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Invited Lecture

Human Capital Accumulation in Post-green Revolution Pakistan: Some Preliminary Results

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INTRODUCTION

In this paper, I present some preliminary findings of a large and complex micro-economic research project. Work on the project, "Human Capital Accumulation in Post-green Revolution Rural Pakistan", began roughly two years ago. Most of the time since then, however, has been devoted to project design, to the administration of the Pakistan Survey of Rural Education, Migration and Employment (PSREME) and to the entry, cleaning and evaluation of the data generated by the survey.

The research team has only just begun the first phase of the econometric analysis of the data. The analytic work programme is scheduled to take another two and a half years to complete, hence my stress on the preliminary nature of the findings I present here. As the work programme progresses these findings will undoubtedly be refined, and in some instances substantially altered.

There is a tension between the understandable desire of policy-makers to have research results "yesterday" and the laudable tendency among academics to ensure that they have got their analysis just right. With a project such as this one it takes a long time to do that. It is not that economists are inefficient producers of knowledge. Rather, despite technological advances that have had a marked impact on our productivity over the last two decades, micro economic research involving primary data collection and analysis remains an extremely time intensive activity. When particularly exasperated at how long a project is taking, I have been known to exclaim "I did not intend to become an economic historian."

Intermediate outputs can help resolve this tension. Though not definitive, the findings I present here demonstrate that the project design was appropriate and that

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Author's Note: This research is being conducted by a multinational team of economists of which I am the leader. Each team member has made a substantial contribution to this paper and, more generally, to the progress made to date on this project. The other members of the team are: Harold Alderman, IFPRI; Jere Behrman, University of Pennsylvania; Shahrukh Khan, Vassar College; John Knight, University of Oxford; Sohail Malik, IFPRI; Amit Ray, IFPRI and David Ross, Williams College.

the analysis is likely to fulfil, indeed exceed, expectations. While it would be premature to derive firm and detailed policy implications, the project's potential contribution to the debate on key policy issues will, I think, be clear.

This project was designed to be a comprehensive assessment of the determinants and consequences of human capital accumulation in rural areas. After a preliminary examination of the data, we are more confident than ever of our ability to achieve this goal. The surveys have worked. We now have in hand a uniquely rich micro data set linking educational investment decisions with the schooling process and with subsequent performance in the labour market, on the farm, and in the household. This will enable us to answer the key questions posed by the research.

In this paper, I discuss the general issues motivating the research and the structural model within which we attempt to address them. I focus briefly on our measures of key variables; our ability to empirically estimate the structural model is what distinguishes the research. I provide examples of important questions the estimated model will enable us to answer. The answers will require the manipulation of a subset of the large number of equations which make up the model, many of which have yet to be estimated. In this paper, however, I am able to present preliminary estimates of a few of the equations in the structural model.

Background to the Project

Many developing countries are at a watershed with respect to the educational attainment of the rural labour force. Until quite recently, parents in rural areas viewed investment in education as a means of gaining access for their children to the urban labour market. Rural-urban migration was highly selective of the educated: in the early stages of educational expansion, migration rates approached unity for primary as well as post-primary school completers [Sabot (1979)]. Despite substantial increases in educational opportunities in rural areas, the rural labour force remained predominantly uneducated. The educational selectivity of rural-urban migration drained source areas of their best endowed workers and skewed the distribution of the benefits of human capital accumulation. Activities in urban areas reaped the bulk of the productivity and other gains yielded by investments in education made by residents in rural areas [Schuh (1982)].

There is evidence of a marked transformation. Increasingly, children educated in rural areas are remaining there. The pattern of migration has been changing, in some countries quite rapidly. Growth in the supply of educated workers has outstripped demand in urban areas at the same time that new opportunities for the educated are emerging in post-green revolution rural areas. The net result has been a rise in the educational attainment of rural populations and a shift toward rural areas in the distribution of the benefits of human capital accumulation.

The economic implications of this potentially massive injection of human

capital into rural areas is, however, poorly understood. Research into the returns to investment in human capital in developing countries has focused on urban areas [Psacharopolous (1985)]. Most of what has been done in rural areas was completed before the trends identified above had become pronounced and focused, rather narrowly, on the effects of primary education on agricultural productivity [Jamison and Lau (1982)]. Very little is known about the effects of secondary education on agricultural productivity or of the consequences of human capital accumulation for non-agricultural productivity and for a range of household behaviour.

This gap in our knowledge is unfortunate. Developing countries spend upwards of $60 billion a year on education. In many countries, at the margin, the level and structure of returns on that investment and, hence, the direction of educational policy depends on the benefits of education in rural areas. Similarly, rural development policies – which, after decades of urban bias, are in many countries being reemphasized – will need to be adjusted to reflect the effects of the rising levels of educational attainment of rural populations.

Human capital accumulation may help sustain agricultural growth. High yielding varieties are now widely disseminated in many developing countries and the productivity gains resulting from the dissemination process are diminishing. There is evidence that the dictum, "peasants are poor but efficient," which applied to traditional agriculture, may not hold in the post-green revolution context [Byerlee (1987)]. Farmers appear to be richer and less efficient on average – both in the sense of operating within the production possibility frontier and in the sense of misallocation at the margin. There is some evidence that suggests that the level of efficiency depends on the ability of farmers to process technical and market information and effectively utilize agricultural extension, hence on their human capital endowments. If this is the case, raising the level of education of farmers may be a means of sustaining productivity growth in agriculture. Unfortunately, little is known about the links among efficiency, the acquisition of cognitive skills from formal schooling, and the acquisition of technical knowledge from agricultural extension.

