Distinguished Lecture

Human Capital Accumulation in Post Green Revolution Rural Pakistan: A Progress Report*

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1. INTRODUCTION

Two years ago at this conference I presented some preliminary results from a large micro-economic research project analysing the determinants and conse- quences of human capital accumulation in rural Pakistan. At that time the entry, cleaning and evaluation of the data, generated by a specially designed rural house- hold and school survey, had just been completed and the first phase of the econo- metric work programme had barely begun. Since then the research team has made substantial progress on the analytic work programme. This paper is a report on that progress.

The research project on which I am reporting was designed to be relevant to important education and rural development policy issues. In my previous paper I noted that, despite productivity enhancing technological change, research based on large special purpose micro data sets remains a time intensive activity. I referred to the resulting tension between the researchers' desire to satisfy the policy makers' urgent need for findings and the researchers' scholarly commitment to sound analy- sis. I suggested that intermediate outputs can help resolve the tension though they then are subject to the caveat of being open to refinement and revision. I am greatly relieved to inform you that none of the results I report today contradict results reported in my previous paper. Some of what I report are, from the research team's perspective "final", while others are from work in progress and, therefore, subject to revision.

For those of you who are not familiar with the project, or who have forgotten, I want to begin by briefly reviewing its background. A decade ago human capital accumulation in rural areas of developing countries was not much of an issue because, as it is defined today, not much of it was occurring. More precisely, rural children were accumulating human capital but their enhanced skills were not augmenting the productivity of rural economic activities. Rural children viewed a school certificate as a ticket into the urban labour market and most migrated in search of employment soon after completing their education.

Today a much larger proportion of the graduates of rural schools, which themselves are far more abundant than a decade ago, are entering rural employment. Growth in the supply of educated workers has outstripped urban labour market demand at the same time that the green revolution has stimulated demand for the educated in rural areas. The result has been a surge in the educational attainment of rural populations. Our survey indicates that in rural NWFP and the Punjab roughly 75 percent of the 45 and older cohort had no formal schooling. By marked contrast for the cohort age 15–29 the proportion without any schooling has been halved (to 37 percent) and the proportion with post-primary schooling more than tripled to between 40 and 50 percent of the cohort.[1]

The aim of this research is to better understand the process by which human capital is accumulated in rural Pakistan and the consequences for labour productivity and various dimensions of household behaviour of the substantial increase in the rural stock of human capital. To do this existing data was inadequate; we needed a specially designed micro data set. Since 1986, the International Food Policy Research Institute (IFPRI), under the auspices of the Pakistan Ministry of Food and Agriculture, has been administering a multipurpose survey to a panel of 800+ rural households containing over 7000 individuals drawn from villages in two districts (Attock and Faisalabad) of the Punjab, one district (Dir) of the North West Frontier Province (NWFP), and one district (Badin) of the Sindh.[2] The households have been interviewed approximately four times each year. Human capital modules were administered in the spring of 1989, the 10th round of the survey.

Today I will focus on two important issues concerning the human capital accumulation process: the gender gap in cognitive skills, its sources and how best to eliminate it; and the choice between improving the quality of rural schooling and increasing the quantity which depends, in large part, on the relative social rates of return to those alternatives. To explore the gender gap issue empirically, for individual respondents we draw on such key measures contained in the human capital modules of our rich data set as family background, school availability, prices of

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[1]See Sabot (1989).

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

schooling, pre-school reasoning ability, educational attainment, and post-schooling cognitive achievement. To assess the impact of school quality on the learning process, and thence the quality-quantity choice, we exploit additional features of the data set, in particular the link between households and the schools attended by household members, and the documentation of the employment experience and earnings of respondents who entered the wage labour market.

2. THE GENDER GAP IN COGNITIVE SKILLS: SOME BACKGROUND

In high income countries the gender gap in human capital accumulation that results from schooling has been nearly eliminated. In most developing countries, women continue to lag markedly in the educational process.[3] Girls tend to receive less schooling than boys. The schooling gap tends to be greater in rural areas and in countries in which Islam is predominant. It has been declining in recent years. As Figure 1 indicates, for all low-income countries, the number of girls per 100 boys enrolled in primary school increased from 52 in 1965 to 75 in 1985.[4]

Since the effect of schooling on productivity appears to be no lower for
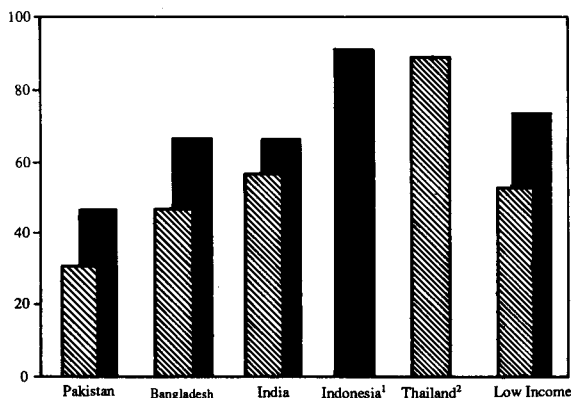
Source: World Development Report, 1988.
[1]Data for 1965 not available.
[2]Data for 1985 not available.

**Fig. 1. Primary School Enrollment: Females per 100 Males
Pakistan Compared with Other Asian Countries
and with the Low-income Average 1965, 1985**

[3]We focus on schooling because of its apparent substantial impact on productivity in various activities [e.g., Behrman (1990a, 1990b); Colclough (1982); Eisemon (1988); Haddad, Carnoy, Rinaldi, and Regel (1990); Knight and Sabot (1990); Psacharopoulos (1985); Schultz (1988) and World Bank (1980, 1981, 1990, 1991)].

[4]Figure 1 indicates that Indonesia is one notable exception to the rule that the gender gap is larger in Islamic countries. For further discussion of gender gaps in education in the developing world in general see King (1990) and King and Hill (1991); for South Asia and Pakistan see Behrman (1991b) and Khan (1989).

women than for men,[5] there is a presumption that lower rates of investment in the education of girls than of boys slow economic growth. Private and social returns to investment in education are generally high.[6] Similarly, output accounting exercises indicate that differences in the stock of human capital explain a substantial proportion of differences among countries in average labour productivity.[7]

Pakistan provides an extreme example of the gender gap. In 1965, Pakistan's female primary school enrollment rate was 32 percent of the male rate;[8] this ratio was among the ten lowest in the world. While the ratio of female to male enrollments in primary school increased markedly from 1965 to 1985, at 47 percent it remained well below the average for all low income countries and, as Figure 1 illustrates, below the levels of other major Asian countries. Indeed it is among the five lowest in the world, as is Pakistan's ratio of female to male enrollments in secondary school (37.5 percent).

