle Available	-10.246	-1.432	-1.903
	(1.50)	(1.34)	(0.58)
Primary Book Cost	-0.059	0.003	0.021
	(1.15)	(0.32)	(1.05)
Middle Book Cost	0.058	0.006	0.0004
	(2.05)	(1.27)	(0.04)
Faisalabad	-3.510	-0.147	0.428
	(1.54)	(0.38)	(0.77)
Dir	6.307	1.069	0.816
	(2.52)	(2.47)	(1.50)
Badin	-8.784	-0.280	-0.437
	(4.13)	(0.80)	(1.00)
Constant	-25.048	15.260	15.470
SER	17.155	2.942	3.373
R^2		0.063	0.121
N	2340	1069	809

(t-statistics in parentheses)

Table A.8
Selection into Wage Employment
Jointly Estimated with Wage Earnings Function

Cognitive Skills	-0.003
	(0.25)
Schooling Attainment	0.045
	(1.09)
Ability	0.024
	(2.51)
Total Experience	0.011
	(0.74)
(Total Experience)^2	-0.005
	(1.53)
Wage Experience	0.027
	(0.19)
(Wage Experience)^2	-0.005
	(0.23)
BMI	-0.102
	(2.26)
Height	0.891
	(0.99)
Father was a Wage Worker	0.390
	(2.56)
Distance to Work	-0.009
	(3.67)
Males over 16	-0.074
	(2.35)
Net Transfers	0.006
	(0.20)
Female	-1.357
	(6.23)
Faisalabad	0.134
	(0.77)
Dir	0.010
	(0.06)
Badin	-0.317
	(1.92)
Rain Fed Acres—Attock	-0.003
	(1.35)
Irrigated Acres—Attock	0.177
	(1.35)
Irrigated Acres—Faisalabad	-0.044
	(3.10)
Rain Fed Acres—Dir	-0.053
	(2.01)
Irrigated Acres—Dir	-0.044
	(0.61)
Irrigated Acres—Badin	-0.007
	(0.91)
Constant	-0.118
Log-likelihood, full model	-650.74
Wald Statistic, Selectivity Controls (df)	385.76 (24)
N	1941

(t-statistics in parentheses)

Table A.9 Teacher Quality Estimated Weights for Components		
	Reading	Mathematics
Cognitive score	0.161 (0.060)	-0.012 (0.03)
Schooling attainment	0.523 (0.53)	0.018 (0.01)
Reasoning ability	-0.543 (1.50)	0.108 (0.15)
Training	0.533 (0.71)	-0.008 (0.03)
In-service training	0.053 (0.27)	0.011 (0.21)
Born in village	-0.066 (0.22)	0.015 (0.23)

Notes: These are maximum likelihood estimates for the weights for the teacher quality indices estimated jointly with the cognitive achievement production functions (Table 5) and the schooling attainment selectivity (reported in the Appendix) for N=221. Teacher experience is normalized to one. Absolute values of t-statistics are in parentheses.