Diversification of the rural economy has been a byproduct of the green revolution. Nonagricultural rural activities tend to be skill intensive. This suggests that the multiplier effects of increases in agricultural productivity and the productivity of rural nonagricultural activities may be a function of the human capital endowments of the rural labour force. Again, however, there has been little empirical assessment of this important proposition.

Human capital accumulation also has the potential of raising the probability of escape from poverty for those born into low income families. The basic thesis here is that productivity enhancement is the most effective means of reducing poverty, that educational expansion in rural areas will accelerate human capital

accumulation among the poor, and that such accumulation is an effective means of enhancing productivity. Other means of reducing poverty, such as providing additional land or physical assets, are not as amenable to government action as the provision of educational opportunities. While this thesis has been widely accepted by designers of anti-poverty programmes, that acceptance is based more on hope than on the conclusions of empirical analysis.

To summarize, the contribution of human capital accumulation to economic growth is now widely recognized. In his Nobel Prize Address, Robert Solow recalled his surprise 30 years ago on discovering that roughly 7/8 of the increase in per capita output in the United States in the first half of the 20th century could be explained only by technical progress and human capital accumulation. He had expected a greater role for the accumulation of physical capital. Solow's basic finding has been replicated many times since. [See, for example, Knight and Sabot (1987)]. More recently, a link has been established between the slowdown in productivity growth in the United States and the decline of standardized test scores for secondary school graduates [Bishop (1989)]. In addition, various positive social externalities of education are now well documented in urban contexts.[1] These include reduced fertility and increased nutrition and health.

Why Pakistan?

There are three reasons why this research focuses on Pakistan. First, the phenomenon with which we are concerned – a marked increase in educational attainment in post-green revolution rural areas – has manifested itself there. Table 1 provides a detailed breakdown of educational attainment of males in the sample by province and cohort. In the Punjab and North-west Frontier Province the increase over time in educational attainment is quite striking: moving from older to younger cohorts the proportion of males with no education declines while the proportion with primary and secondary rise sharply. Between 40 and 50 percent of the youngest cohort (15–29) in both the Punjab and NWFP have middle or more schooling.[2]

Second, in Pakistan we had the opportunity to generate a uniquely rich micro data set at low marginal cost. Since 1986, the International Food Policy Research Institute (IFPRI), under the auspices of the Pakistan Ministry of Food and Agriculture, has been administering a survey to a panel of over 800 rural households. The survey yields longitudinal data on a number of dimensions of behaviour and

[1] See citations in Jamison and Lockheed (1987); Cochrane (1983) and Rosenzweig and Schultz (1987).

[2] The contrast offered by the Sind is equally striking. There has been virtually no change over time: only a small proportion of both the oldest and youngest cohorts have any formal schooling.

Table 1

Rural Pakistan: Educational Attainment of 3 Age Cohorts of Males in 3 Provinces, Rural Pakistan, 1987

Age Cohort	Uneducated	Primary	Middle	Secondary or More		
			Punjab			
15–29	129	81	60	69	13	352
	36%	23%	17%	.....23%.....		100%
30–44	101	25	26	42	15	209
	48%	12%	12.4%	.....27.3%.....		100%
>44	226	38	25	16	4	309
	73%	12.3%	8.1%	.....6.5%.....		100%
			NWFP			
15–29	108	36	59	60	22	285
	38%	12.6%	20.7%	.....28.7%.....		100%
30–44	99	21	13	39	29	201
	49%	10.4%	6.5%	.....33.8%.....		100%
>44	165	25	7	14	5	216
	76%	11.6%	3.2%	.....8.7%.....		100%
			Sind			
15–29	212	32	4	4	1	253
	84%	13%	1.6%	1.6%	–	100%
30–44	143	28	8	5	3	187
	76.5%	15%	4.3%	2.7%	1.6%	100%
>44	157	18	5	2	–	182
	86.3%	9.9%	2.8%	1.1%	–	100%

permits the integration of special topic modules. In the 10th round of the surv (beginning in December 1988), the Pakistan Survey of Rural Education, Migrati and Employment was administered as one of these modules.

Finally, the policy-relevant nature of the proposed project makes it attract to conduct the research in a country where the issues addressed are considered to of high priority by the government. This is the case in Pakistan, where the Sever Five Year Plan, 1988–93, explicitly recognizes the urban bias of previous gove ment policy and emphasizes rural development (pp. 63-64), human capital accun lation (pp. 186-187) and poverty alleviation (Ch. 13) as closely related compone of its new development strategy. The plan notes:

> Improving the distribution of economic benefits and alleviating pover will constitute an important element of the Perspective Plan strategy. . Priorities have to be assigned to certain specific areas of operation. [C area] which needs immediate attention in this context [is] human resou development. . . .Human development is not only inherently desirable, b it also increases human productivity. The Perspective Plan, in taking n of the importance of investment in human beings, outlines a dynamic strate which will effect a perceivable improvement in human resources throu education, skill development, nutrition, and health care (pp. 73-74).