Differences in enrollment rates, however, may be a crude proxy for the gender gap in education. Time spent in school is but one of many inputs into the education production process – others include pre-school ability, the quality of schooling and out-of-school investments in human capital – and may be, therefore, a poor predictor of the output of that process. Two people with the same years of schooling may differ markedly in their level of cognitive skills.[9] By implication two countries with the same gender gap in enrollments may differ markedly in the gender gap in cognitive skills. It is the output of schooling that, in human capital models, is presumed to affect subsequent productivity.[10]

To our knowledge, for the first time for a developing country, we use indicators of an output of the education production process, cognitive skills, to measure the gender gap. Our data indicate a large and significant gender gap in cognitive skills in rural Pakistan,[11] which presumably results in a large gender gap in produc-

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[5]If anything, estimated rates of return to investment in schooling in developing countries tend to be higher for girls than for boys. [See Behrman (1991b) and Schultz (1991) for reviews and Birdsall and Sabot (1991); Behrman and Deolalikar (1990) and Khandker (1990) for some additional studies.]

[6]See the references in note 1.

[7]Krueger (1968) and Knight and Sabot (1987).

[8]Some estimates place it as high as 38 percent World Bank (1988).

[9]We use cognitive skills and cognitive achievement interchangeably to refer to the product of schools, though we recognise that there may be other capabilities that are produced by schools. In our empirical work, lacking measures of other outputs, we use cognitive achievement test scores alone to represent the direct output of schooling.

[10]For evidence of the relationship between cognitive achievement and wages in developing countries, see Boissiere, Knight and Sabot (1985) and Glewwe (1990). Our preliminary estimates (see below) indicate that the relationship holds in rural Pakistan as well.

[11]The t-statistic for the difference in the means of the two distributions in 11.8. For the 30 – 44 cohort on which we also focus, the gender gap in cognitive skills is even larger at 89 percent (with t-statistic equal to 13.3).

tivity and in the command over resources. For example, for the 20–24 age cohort in 1989 we find that the gender gap in cognitive achievement is 76 percent.[12] That is, the mean score for women on a test of cognitive skills is only 24 percent of the male score –15.7 for men and 3.8 for women out of a maximum of 72.

To what is this large gender gap in the product of schooling due? It could result from parental biases in preferences that favour boys over girls. Alternatively, as Rosenzweig and Schultz (1982) and others have argued, greater investment in boys than in girls may reflect a gender gap in the expected returns to those investments. This gap in total returns may be traced to: wage discrimination in labour markets; strong attachments to traditional gender roles that effectively limit female access to high productivity sectors, activities or occupations; and gender roles within the household that result in different shadow prices for out-of-school investments in human capital and for time in school.

Or it could be that expectations regarding the total benefits of schooling are gender neutral but that parents, who are not entirely altruistic in their investment decisions, expect to receive a higher proportion of the benefits reaped by men. Parents may have such expectations because men are more likely to support parents in their old age.[13]

The common thread in all of these explanations is that differences in the demand for schooling account for the gender gap in human capital accumulation.[14] The gender gap in human capital accumulation, however, could originate on the supply side of the market for education.[15] There may be gender differences in school availability or in school quality. Where most schools are single sex, as in rural Pakistan, it is easy to observe the extreme form of discriminatory rationing in which schools are available only for boys. Parents might send their girls to school if only a school was available. Both the social costs of the gender gap and the prospects for public policy having an ameliorative impact are likely to vary

[12]Data on gender differences in cognitive skills are not available for many developing countries. For the U. S., the mean differences are quite small and tend to favour males for quantitative skills and females for literary skills.

[13]Conversely, rates of return to investing in their daughters' education may be augmented if parents provide dowries for their daughters and if the dowries necessary to obtain a husband with given attributes for their daughters are inversely related to the daughters' education. Rao (1990) finds such a tradeoff between dowries and the education of daughters for rural south India.

[14]Haddad, Carnoy, Rinaldi and Regel (1990); Stromquist (1988) and Schultz (1991) all stress the importance of household demand in the explanation of the gap.

[15]Schools are all government run in our sample, with their availability determined directly by decisions at the district, state and national levels. Demand may influence school supply policies through political processes, though it appears that the responsiveness of policies to parental demands was quite limited during the time periods of relevance for the cohorts that we study. Moreover, the supply-demand distinction is useful because policies affect schooling availability more directly than does parental demand. For these reasons we treat school supply as exogenous.

markedly with the extent to which the immediate source of the gender gap is on the supply side and thus subject to direct governmental policies or on the demand side and, therefore, deeply imbedded in preferences and incentive structures for large numbers of individuals.

Our rich data set permits us to estimate a behavioural model of cognitive achievement and then use the model to decompose the gender gap in cognitive achievement and answer the following questions: By how much would this gender gap be reduced if the availability of schooling were the same for boys and girls? By how much would it be reduced if the demand for primary school (or for subsequent levels) were the same for boys and girls? By how much would the gender gap be reduced if boys and girls attended school of the same quality and benefitted from the same level of parental inputs?

3. THE MODEL AND THE GENDER GAP DECOMPOSITION METHOD

To decompose the gender gap in cognitive achievement, we model gender differences in the determinants of schooling attainment *(SA)*,[16] conditional upon school supply *(SS)*,[17] and in the production of cognitive achievement *(CA)*. Because most students in rural Pakistan attend government schools, supply is a matter of public policy–beyond the household's direct control.[18] Given school availability, the household determines the level of schooling attainment by equalising expected marginal benefits and marginal costs.

In rural Pakistan, primary school (generally kindergarten plus five grades) is followed by middle school (grade 6 – 8). Students continuing in school usually complete two more grades (9-10) before sitting for the matric exam, two more grades (11-12) before taking the FA or FSc exam, and two more grades (13-14) before taking the BA or BSc exam. Preparation for these exams occurs at high schools and post-secondary institutions that may be located in towns some distance from home.[19]

We estimate, conditional on availability, reduced from schooling attainment

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[16]This term is used in the schooling literature to refer to the schooling level completed.

[17]We consider a school to be available if there is one in the village or sufficiently nearby that costs of travel do not preclude attendance by students with the highest expected returns.

[18]In our sample districts, there are no private schools. In principle, location (hence, availability of schooling) can be changed by migration. But migration is very limited within rural Pakistan (though there is more emigration from rural to urban areas). Fewer than 2 percent of respondents in our sample attended primary school away from the immediate vicinity of their village. Therefore we avoid the analytic problems due to intra-rural migration that are discussed in Rosenzweig and Wolpin (1988).

[19]For most respondents, different school levels correspond to different schools attended, with corresponding variations in school quality.

functions.[20] Likewise, we estimate cognitive achievement functions at each level of schooling, controlling for the resulting selectivity bias that arises as students move from level to level.[21] This yields the following system of seven relations:

(1)   Probability of having had some schooling (conditional on $SS_{Pi} = 1$)
$SA_{So} = SA\ (G, PSA, F, A, P, QS, R)$;

(2)   Probability of having completed primary school (conditional on $SA_{So} = 1$)
$SA_{Pi} = SA\ (G, PSA, F, A, P, QS, R)$;

(3)   Probability of having completed middle school (conditional on $SA_{Pi} = 1$ and $SS_{Mi} = 1$)
$SA_{Mi} = SA\ (G, PSA, F, A, P, QS, R)$;

(4)   Probability of matriculation (conditional on $SA_{Mi} = 1$)
$SA_{Ma} = SA\ (G, PSA, F, A, P, QS, R)$;

(5)   Cognitive achievement of primary leavers (conditional on $SA_{Pi} = 1$ and $SS_{Mi} = 0$)
$CA_{Pi} = CA\ (G, PSA, F, A, QS)$;

(6)   Cognitive achievement of middle leavers (conditional on $SA_{Mi} = 1$ and on $SA_{Mi} = 0$)
$CA_{Mi} = CA\ (G, PSA, F, A, QS)$; and

(7)   Cognitive achievement of matriculates (conditional on $CA_{Ma} = 1$)
$CA_{Ma} = CA\ (G, PSA, F, A, QS)$.

Where

SS_{Pi} is the probability that a primary school is available;

SS_{Mi} is the probability that a middle school is available;

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[20]Underlying the schooling attainment function are a number of structural relations including the cognitive skills production function (which we do estimate), expected marginal productivity relations for the impact of schooling attainment through cognitive achievement on future outcomes (which we do not estimate), and marginal conditions for equating the expected rate of return on such investments to the rate of interest on investible resources.

[21]Prices identify the selectivity controls in these relations. Because of the small number of students taking the FA and BA exams, we cannot control for selectivity at these levels.

G is gender;

PSA is the pre-school ability of the individual;

F is a vector of family background characteristics including parental education and household income;

A is age;

P is a vector of prices including travel costs and costs of books and of other supplies for schooling;

QS is a vector of the quality characteristics of local schools; and

R is region.

The determinants of the demand for schooling $(1 - 4)$ include predetermined attributes of the child (G, PSA, A), of the parents (F), of the school system (QS), of the region (R), and prices (P). The expected benefits are assumed to be primarily the increments to expected marginal product, which is a function of cognitive achievement. However, as noted above, schooling attainment is not the only determinant of cognitive skills. For any level of schooling attainment, the determinants of cognitive achievement include as well the quality of schooling, pre-school ability and various elements of family background, such as parental schooling, that affect concurrent out-of-school human capital investments in the child, as in relations $5 - 7$.[22]

With estimates of Equations $1 - 7$, we can decompose the gender gap in cognitive achievement. We predict female cognitive achievement by summing the predicted female cognitive achievement at the completion of each level of schooling weighted by the predicted probability of having left school after completing that level.[23] This is done by setting, in each of our estimated equations, all variables to their sample means except the gender variable and, in one set of estimates, the pre-school ability variable.

$$CA^F = \Pi^F_{Pi} CA^F_{Pi} + \Pi^F_{Mi} CA^F_{Mi} + \Pi^F_{Ma} CA^F_{Ma}$$

where

[22]Our model yields a system of seven equations that, in principle, might be estimated jointly. Joint estimation, however, would be computationally intractable. Instead, we use the recursive nature of the equations to simplify the estimation. In particular, we treat Equations $(1 - 4)$ as a series of separate probits; estimate Equation 5, controlling for selectivity; and estimate Equations 6 and 7 jointly, controlling for selectivity.

[23]Because we did not administer the cognitive skills tests to respondents with less than four years of schooling, we are unable to estimate production functions for those who did not complete primary school.

$$\Pi_{Pi}^{F} = SS_{Pi}^{F} \quad SA_{So}^{F} \quad SA_{Pi}^{F} \quad (1 - SA_{Mi}^{F}),$$

$$\Pi_{Mi}^{F} = SS_{Pi}^{F} \, SS_{Mi}^{F} \, SA_{So}^{F} \, SA_{Pi}^{F} \, SA_{Mi}^{F} \, (1 - SA_{Ma}^{F}), \text{ and}$$

$$\Pi_{Ma}^{F} = SS_{Pi}^{F} \, SS_{Mi}^{F} \, SA_{So}^{F} \, SA_{Pi}^{F} \, SA_{Mi}^{F} \, SA_{Ma}^{F}$$

Male cognitive achievement is predicted analogously. The extent to which the ratio CA^{F}/CA^{M} falls below one yields a measure of the gender gap. We decompose this gap into its components by successively setting the component conditional probabilities and cognitive achievement scores to their sample means. For example, to eliminate the impact of differences in school availability, we calculate the gender gap setting

$$SS_{Pi}^{F} = SS_{Pi}^{M} = \overline{SS}_{Pi} \text{ and } SS_{Mi}^{F} = SS_{Mi}^{F} = \overline{SS}_{Mi} ,$$

Where the bar indicates an estimate at the sample means.

4. DATA

I discuss here the measurement of a few of the key variables used in the analysis of the gender gap and of the relative returns to improving quality and increasing quantity.[24]

School Availability

Whether a school was available in the village at the time the respondent was of the age to attend was indicated by our school survey. If a respondent was from a village not included in the school survey, we proxied school availability by determining the earliest date a respondent from the village attended school in or near the village.[25]

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[24]Throughout, for intertemporal comparisons, we analyse two cohorts with age ranges of 20 – 24 and 30 – 44, respectively. For the younger of these cohorts we have usable data on 435 respondents. This is the youngest group for whom we have information on completed school of all respondents. Given the flat age pyramid of the Pakistani population and the lower enrollment rate of older cohorts, the older cohort covers a broader age range so as to have at least as many usable observations as the younger cohort.

[25]We verified in villages in which we administered the school survey that the proxy was an accurate indicator of the year the school was first available.

Cognitive Achievement:

Our measure of cognitive skills 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. [26,27] Among those who took the cognitive skills test, the distribution of the scores was not truncated, exhibits substantial variance and appears to be normally distributed.

Pre-school Ability

To obtain a measure of pre-school reasoning ability, we administered Raven's (1956) Coloured Progressive Matrices (CPM), a test of reasoning ability that 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, though performance may reflect early childhood environment as well as innate capacity. The distribution of the CPM test scores is not truncated at either tail; it exhibits substantial variance and appears to be normally distributed. The disaggregated distributions for the NWFP, the Punjab and the Sindh are very similar. Since educational levels differ substantially across regions, this similarity is consistent with the presumption that educational attainment does not influence performance on Raven's CPM test.