Conceptual Framework and some Key Variables

The key relationships to be explored in our analysis of the determinants a consequences of human capital accumulation in post-green revolution rural Pakist are described in Figure 1. The top half of the structural model focuses on access

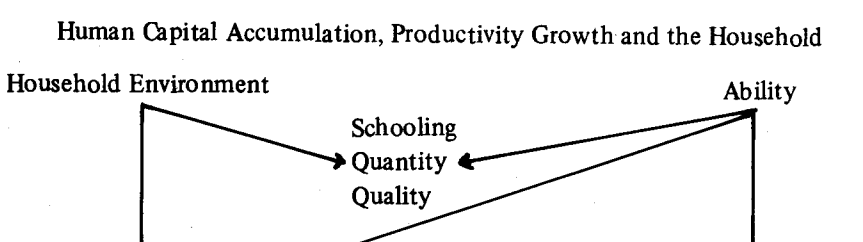

Figure 1. Structural Model.

(quality) schooling and the determinants of the production of cognitive skills and technical knowledge. The bottom is concerned with the consequences of the accumulation of human capital for productivity and various dimensions of household behaviour. The model describes several routes by which human capital accumulation can improve income. Direct routes include improved access to jobs, increased productivity in those jobs and in self employment (some of which may derive from improved access to complementary inputs). Routes which raise income indirectly include better nutrition, reduced morbidity, lower fertility, improved performance in school, as well as regional multiplier effects of human capital accumulation on output, labour demand, and (ultimately) the returns to labour.

Most data sets on which the economic analysis of education is based do not contain measures of many of the variables in this model. By contrast the Pakistan surveys are generating data necessary to estimate all of the key relationships. Among the more innovative variables in the data set are the following:

Cognitive Skills

Years of schooling is generally used as the measure of human capital despite the fact that schooling is an input into what education produces. Our cognitive skill variables give us a measure of output. This is important because the variance in human capital endowments among those with the same number of years of schooling is substantial.

Our measure of cognitive skills was generated by administering to every person in our sample more than 10 years old, and with at least 4 years of schooling, specially designed tests of literacy and numeracy. Figure 2 plots the distribution of cognitive

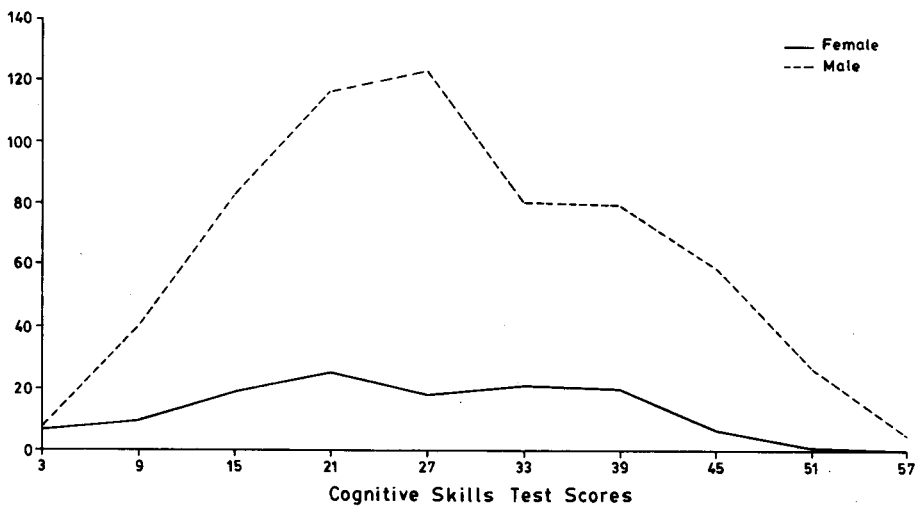

Figure 2. Distribution of Cognitive Skills Test Scores – All Regions.

skills test scores (the sum of the scores on the two tests) for males and females. The scores exhibit substantial variance and appear to be approximately normally distributed. The flatter curve for females reflects the markedly smaller numbers of females than males with four or more years of schooling.

Native Ability

In other contexts native ability has been shown to be an important determinant of both performance in school and educational attainment. Differences in ability help explain variation in cognitive skills among children with the same number of years of schooling. Therefore, we administered Raven's Progressive Matrices, a test of reasoning ability which involves the matching of patterns, to everybody in the sample 10 years of age or older.

The test is designed so that formal schooling does not influence performance. As Figures 3 indicates, the Raven's test scores also exhibit substantial variance and appear to be normally distributed. When disaggregated (figures not shown) the distributions in NWFP, the Punjab and the Sind are very similar. Since educational levels differ across regions this similarity is consistent with the assertion that educational attainment has no influence on performance on the Raven's. There is, however, a noticeable differences in the distributions of the scores achieved by males and females, a puzzle that remains to be resolved.