The average score on the Raven's CPM test is roughly 6 points (out of a possible 35) lower for women than for men in both the 20 – 24 and 30 – 44 cohorts. This statistically significant differential on a test designed to be gender neutral[28] holds with the same magnitude for the other age groups in our sample. The gender gap in the CPM test score could be due to pre-school acculturation that inhibits performance on the test for females, to a true gap in innate ability, or to measurement error.

We were unsuccessful in attempts to attribute the gap to sampling bias or to gender differences in familiarity with testing procedures.[29] There is evidence that ability as we measure it is not solely determined by genetics. However, if early

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[26]Since tests were administered only to those with at least four years of schooling, scores had to be imputed for those with less schooling. Those with no education were assigned zero scores. (The scores of a subsample of the uneducated who were given the tests confirmed the appropriateness of this assignment.)

[27]We assume that cognitive skills so measured, perhaps several years after the completion of school, reflect the cognitive skills at the time of termination of school. That is, there is not subsequent further augmentation nor depreciation in cognitive skills. Estimates indicate that time and experience to schooling do not affect cognitive achievement in our data.

[28]Raven (1956).

[29]For detailed discussion of our attempts to identify the origin of the gender gap in ability see Alderman, Behrman, Ross and Sabot (1991).

childhood cultural deprivation constrains girls from achieving their potential ability it is through a process we cannot capture with the data available to us.[30] We discuss the implications for our results of alternative interpretations of the gender gap in pre-school ability below.

Family Background

We use predicted rather than observed household income for two reasons. First, Pakistani rural incomes vary substantially from year to year. Therefore, current income may be a poor indicator of the household's longer run resources that are of interest for our purposes. Second, the income that influences educational choice is not current income but permanent income or the income at the time the decision was made. Predicting income on the basis of parents' assets and other characteristics yields an unbiased measure of past family income.[31]

Price of Schooling

To calculate distance (time) to the nearest available school, we used the average travel time for children currently in school in each village as a proxy for the travel time of all respondents.[32] Expenditures on books and school supplies are dependent not only on the school system, but also on the household's preferences and income and, consequently, have endogenous components. To obtain a proxy for the exogenous cost component, we estimated educational expenditure functions including 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 exogenous costs, i.e., prices.

School Characteristics

As noted above, the school survey permits us to identify which schools respondents attended. It also provides measures of a number of school characteris-

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[30]The score on Raven's CPM test is related to no exogenous variable in our data set other than gender and the same gender parent's score. Controlling for these factors, we find no correlation between the CPM test score of children and income, parental education, and parental occupation. In the results reported below we rely on the exogeneity of our ability measure to formal schooling and concurrent parental inputs [Raven (1956)].

[31]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.

[32]Where there are currently fewer than five children in school for a village, we proxied travel time by the mean travel time conditioned on district and whether the nearest school is located in the village or a nearby village or town.

tics that we intend to use in our analysis. A number of these pertain to the teachers in the school: average years of teaching experience, average years of teaching experience at the school, average schooling level of teachers, average cognitive achievement scores for teachers on both reading and mathematics tests, average teacher ability scores, average teacher pay, and average years of training for teachers. Others pertain to physical characteristics of the school: year in which school constructed, year in which classes began, number of classrooms, number of classrooms with blackboards, whether there is enough chalk, whether there are desks for all students, whether there is a student library, and whether textbooks are provided. These variables exhibit substantial variance; the lower tails of the distributions are suggestive of low quality schools.[33]

5. ESTIMATES AND GENDER GAP DECOMPOSITION

In this section, we consider in turn each of the three components of the gender gap in cognitive skills and conclude with counterfactual exercises to determine by how much the gender gap in cognitive skills would be reduced by eliminating gender differences in school supply, demand, and the production of cognitive skills.

Because ability is a determinant of performance in school, and hence of expected returns, it enters the schooling attainment (demand) functions as well as the cognitive skills production functions. Given the higher measured average pre-school ability of men than of women, the gender gap in cognitive skills is larger for the sample as a whole than for men and women of comparable pre-school ability. Since we are unable to determine decisively the correct explanation for the gender gap in pre-school ability we calculate and decompose the gender gap in cognitive skills in two ways. Our first set of calculations incorporates the gap in pre-school ability. In the second, we set the CPM test score for both men and women to the sample mean.[34]

A. School Supply

The first panel of Table 1 presents probabilities for the availability of primary school controlling for gender; the next panel presents the probabilities for the availability of middle school (conditional on a primary school having been

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[33]While we include in our specification in Section 3 the quality of school, we lack direct measures of school quality for a large portion of our sample. Hence the analysis of improving quality versus increasing quantity is confined to this smaller sample. In the gender gap analysis, to the extent that school quality varies by region or by gender, these variables may partly represent school quality in our estimates.

[34]We also dropped pre-school ability from our estimates and find that the results do not differ qualitatively from those reported for the first case.

Table I

Predicted Probabilities of School Availability and Attendance

Part 2.1 – Incorporating Gender Gap in Pre-School Ability

	A			B		C		D		E		F	
	30–44	20–24	10–14	30–44	20–24	30–44	20–24	30–44	20–24	30–44	20–24	30–65	20–24
At Point of Means	48.4	71.5	79.9	79.5	92.9	62.3	75.0	89.9	89.9	70.4	68.9	62.9	61.5
By Gender													
Male	84.2	97.6	99.5	–*	–*	75.4	84.8	94.6	94.7	79.5	78.9	–*	–*
Female	18.2	47.8	55.9	–*	–*	26.1	56.9	66.1	77.0	37.5	42.2	–*	–*
N	702	435	468	702	435	362	311	174	187	127	141	127	95

Part 2.2 – Eliminating Gender Gap in Pre-School Ability

	A			B		C		D		E		F	
	30–44	20–24	10–14	30–44	20–24	30–44	20–24	30–44	20–24	30–44	20–24	30–65	20–24
At Point of Means	48.4	71.5	79.9	79.5	92.9	62.3	75.0	89.9	89.9	70.4	68.9	62.9	61.5
By Gender													
Male	84.2	97.6	99.5	–*	–*	68.0	78.4*	91.4	–*	–*	–*	–*	–*
Female	18.2	47.8	55.9	–*	–*	33.6	67.9*	74.5	–*	–*	–*	–*	–*
N	702	435	468	702	435	362	311	174	187	127	141	127	95

A = Probability that a primary school was available.
B = Probability that a middle school was available conditional on availability of a primary school.
C = Probability of having attended primary school conditional on availability of primary school.
   Parameter estimates appear in appendix table columns a and e.
D = Probability completed primary school conditional on attending primary school.
   Parameter estimates appear in appendix table columns b and f.
E = Probability completed middle school conditional on completing primary school and availability.
   Parameter estimates appear in appendix table columns c and g.
F = Probability passed matric exam conditional on completing middle school.
   Parameter estimates appear in appendix columns d and h.
* = Difference *Not* significant at 2-tilled 10 percent level.

available).[35] As a consequence of the large school construction programme in Pakistan, the availability of primary school in rural villages has increased markedly.[36]

Though declining, the gender gap in primary school supply remains substantial. For the 30 – 44 cohort, 84.2 percent of boys of primary-school age had access to a primary school, but only 18.2 percent of girls did. Girls have been a principal beneficiary of the school construction programme in rural Pakistan. For the 20 – 24 cohort, the respective percentages increased to 97.6 and 47.8. Expressed as a fraction of the male probability, the gender gap in primary school availability fell from 78.4 percent[37] for the 30 – 44 cohort to 51.0 percent for the 20 – 24 cohort to 43.8 percent for the 10 – 14 cohort. Still, even for the 10 – 14 cohort, only roughly half as many girls had access to local primary schools as did boys.