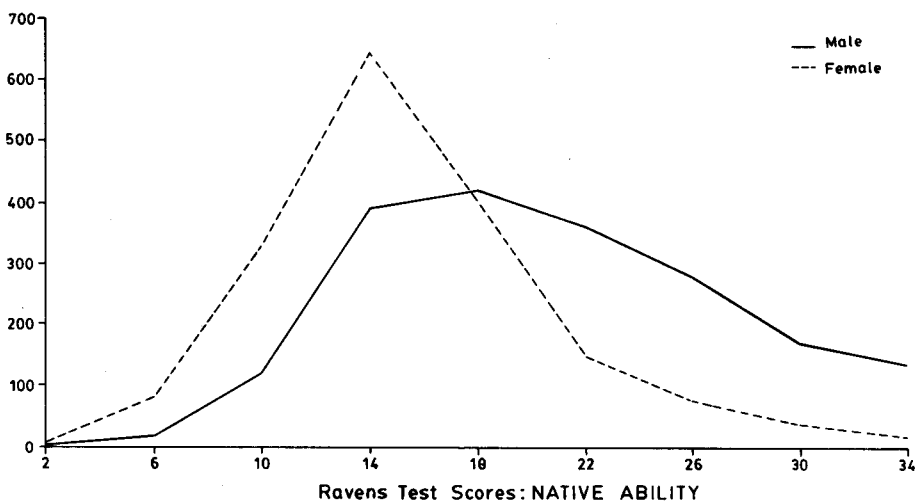

Figure 3. Distribution of Raven's Test Scores – All Regions.

Quality of Schooling

Variation in the quality of schools attended is another reason cognitive skills

will vary among children with the same number of years of schooling. We administered a questionnaire in the schools attended by the respondents of our household survey. The school survey, which collected data on such characteristics as physical plant, the availability of textbooks and other inputs, will yield a number of measures of school quality.

Perhaps most notable, the teachers in the schools were given the same tests we administered to their students. We will be able to assess the hypothesis that how much a child learns is, in part, a function of how much his teacher knows. On average the 579 teachers in our sample, who are a select group with respect to educational attainment, do considerably better on the cognitive skills tests than household survey respondents. However, there is substantial variation in the performance of teachers: a few obtained nearly perfect scores on our tests while, at the other extreme, there were some teachers whose cognitive skills were so limited that they could not answer any of the test questions correctly.

Technical Skills of Farmers

As the structural model indicates, we do not expect to find that the cognitive skills of wheat farmers have a direct influence on agricultural productivity. Rather our hypotheses are that cognitive skills enter the technical knowledge production function, i.e., farmers with higher levels of cognitive skills are better able to acquire technical knowledge from printed material and agricultural extension, and that technical knowledge, in turn, enters the agricultural production function. To assess these hypotheses and measure the linkages we designed, and administered to the 520 wheat farmers in our sample, a test of technical skills. We were gratified to see that the results of this test also exhibit considerable variance and appear to yield a normal distribution.

Various Outcome Variables

One strength of our data set is that it offers us the opportunity to assess the consequences of human capital accumulation for a variety of outcomes. Our wage data permit us to estimate appropriately specified wage functions which can be used to evaluate the productivity benefits of cognitive skills in the market for wage labour. Data on agricultural outputs, inputs and prices enable us to estimate agricultural production functions which can be used to evaluate the productivity benefits of cognitive skills and technical skills in agricultural self employment. Anthropometric data permit us to estimate nutrition production functions which can be used to evaluate a key benefit for children of the cognitive skills of their parents. We also have the data necessary to assess the relationship between cognitive skills and fertility.

Where Do We Go from Here?

The first phase of the econometric analysis focuses on the relationships in the top half of the model: those concerned with access to schooling and the accumulation of human capital. The second phase focuses on the relationships in the bottom half of the model: those concerned with the consequences of human capital accumulation for labour productivity in wage employment and in agricultural and non-agricultural self employment and for various dimensions of household behaviour related to fertility, child nutrition and health, and the schooling of the next generation.

We have begun the process of estimating the key functions included in the structural model. These functions will serve as the analytic building blocks for the policy analysis to follow. The list of functions is long and includes: educational attainment functions, school availability functions, education production functions, technical skills production functions, occupational attainment functions, wage functions, agricultural production functions, nutrition production functions, fertility functions, and other functions describing the labour allocation, investment, and consumption decisions of the household.

Once estimated these functions will be used in Phase 1, in various combinations, to conduct policy relevant analyses on such topics as:

(1) Explaining gender differences in human capital endowments (To what extent are the higher levels of cognitive skills observed among males due to gender differences in demand for schooling and/or the supply of schooling, differences in the quality of schooling, and in out of school investments in human capital);
(2) Explaining differences in human capital endowments of children from high and low income households (To what extent are the lower levels of cognitive skills observed among the children of the poor due to differences between low and high income households in demand for schooling and/or the supply of schooling, differences in the quality of schooling, and in out of school investments in human capital?);
(3) Explaining differences in human capital endowments of children across regions (To what extent are the higher levels of cognitive skills observed among the children in the Punjab due to differences among regions in demand for schooling and/or the supply of schooling, differences in the quality of schooling, and in out of school investments in human capital?);
(4) What are the major determinants of school quality and how important are they relative to other factors influencing how much students learn?;
(5) Teacher effectiveness and teacher incentives (Do the cognitive skills of teachers influence how much students learn? Do the economic incentives

facing teachers positively influence the quality and effectiveness of teachers?);

(6) Assessing the tradeoff between improving quality and increasing the number of schools (To obtain a given increase in the cognitive skill level of the labour force, is it more cost effective to increase enrollments at current levels of quality or to improve the quality at current levels of enrollment? What are the implications for the distribution of schooling of these alternatives?); and

(7) What are the major determinants of technical skills in agriculture? (How important is the quantity and quality of schooling in determining the technical knowledge of farmers?).