B. Demand for Schooling

Given the availability of a school, what is the difference between girls and boys in the probability of attending? The third panel of Table 1 gives the predicted probabilities of attending primary school. Part 2.1 refers to estimates that reflect the observed gender gap in pre-school ability and Part 2.2 refers to estimates that eliminate the ability gap. These estimates indicate that aggregate demand (conditional on supply) has increased: the predicted conditional probability of having attended school rose from 62.3 percent for the 30 – 44 cohort to 75 percent for the 20 – 24 cohort.[38]

The gender gap in the demand for primary school (conditional on supply) has declined substantially irrespective of our treatment of pre-school ability. With the gender gap in pre-school ability incorporated (Part 2.1) the gender gap in demand was quite large for the older cohort: the probability of a girl attending primary school was 65.4 percent less than the male probability. For the younger cohort, however, the gap was much smaller: the probability of a girl attending primary

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[35]The two parts of the table are identical for the probabilities that schools are available (panels A and B) and for the probabilities at the point of means for panels C-F, but differ for males versus females in panels C-F.

[36]79.9 percent of children in the 10 – 14 age cohort in 1989 had access to a nearby primary school. By contrast, for respondents 30 – 44 years of age, the probability that a primary school was available when they were of primary-school age was only 48.4 percent. The expansion in the availability of middle school has been greater still. Of the 48.4 percent of children in the 30 – 44 cohort who had a primary school available, 79.5 percent also had a middle school available; of the 71.5 percent in the 20 – 24 cohort, fully 92.9 percent had a middle school available.

[37]$(84.2 - 18.2)/84.2$

[38]Consistent with human capital theory, our results indicate that significant determinants of the demand for primary schooling include pre-school ability, father's education, family income, the cost of schooling, gender and region.

school was 32.9 percent less than the male probability. For the boys for whom primary school was available, the predicted probabilities in the third panel (Part 2.1) indicate that 84.8 percent started school; for the girls, 56.9 percent entered the schooling system.

Because pre-school ability of children influences demand for primary schooling, eliminating the gender gap in pre-school ability when calculating the predicted probability of attendance (the third panel, Part 2.2) reduces the gender gap in demand. For the older cohort the gender gap in demand is 50.4 percent; for the younger cohort it declines to only 13.4 percent.[39] For those in the younger cohort for whom primary school was available, the predicted probability of starting school was 78.4 percent for the boys and 67.9 percent for the girls.

The gender gap in the probability of completing primary school (conditional on having started) also has declined substantially. Again, this result is not sensitive to our treatment of pre-school ability. The fourth panel indicates that for both cohorts, an estimated 90 percent of children who started primary school completed it. In Part 2.1, for the 30 – 44 cohort, the probability that a girl starting school completed primary school was only 66.1 percent; a boy had a 94.6 percent chance of completing. For the 20 – 24 cohort, the gap was smaller: the percentages were, respectively, 77.0 and 94.7 percent. For boys and girls of equal pre-school ability in Part 2.2, for the older cohort the probability of completing primary school for a boy was 91.4 and for a girl, 74.5; for the younger cohort there is no significant difference even at the 10 percent level between girls and boys in the conditional probability of completing primary school.

Given the availability of a middle school, what is the difference between girls and boys who completed primary school in the probability of attending? The answer to this question is sensitive to the treatment of pre-school ability.[40] In the fifth panel, Part 2.1 the probability for girls in the older cohort is 52.8 percent of the probability for boys; the gap declines to 46.5 percent for the younger cohort. In Part 2.2 there is no significant difference between girls and boys in the probability of attending middle school for either cohort, i.e. parents of children completing primary school and for whom a middle school is available would be just as likely to send a daughter to middle school as a son, were there no difference in pre-school abili-

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[39]In the estimated model (Column C of the Appendix Table), the gender difference is statistically insignificant. We report the point estimates because this difference becomes significant if we expand the cohort to include 19 year-olds; that is, the insignificance appears to be a small numbers problem.

[40]As was the case with the demand for primary school, pre-school ability, region, and (for middle school) the cost of books are significant determinants of demand. To obtain a large enough sample to achieve significant estimates of the determinants of the probability of passing the matric exam, we added respondents age 45 – 65. Within the 30 – 65 cohort, the demand for schooling is inversely associated with age.

ty.[41] The sixth (right most) panel presents the conditional probabilities of matriculation. There is no evidence of a gender gap in the demand for matriculation; this result is not sensitive to our treatment of ability.

The probabilities in the last three panels imply that gender differences in the rate of progression through the rural school system in Pakistan have been declining. They also imply that for the younger cohort, once girls of a comparable pre-school ability get into the rural school system, given equal school availability, their probability of progressing is indistinguishable from that of boys.

C. The Production of Cognitive Skills

Do girls and boys with the same years of schooling and pre-school ability have the same level of cognitive achievement, or do differences in school quality and parental inputs place girls at a disadvantage in the cognitive skill production process? To answer this question, Table 2 presents maximum likelihood estimates of the cognitive skills production functions for our two cohorts (columns 2 and 5) jointly with the selectivity controls (columns 3 and 6) for each cohort for primary school leavers, along with, for comparison, ordinary least squares estimates of the production functions (columns 1 and 4).[42] Table 3 presents parallel estimates for the middle and matriculation schooling levels.[43]

Our best estimates in this table are obtained for the younger cohort at the middle and matriculate levels. The system of estimates indicates plausible patterns. Even though pre-school ability does not affect significantly cognitive achievement among the 34 individuals in the 20 – 24 age cohort who finished primary but not middle school (Table 2, column 2), it has a significantly positive impact on the probability of completing primary school (Table 2, column 3) and on the cognitive achievement of those who continued beyond primary school (Table 3, columns 3 – 5).

For the older cohort, controlling for individual ability, parental education, and region of residence, we find that at none of the five levels of schooling is the cognitive achievement of women less than that of men. The few girls who attended school apparently received schooling of a quality and parental investments in cognitive achievement at least equal to those of boys. For the younger cohort, those girls

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[41]This conclusion is based on a sample which includes only a small number of women who both completed primary school and had a middle school available. Nevertheless, it is robust over different cohorts and levels of post-primary schooling.

[42]Table 2 presents estimates of relation (5), using relation (3) as a selectivity control. Table 3 presents estimates of (6) and (7), using (4) as the selectivity control. The detailed specifications omit selected variables as a result of small dummy variable cell sizes and multicollinearity.

[43]We include dichotomous variables to indicate whether the respondent passed the FA (FSc) and BA (BSc) exams.

Table 2

Cognitive Achievement Production Functions Primary Leavers

	20–24 Cohort			30–44 Cohort		
	OLS	Maximum – Likelihood		OLS	Maximum – Likelihood	
	(1)	(2)	(3)	(4)	(5)	(6)
	Primary	Primary	Selectivity	Primary	Primary	Selectivity
Constant	13.56	13.69	0.32	28.67	32.74	−2.12
	(1.32)	(1.42)	(0.31)	(2.22)	(2.42)	(1.79)
Female	0.73	1.84	−0.77	4.08	4.45	−0.52
	(0.14)	(0.27)	(2.06)	(0.56)	(0.98)	(0.91)
Pre-School Ability	0.21	0.13	0.06	0.16	−0.01	0.07
	(0.60)	(0.27)	(3.17)	(0.57)	(0.02)	(2.60)
Income	0.18	0.16	0.01	−0.46	−0.56	0.06
	(0.68)	(0.72)	(0.37)	(0.88)	(1.18)	(2.69)
Attock			0.39	−8.21	−10.18	0.89
			(0.92)	(1.55)	(1.59)	(2.14)
Faisal			0.78	3.53	1.93	0.57
			(1.78)	(0.62)	(0.32)	(0.96)
NWFP			0.11	6.32	1.78	0.60
			(0.19)	(0.54)	(0.18)	(1.02)
Father Primary and up			−0.03	−11.78	−12.03	0.24
			(0.09)	(1.93)	(2.78)	(0.63)

Continued –

Table 2 – (*Continued*)

	20–24 Cohort			30–44 Cohort		
	OLS	Maximum – Likelihood		OLS	Maximum – Likelihood	
Father Middle up	−1.85	−2.80	0.66	18.46	17.55	0.31
	(0.26)	(0.35)	(1.35)	(2.33)	(3.04)	(0.61)
Distance to School			0.00			−0.01
			(0.36)			(0.66)
Price of Books			−0.01			−0.01
			(2.17)			(0.75)
σ			11.59			(8.24)
			(6.79)			(3.25)
ρ			−0.17			−0.50
			(0.23)			(0.67)
Wald Statistic		0.78			19.99	
N	34	34	141		28	124

t -statistics in parentheses.

Table 3

Cognitive Achievement Production Functions: Middle Leavers and Matriculates

| | 20 – 24 Cohort | | | | | 30 – 44 Cohort | | | | |
| | OLS | | Maximum–Likelihood | | | OLS | | Maximum–Likelihood | | |
	(1) Middle	(2) Matric	(3) Middle	(4) Matric	(5) Selectivity	(6) Middle	(7) Matric	(8) Middle	(9) Matric	(10) Selectivity
Constant	6.62 (0.56)	−7.71 (0.90)	6.61 (0.78)	−7.59 (0.84)	−1.55 (1.97)	10.54 (1.00)	19.38 (3.28)	10.07 (0.79)	21.09 (3.29)	−0.29 (0.48)
Female	7.87 (1.40)	10.47 (2.27)	7.88 (1.84)	10.54 (3.38)	0.06 (0.16)	−1.07 (0.12)	−2.03 (0.39)	−1.30 (0.20)	−2.03 (0.54)	0.14 (0.27)
Attock	0.20 (0.03)	−0.64 (0.13)	0.24 (0.06)	−0.64 (0.12)	0.09 (0.18)	−4.63 (0.80)	4.74 (1.14)	−4.14 (0.75)	5.26 (1.33)	−0.52 (1.28)
Faisal	3.65 (0.57)	0.65 (1.68)	3.58 (0.93)	8.77 (1.60)	−0.13 (0.25)	−3.56 (0.56)	2.91 (0.78)	−3.32 (0.68)	3.46 (0.98)	−0.46 (1.22)
NWFP	5.34 (0.74)	8.85 (1.66)	5.86 (1.21)	8.83 (1.80)	0.14 (0.25)					
Father Primary						5.46 (0.79)	−0.42 (0.10)	5.48 (0.10)	−0.24 (0.06)	−0.11 (0.26)
Father Middle Up	4.59 (0.91)	0.76 (0.24)	4.59 (1.00)	0.77 (0.31)	0.05 (0.16)	11.33 (1.16)	3.59 (0.77)	10.87 (2.04)	2.96 (0.82)	0.61 (1.25)
Pre-School Ability	0.49 (1.62)	1.01 (3.82)	0.45 (1.79)	1.02 (4.95)	0.04 (1.57)	0.71 (1.78)	0.22 (0.90)	0.66 (1.64)	0.10 (0.82)	0.04 (1.55)

Continued –

Table 3 – (*Continued*)

| | 20 – 24 Cohort | | | | | 30 – 44 Cohort | | | | |
	OLS		Maximum–Likelihood			OLS		Maximum–Likelihood		
Income	0.05 (0.15)	0.14 (0.97)	0.05 (0.27)	0.14 (1.00)	0.03 (1.94)					
FA	4.90 (2.57)			4.85 (1.85)			6.57 (1.68)		6.62 (2.00)	
BA						7.23 (1.53)			7.27 (1.85)	
σ				9.44 (7.74)	8.87 (13.19)				8.21 (8.76)	9.48 (11.40)
ρ				0.04 (0.12)	–0.09 (0.30)				0.16 (8.73)	–0.22 (1.07)
Wald Statistic			12.67	42.18				17.84	24.62	
N	36	58	36	58	103	25	55	25	55	119

t -statistics in parantheses.

who made it past the primary level actually emerged from each of the subsequent levels of the educational system with higher cognitive achievement than did boys.[44]

D. Decomposing the Gender Gap

With our estimates of school supply, school demand and cognitive skill production functions, we now can decompose the gender gap in cognitive skills. Since the gender gap varies for our two cohorts and also depends on our treatment of ability, four sets of decompositions are presented.[45] Table 4 shows the effect on the gender gap in cognitive skills of simulating the elimination of gender differences in, first, school supply, then, cumulatively, in school demand, and, finally, in the cognitive skill production function.[46]

We can now answer the three counterfactual questions posed in the introduction. *First,* by how much would the gender gap be reduced if the availability of schools were the same for boys and girls? If the gender gap in pre-school ability is incorporated (column 1), for the 20 – 24 cohort the gender gap in cognitive achievement is cut virtually in half (i.e., reduced from 68.3 to 35.9 percent) by equating the supply of primary school. We do not detect a statistically significant gender gap in the availability of a middle school among children who had access to a primary school. Therefore in our decomposition, equalising the supply of middle school, conditional on completion of primary school, has no effect on the gender gap in cognitive skills.