This list is far from exhaustive. We expect other topics, many of which also will be relevant to policy, to become apparent in the course of analysis.

Preliminary Findings

In this section I present some preliminary, but revealing, estimates of wage functions, education production functions, and education attainment functions. Following brief general discussions of the models I speculate about the implications of the results for some of the larger issues listed in the previous section.

Table 2 presents estimates of a human capital wage function which includes

Table 2

Wage Function

Independent Variables	OLS Estimation of Log (Wages)	
Intercept	6.398	(32.621)**
Experience	0.055	(3.391)**
Experience^2	–0.001	(2.017)*
Cognitive Skills	0.009	(2.616)**
Years of Education	–0.011	(0.985)
Ravens Scores	0.002	(0.393)
Sex-dummy	–0.104	(0.710)
N =	160	
R^2	0.22	
Adjusted R^2	0.19	
F	0.84**	

Note: Figures in parentheses are absolute t-ratios.

*Indicates statistical significance at 95 percent level.

**Indicates statistical significance at 99 percent level.

our measures of reasoning ability and cognitive skills, in addition to the usual variables measuring the employment experience and the number of years of schooling of the employee. The log of monthly wages is the dependent variable. As usual, earnings are shown to increase with the experience of the worker though at a declining rate of increase: the experience variable is positive and significant while its square is negative and significant.

The cognitive skills variable is positive and significant. In contrast to the usual human capital wage function, in which a years of schooling variable is the only measure of human capital acquired in school and is virtually always positive and significant, in this equation the years of schooling variable is not significant.[3] Nor is the ability variable.

Cognitive skills are rewarded by employers, presumably because those skills enhance productivity, i.e., these results are consistent with the human capital interpretation of the positive relationship between years of schooling and wages. They are not consistent with either the credentialist or screening interpretations of the education-wage relationship. The credentialist hypothesis predicts that a worker will be rewarded for his years of schooling, irrespective of whether he learned anything which proved to be productive in the workplace. The screening hypothesis predicts that a worker will be rewarded for his innate (and economically productive) ability, for which schools screen, rather than for skills acquired in school.

The implication of these findings is that the skills acquired in school in Pakistan's rural areas are increasing rural labour productivity. Preliminary estimates, based on our data, of agricultural production functions reinforce this conclusion. However, before conclusions can be reached regarding the social returns to investment in education it will be necessary to refine and extend this analysis. In particular the categories of benefits must be broadened to include productivity gains in non-agricultural self employment and various changes in household behaviour that may yield such non-pecuniary (at least in the short run) benefits as improvements in the nutrition and health of children. And the costs of education, including the opportunity costs and government subsidies, as well as the out of pocket costs borne by parents, must be taken into account.

The statistical insignificance in the wage function of the years of schooling and ability variables does not imply that in rural Pakistan schooling and ability have no influence on productivity and wages, only that they have no direct influence. Our estimates of education production functions and educational attainment functions, to which we now turn, demonstrate a powerful indirect influence.

[3] The years of schooling variable is positive, large and significant when the equation is estimated without the cognitive skills or ability variables, confirming that the typical education-wage relationship is manifest in the market for wage labour in rural Pakistan.

The education production function is generally conceived to be simply a set of input-output relationships [see e.g., Hanushek and Erik (1979); Lau, (1979)]. The worker's score on our math test and his score on our reading test are, respectively, the dependent variables – the measures of output – in the education production functions presented in Table 3 [columns (1) and (2)]. In these parsimonious specifications the inputs are years of schooling, reasoning ability, gender, and father's education.

In both equations the coefficient on years of schooling is positive and highly significant: *ceterus paribus,* workers with more years of schooling have greater cognitive skills. Similarly the coefficient on the ability variable is positive and significant: controlling for years of schooling, high ability workers have greater congnitive skills than low ability workers, presumably because, as students, they were more efficient learners. The indirect impact of ability and years of schooling on productivity and wages should now be apparent. Workers with relatively more schooling and/or high ability are likely to be relatively well endowed with productivity augmenting cognitive skills.

The production functions also indicate that father's education has a positive and significant influence on cognitive skill endowments. This may reflect the ability of educated fathers to make virtually costless out of school investments in the human capital of their children. To provide similar educational stimuli in the home, an uneducated father might have to employ a tutor. Alternatively, it may be that the higher incomes of educated fathers permit them to provide their children with relatively high quality schooling.

The production functions include a gender variable. Males perform significantly better on the math exam than females with the same level of ability and years of schooling, while females perform significantly better on the reading exam. These differences in performance do not help much to explain the gender gap in human capital endowments in rural Pakistan. However, stratifying the production functions by gender [Table 3, columns (3) to (6)] suggets one explanation for the gender gap in cognitive skills while rejecting another.