For boys and girls of equal ability, the result is still more striking: the gender gap in cognitive achievement is closed, and indeed reversed, by equating the supply of primary school. The change in the gender gap is from 42.0 to –18.4 percent. The negative gap implies that, *ceteris paribus* in the absence of a gender gap in supply, young women would have a higher level of cognitive achievement than young men. Again, equalising the supply of middle school has no further effect. While the effect of simulating the elimination of the gender gap in school supply is sensitive to our treatment of pre-school ability, with either treatment it is apparent that for the younger cohort, the gender gap in the availability of primary school accounts for a

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[44]We find no significant gender difference in the cognitive achievement of primary leavers.

[45]As noted above, the gross gender gap in cognitive achievement for the 20 – 24 cohort is 76 percent. By holding constant at the sample mean differences between men and women in the independent variables of our seven equation system that are presumed not to be the product of gender bias, we calculate a gender gap of 68.3 if we incorporate the gender gap in ability and 42.0 percent if we do not.

[46]The cognitive achievement production functions are based on quite small sample sizes. Therefore, in calculating the impact of gender differences in the production of cognitive skills, we use the gender and pre-school ability coefficients as best estimates, regardless of statistical significance. The results are qualitatively unchanged if we set insignificant coefficients to zero, except that a negative gender gap appears for the 30 – 44 upon equating demand for matric and monotonically falls to zero as cognitive achievement is equated at each level.

Table 4

Decomposing the Gender Gap in Cognitive Skills

20 – 24 COHORT	Gap as Percent of Male Score			
	(1)		(2)	
Estimated Net Gender Gap	68.3		42.0	
Equation Supply of Primary School	35.9			−18.4
Equating Supply of Middle School	35.9			−18.4
Equating Demand for Some Schooling		4.5		−36.8
Equating Demand for Primary School		−17.5		−36.8
Equating Demand for Middle School	−27.9		−36.8	
Equating Demand for Matric	−27.9		−36.8	
Equating Primary Cognitive Achievement Function	−23.9		−29.2	
Equating Middle Cognitive Achievement Function		−17.7		−19.0
Equating Post-Matric Cognitive Achievement Function	0.0		0.0	
30 – 44 COHORT				
Estimated Net Gender Gap	95.6		90.9	
Equation Supply of Primary School	79.6		58.0	
Equating Supply of Middle School	79.6		58.0	
Equating Demand for Some Schooling		41.0		15.1
Equating Demand for Primary School		15.6		−4.2
Equating Demand for Middle School	0.9		−4.2	
Equating Demand for Matric	0.9		−4.2	
Equating Primary Cognitive Achievement Function	9.1		4.1	
Equating Middle Cognitive Achievement Function		4.7		3.0
Equating Post-matric Cognitive Achievement Function	0.0		0.0	

(1) – Incorporating the gender gap in pre-school ability.
(2) – Eliminating the gender gap in pre-school ability.

substantial proportion of the gender gap in cognitive skills.

For the 30 – 44 cohort, the gender gap in supply contributed less to the gender gap in cognitive achievement. The proportion of the latter due to the former is smaller in both absolute and relative terms than for the younger cohort. Equalising the supply of primary schools reduces the gender gap in cognitive skills from 95.6 to 79.6 percent and from 90.9 to 58.0 percent, respectively, for the alternative treatments of pre-school ability. For this older cohort, equalising the availability of middle schools does have some impact on the gender gap in cognitive skills, but the effect is small.

Second, by how much would the gender gap in cognitive achievement be reduced if the demand for each of the schooling levels were the same for boys and girls? The answer to this question is the complement, though not the precise complement,[47] of the answer to the previous question. Our simulations indicate that the elimination of the gender gap in demand would have a larger impact on the gender gap in cognitive achievement for the older than for the younger cohort and for the gap in cognitive achievement that incorporates the gender gap in pre-school ability than for the one that does not. For the 20 – 24 cohort if the gender gap in pre-school ability is incorporated the gender gap in cognitive achievement is reduced by 63.8 percentage points,[48] with the biggest effects resulting from equating demand for some or for completed primary school. In contrast, for boys and girls of comparable ability, the combined effect of equating the demand for various schooling levels is to reduce the gender gap in cognitive achievement by only 18.4 percentage points.[49] For the 30 – 44 cohort, irrespective of the treatment of the ability gap, the contribution of the gender gap in demand to the gender gap in cognitive skills is much larger with, once again, the biggest effects resulting from equalising the demand for some and completed primary schooling.

Third, by how much would the gender gap in cognitive achievement be reduced if boys and girls attended schools of the same quality, used their time identically, and benefitted from the same level of parental inputs during their school years? We have found no evidence that girls, once in school, are at a disadvantage with regard to the acquisition of cognitive skills. Indeed girls generally appear to be

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[47]If all inputs in the cognitive achievement production function are equated, our results suggest the women in our sample learned more than the men at some levels of schooling. As a result, the estimated gender gaps do not fall monotonically as demand and the production of cognitive skills are equated. If all elements of supply and demand are equated, the gender gap in cognitive achievement is negative (–23.9 and –29.2 percent respectively) for the 20 – 24 cohort. This implies that the sums of the contributions of supply and demand factors to the gender gaps in cognitive achievement are greater than 100 percent.

[48] $63.8 = 35.9 - (-27.9)$.

[49] $18.4 = -18.4 - (-36.8)$.

at an advantage. Thus, when in our simulations, we equalise the quality of school-ing and parental inputs there is no additional increase in the predicted cognitive skills of girls relative to boys for either treatment of pre-school ability or for either cohort.

6. IMPROVING THE QUALITY VERSUS INCREASING THE QUANTITY OF SCHOOLING: SOME BACKGROUND

In human capital models it is the output of schooling – cognitive and other skills – not such inputs to educational production as years of schooling, that is presumed to affect subsequent productivity. The variance in cognitive skills among children with the same number of years of schooling is generally high. Some of the variance is due to differences among children in such other inputs to educational production as ability and out of school investments in human capital made by parents, which are not directly influenced by government policy. Some of the difference, however, is due to differences in the quality of schooling, a policy vari-able. This implies that improving the quality of schooling is an alternative to increasing the quantity as a means of increasing the skill level and productivity of the labour force.