First, consider the rejected hypothesis. The production functions do not yet include measures of the quality of school attended. However, the output of congitive skills in relation to key inputs is a general indicator of quality. If there was a tendency for boys to attend higher quality schools than girls we would expect to find larger coefficients on the years of schooling and ability variables. In fact, the coefficients on those variables are not consistently larger in the educational production function for males than in the female production function. The implication is that there is no gender gap in the quality of schooling. If subsequent, and more thorough, analysis supports this finding, then to narrow the large gender gap in human capital endowments in rural Pakistan the policy focus should be on gender

Table 3

Educational Production Functions

Sample	Combined Sample		Male Sample		Female Sample	
Dependent Variable	Math	Read	Math	Read	Math	Read
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	1.507	3.781	1.213	4.193	1.374	5.643
	(1.471)	(3.303)**	(1.088)	(3.707)**	(0.870)	(1.713)
Years of Education	0.657	0.625	0.673	0.643	0.551	0.617
	(7.952)**	(6.748)**	(7.487)**	(7.023)**	(2.537)*	(1.877)
Ravens Scores	0.182	0.183	0.172	0.152	0.211	0.299
	(4.755)**	(4.277)**	(3.988)**	(3.457)**	(2.576)*	(2.405)*
Father's Education	0.664	0.454	0.873	0.562	−0.011	0.079
	(3.473)**	(2.123)*	(3.989)**	(2.529)*	(0.030)	(0.135)
Sex Dummy	−1.265	3.155				
	(1.977)*	(4.403)**				
N =			520			
R^2			0.198			
Adjusted R^2			0.193			
F						

Note: Figures in parentheses are absolute t-ratios.

*Indicates statistical significance at 95 percent level.

**Indicates statistical significance at 99 percent level.

differences in the quantity of schooling. In our discussion below of the estimates of educational attainment functions we document the disadvantage in access to both primary and middle schooling experienced by girls.

The stratification of the production function by gender does result in one striking difference between males and females. While the level of education of fathers has a positive, substantial and highly significant effect on the acquisition of cognitive skills by sons, it has no apparent influence on the cognitive skill acquisition process of daughters. Educated fathers contribute to the learning process of their sons but do not contribute to the learning process of their daughters. This difference may reflect the more limited contact fathers have with their daughters than with their sons.

The lack of influence of educated fathers on the human capital accumulation process of daughters is not compensated for by the influence on daughters of educated mothers. The level of education of mothers does not influence the cognitive skill acquisition process of either sons or daughters. This is not necessarily because mothers are less effective at transferring their skills to the next generation. A more likely explanation lies in the small number of educated mothers. There are so few mothers with any education that their influence is not statistically significant.

Educating one generation appears to improve the efficiency of the educational process of the next generation. Furthermore, it appears that the marked gender difference in educational opportunities of the current generation of adults in rural Pakistan is now placing their daughters at a learning disadvantage in school relative to their sons and that this learning disadvantage contributes to the persistent gender gap in human capital endowments. These results suggest that a policy emphasis on increasing the quantity of educational opportunities for girls will have both a short run and a reinforcing longer run (intergenerational) tendency to reduce the gender gap.

Table 4 presents estimates of educational attainment functions. These are probit functions. The dependent variable in the first two equations is a 0-1 variable signifying whether the respondent attended primary school. The dependent variable in the other two equations, estimated only for those who had completed primary school, signifies whether the respondent entered middle school. Our aim is to analyze the determinants of the probability of attending primary school and, having completed primary, of attending secondary.

The independent variables are the same in both sets of equations: the respondent's score on the test of reasoning ability; the respondent's age (an indicator of the respondent's cohort, there being a presumption that, with educational expansion, the average probability of access would increase from one cohort to the next); the respondent's gender; the educational attainment of the respondent's father and mother; and the respondent's district of residence.

Table 4

Educational Attainment Functions

Independent Variables	Primary Attainment		Middle Attainment	
	All Sample	Age > 30	All Sample	Age > 30
	(1)	(2)	(3)	(4)
Intercept	−1.910	−1.807	−1.263	−2.301
	(8.49)**	(4.79)**	(4.58)**	(2.96)**
Raven's Scores	0.063	0.081	0.044	0.062
	(13.46)**	(10.15)**	(5.82)**	(4.01)**
Age	−0.035	−0.035	−0.006	−0.006
	(19.28)**	(8.30)**	(1.68)	(0.76)
Sex	−1.136	−1.460	−0.867	−1.012
	(18.29)**	(11.66)**	(6.69)**	(2.80)**
Attock Dummy	1.014	0.815	0.817	1.128
	(12.85)**	(6.31)**	(5.70)**	(4.50)**
Faisalabad Dummy	1.115	1.161	0.801	1.112
	(14.42)**	(8.60)**	(5.61)**	(4.35)**
Dir Dummy	0.781	0.641	1.101	1.696
	(10.17)**	(4.61)**	(7.42)**	(5.52)**
Father's Education	0.318	0.456	0.120	0.217
	(9.83)**	(6.07)**	(2.69)**	(1.83)
Mother's Education	0.768	0.328	0.137	0.305
	(4.00)**	(1.21)**	(0.92)	(0.59)
N =	3495	1611	838	245
X^2	1729.02	609.23	162.31	68.14

Notes: Figures in parentheses are absolute t-ratios.

**Indicates statistical significance at 99 percent level.

In the first of the primary equations, all of the independent variables are highly significant. Controlling for other characteristics, the higher the ability test score, the greater the probability that parents will have sent their child to primary school. Parents appear to recognize that more able children will benefit more from schooling. More surprising, they appear to have the means to distinguish more able from less

able children when the children are still very young. The level of education of the respondent's father and mother both positively influence the probability of attending primary school. Educated parents may place greater value than uneducated parents on the education of their children. Alternatively they may be more likely to live in villages with greater educational opportunities or, as a consequence of higher incomes, have fewer problems bearing the costs of education.

Gender is an important determinant of access. A girl with the same level of ability as a boy, and with equally well educated parents, who is in the same cohort as the boy and lives in the same district, nevertheless has a substantially lower probability of attending primary school. District of residence is also an important determinant. *Ceterus paribus* children in Faisalabad have substantially higher probability of attending than children from the Sind where the probability is the lowest. The probability of having attended primary school is inversely related to age. Reflecting the growth of primary school places in rural Pakistan over the last two decades, younger respondents are more likely, *ceterus paribus,* to have gone to primary school.

In the first of the middle school equations all of the independent variables, with the exception of mother's education, are statistically significant. Moreover, the pattern of determinants of access to middle school are similar to those for access to primary school. Having greater ability and a father with education enhances the probability of access, while belonging to an older cohort or being female reduces the likelihood that the respondent would have continued education beyond the primary level. Once again, residents of the Sind are the least likely to gain access, but it is residents of NWFP who, having attended primary, have the highest probability of continuing their education.

A comparison of columns 3 and 4 in Table 4 indicates that, as with access to primary school, the disadvantage in access to middle school experienced by girls who have completed primary has declined over time. While the disadvantage in access to primary schooling for residents of Sind did not change over time, their disadvantage in access to middle school appears to have declined.

In conclusion I want to emphasize one implication to emerge from these estimates. A child endowed with exceptional ability is more likely to gain access to primary and middle schools, and is likely to learn more in school, than his less able peers. As a consequence, the exceptional child is likely to have accumulated more cognitive skills and is likely to become a more productive worker, and to earn more.

There are, however, many exceptionally able children in rural Pakistan who, for one reason or another, do not attend school. Workers with exceptionally high ability who have not had the opportunity to develop their considerable potential, appear to be no more productive and to earn no more than workers who are not very able. The exceptionally able children in rural Pakistan who have been deprived

of formal schooling represent a tragic waste: if given the opportunity to realize their potential their incomes would be substantially higher, as, undoubtedly, would levels of labour productivity and economic growth.

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Comments on "Human Capital Accumulation in Post-green Revolution Pakistan: Some Preliminary Results"

This highly interesting paper has implications that go beyond the understanding of the very relevant issues it discusses. Indeed, the paper demonstrates the fruitfulness of a precise analytical approach in the search for explanations. It also demonstrates the value of in-depth surveys like the one conducted by the author. Since I have no knowledge of rural Pakistan and I find nothing objectionable in the paper, I shall only stress here the wider implications for the orientation of positive research on socio-economic phenomena.

We economists, and more generally social scientists, must try to discover and characterize cause-effect relations. We would like to have simple and broad explanations, which would be powerful for both our understanding of phenomena and our policy recommendations. Our first hope is to find in the observed facts that direct confirmation of whatever simple and broad hypothesis we find attractive. But most frequently this hope cannot be fulfilled.

On the particular question he is considering, namely the effect of investment in education on labour productivity, Professor Sabot argues convincingly that one has better to do than to fit a direct regression between two variables respectively measuring the volume of education and labour productivity. One has to analyze and observe the causal relation in detail, so as to sort out intermediate effects that play an important role in shaping the global phenomenon. The arrow-scheme exhibited in Figure 1 shows what the important intermediate links are likely to be. Estimation of all these links gives us a good understanding of the whole causation chain and reveals how we can best act in order to improve the performance of the education system.

I should like to submit on this occasion that more generally progress in our objective knowledge of economic phenomena will often come from similar detailed analyses of the relevant causation chains. All too often economists are inclined to bypass the step-by-step study and to stick to broad synthetic hypotheses that cannot be fully checked and whose exact meaning is even frequently obscure.

The feasibility of the analytic approach of course depends on observations made at the intermediate levels. These observations provide an important new

information about the causal links they concern, hence about the whole causation chain. In the present case Richard Sabot draws such observations from the sample survey to the elaboration of which he was associated. The information so collected appears to be quite fruitful.

I should like to submit that in depth sample surveys of the same type will often bring an essential improvement of our knowledge. Such surveys are sometimes said to be too costly to be contemplated. They are indeed costly, since they require a sufficiently large and representative sample, a careful planning and a qualified personnel. But the cost appears quite worth bearing when one realizes how informative these surveys may be. In this part of the world it is pleasant to recall that one of their first and best promoters was Professor Mahalanobis, who since the early 40s had realized their usefulness in India and more generally in the LDCs.

Concerning again the paper under discussion, it is clear that the preliminary results here given, as interesting as they are, do not yet exhaust all the information contained in the survey. For instance conjectures are offered toward the end as to the reason why the levels of education of the respondent's father and mother both positively influence the probability of attending primary school: educated parents may place greater value than uneducated parents on the education of their children; alternatively they may live more often in villages with greater educational opportunities; or still, as a consequence of usually higher incomes, they may have fewer problems in bearing the cost of education. The data collected should permit to assess to which extent each one of these conjectures applies, although colinearity may be too strong for a clear discrimination.

Finally I should like to suggest to the author to discuss more closely in his revised text how it may be that Raven's test measures pure native ability, independently of any influence of schooling. This property of the test plays an important role in the interpretation of the results and was probably quite difficult to achieve when the test was set up.

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Comments on "Human Capital Accumulation in Post-green Revolution Pakistan: Some Preliminary Results"

The author and I first met as participants in a seminar on migration in Africa held in Dakar, Senegal in 1972. Considering the subject he chose for the invited lecture that we are about to discuss, he has clearly remained very faithful during his career to the field of human resources. Since I have left that field of research a long time ago, I feel less than adequately equipped when offering my comments. Still, I am not at all complaining as the paper he wrote is a very interesting one which I thoroughly enjoyed reading.

Let me first of all underline what has been said in the paper about the importance of human capital formation in socio-economic development in any country, and especially in Pakistan. In terms of educational attainment this country is clearly lagging behind countries with a comparable level of income per head. It is certainly possible that, as a result, Pakistan's development will sooner or later, or may already be curbed. The President of Pakistan, Mr Ghulam Ishaq Khan, in his opening address to the present conference used strong terms when he declared the country's educational performance a national scandal. It would indeed be highly desirable for Pakistan to embark on an effort to make up its arrears in education, all the more so because the educational system is characterized by a long period of gestation.

The concern for Pakistan's educational performance reflects the views of those who look at education (i) as an investment building up the human capital required for sustained economic growth and (ii) as a means to achieve a more equal distribution of economic opportunities promoting equity *as well as* efficiency. Sabot is of course right in pointing out that these views are based more on hope and belief than on empirical analysis, although more and more supporting evidence is coming forth. Hence the importance of the project described in his lecture which promises to generate a mass of information on unsettled issues. Not only can the project help to shed light on the question whether an expansion of the educational system can indeed be expected to promote development. The micro-economic approach adopted in the project can also answer crucial questions as:

- which are the main obstacles to participation in education;

- which specific attainments does education actually provide;
- do the recipients profit from education and, if so, in which ways; and
- which improvements can be made in the present system?

Although the study is not even half-way, it has already yielded important information. Take, for example, the result of the experiment in which teachers were requested to do the tests administered to their students and where a few teachers appeared to be unable to answer any of the questions correctly. Those responsible for the quality of education in the country should immediately respond to such a finding by checking the conclusion and, if it is found to be correct, taking remedial action.

Before briefly enumerating my remaining comments, I must indicate that I feel somewhat handicapped by the provisional nature of the conclusions and the presentation. I am sure that the paper would have looked different, if more time had been available for its preparation. Thus, I find it hard to decide if my comments relate to matters of substance or presentation.

Although the introduction announces a discussion of the structural model within which the analysis is to carried out, the paper is reticent on this matter. Figure 1 gives some idea of the conceptual framework, but, by its brevity, raises a number of questions. For example, nothing is said about parents' motives to allow their children to obtain education, or not. Which are the expectations (and are they satisfied), which are the constraints, which factors cause drop-out? The arrow connecting "household environment" to "schooling quantity/quality" in Figure 1 suggests an interest in these matters, but they do not appear in the subsequent list of key functions. Still, it is hard to imagine that a "school-entry function" would not be considered. Further, the Figure also does not link "schooling" with "technical knowledge". But certainly there exist technical/professional schools and courses which precisely aim at establishing this link.

Figure 2 presents an interesting frequency distribution of scores in a cognitive skills test for males and females, where the curve relating to females is markedly flatter than for males. The author attributes this outcome to the fact that the number of observations is much smaller for females than for males. Here I disagree. Of course the number of observations determines the height of a frequency distribution (its distance from the horizontal axis), but it does not affect the shape of the distribution at least as long as the distribution is statistically significant. And if the number of observations is too small to obtain a statistically significant result, no conclusion at all should be drawn regarding the shape of the distribution.

Another comment concerns the relation between cognitive skills and agricultural productivity which the author expects not to be significant. I hope, however, that this expectation will not be considered a foregone conclusion and that it will be

tested thoroughly. For it is certainly conceivable that general, cognitive skills will enable a farmer to deal with formal financial institutions more adequately and, thus, to obtain credit at better terms. Or they may give him access to information on agricultural technologies. A farmer with such skills may even play an innovative role and through his actions have a positive external effect on productivity of other farmers.

But all these comments do not detract from the general conclusion that the project is sitting on a goldmine in the form of the very valuable information that has been collected so far. Already at this early stage some remarkable findings have been obtained and there are surely more to come. One looks forward to subsequent publications from this project.

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