Which investment strategy is preferable depends on their relative costs and benefits. Here we estimate and compare rates of return to investment in improving the quality of schooling (holding quantity constant) and increasing the quantity of schooling (holding quantity constant).

Most studies that have investigated the impact of schooling quality in devel-oping countries focus on its influence on grades or test scores, not on post-school outcomes, and have limited controls for pre-school ability and for family and community background. These estimates of educational production functions have yielded mixed results with regard to magnitudes, but they do consistently find evidence of an impact on achievement of variation in school inputs.[50] The few stud-ies that consider the impact of school quality on post-schooling productivity, prox-ied primarily by wages, suggest that the impact of schooling quality may be considerable, with rates of return at least as high as those for investing in school quantity.[51] However, none of these studies trace the links from quality to cognitive outputs and thence to labour productivity. Nor do they control for pre-school ability or for family background, so the estimated returns to school quality and quantity may reflect omitted variable and selectivity biases. A third limitation of these stud-

[50]See the recent surveys in Fuller (1986); Haddad, Carnoy, Rinaldi and Regel (1990); Hanushek and Harbison (1990) and Hanushek (1986, 1989).

[51]See Behrman and Birdsall (1983, 1985); Behrman, Birdsall and Kaplan (1991); Behrman and Sussangkarn (1989) and King and Bellew (1988).

ies is that the quality indicators that have been used are highly aggregated and crude, depending on variations across large (regional) groupings of schools in such characteristics as teachers per student or average teacher schooling.

Our survey, which permits us to go beyond previous analyses of the relative returns to the quality and quantity of schooling, links households with the schools attended by household members; one questionnaire, and a set of tests, were administered in surveyed households and another questionnaire, and the same set of tests, to teachers in surveyed schools. As noted above the data set contains, *inter alia,* measures of pre-school ability, of a wide range of school "quality" characteristics, some of which have not been available for previous analyses, of other inputs into the education production process, of cognitive outputs (literacy and numeracy) of that process, and of the earnings of employed members of the household.

The data permit the investigation of the whole chain that links family background and pre-school ability through the quality and quantity of schooling to labour market outcomes, not just part of this chain as in previous studies. Estimates of education production functions, which incorporate school quality variables as well as years of schooling, ability and family background variables, and wage functions which incorporate measures of cognitive skill, permit us to assess the relative impact of school quality and years of schooling on cognitive achievement and thence on productivity and income. By taking account of the costs of additional years of schooling and the costs of improvements in quality, we are able to calculate rates of return to these alternatives.

Developing countries have increased substantially their investments in schooling in recent decades, and in the aggregate currently spend more than $ 60 billion per year in direct public expenditures on schooling.[52] The issue of subsidies to education is now more pressing than it was two or three decades ago when government expenditures were small. The rise in the share of government budgets devoted to education together with slower economic growth and the tighter budgetary constraints imposed by structural adjustment efforts have increased the pressure to find more cost-effective means of educating the labour force.

Some schools in developing countries are equal in resources per student and teacher qualifications to high quality schools in high income countries. However, a substantial proportion of schools, particularly in rural areas, are without many inputs, such as the following, which in high income countries are considered essential: an all weather building, electricity, desks and chairs, blackboards and chalk, paper and pencils, books, literate and numerate teachers. For example, – percent of the teachers in our rural Pakistan sample scored on our reading and math tests below the level signifying literacy and numeracy. The recognition of the very poor

[52]See Behrman and Schneider (1991) and Sabot (1990).

quality of a large proportion of schools in developing countries has stimulated interest in determining whether using scarce investment resources to improve the quality of education that children receive is more cost effective than using them to further increase the quantity of education they receive.

Section 7 presents a simple framework within which to consider the roles of schooling quality and quantity. Section 8 presents some preliminary estimates of the impact of schooling quality and quantity on cognitive achievement and – through cognitive achievement – on daily earnings in labour markets, and the implied rates of return to investments in school quality versus quantity. Section 9 concludes our assessment of the determinants of the gender gap and of the relative returns to improving quality and increasing the quantity of schooling.

7. CONCEPTUAL FRAMEWORK FOR THE ANALYSIS OF THE RELATIVE RETURNS TO IMPROVING QUALITY AND INCREASING QUANTITY

In our framework both the quantity and the quality of schooling received are presumed 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 earnings, as proxied by daily earnings in paid labour markets. Thus our system of relations includes a cognitive achievement production function conditional on the quality of local schools and an earnings function dependent in part on cognitive achievement, rather than, as in a conventional Mincerian earnings function, on years of schooling:

(1) $CA = CA\ (G, PSA, F, A, QS, SA)$ and

(2) $E = E\ (G, CA, A, R)$,

where

    CA is cognitive achievement;
     G is gender;
  PSA is pre-school ability;
      F is a vector of family background characteristics including parental education and household income;
      A is age;
    QS is, alternatively, a vector of dummy variables signifying the school attended by the respondent or a vector of quality characteristics of schools attended;

SA is schooling attainment;
E   is earnings; and
R   is region.

To isolate the independent effects of quality and quantity (attainment) on cognitive achievement and to avoid omitted variable bias, the production function includes indicators of both, as well as such other determinants of achievement as pre-school ability and, as a proxy for out of school investments in human capital, family background. Using estimates of relations (1) and (2) we can trace the impact of a given resource outlay on, alternatively, improvements in quality and increases in quantity (attainment) and thence on increases in cognitive achievement and earnings. We are, therefore, able to calculate and to compare the rates of return to these alternatives.

For the relevant time period in rural Pakistan, almost all schools were public. Primary school (generally kindergarten plus five grades) is followed by middle school (grades 6 – 8), and our analysis below focuses on these two school levels since relatively few individuals continue beyond them. Virtually all students attend primary and middle school in their village or in a nearby village or town. The quality of local schools appears to be determined by district and higher level decisions, perhaps in response to wishes of politically powerful individuals such as landlords and military officers, but not in direct response to household demands. Therefore, we consider the quality of locally available schools to be given from the point of view of individual households. Our estimation of the cognitive achievement production function in relation (1) is thus conditional on the quality of schools attended by respondents.[53]

The rate of return to a given investment in education is defined as that rate of interest which equalises the present value and of the benefits and the costs of that investment. Figure 2 illustrates how we calculate the rates of return to investment in middle schooling for a graduate of an average quality primary school and to augmenting the quality of primary schooling. O-U, O-Plc, O-P, O-Phc, and O-M represent the lifetime earnings profiles of, respectively, uneducated workers, graduates from low, average and high quality primary schools, and graduates from middle schools.

Comparing these profiles during the period in which all these groups are economically active, O-P lies above O-U because workers with five years of primary schooling are presumed to have more productivity augmenting cognitive skills than uneducated workers. Similarly workers with middle schooling are presumed to

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[53]As noted above, households may of course have some indirect effect on the availability and the characteristics of government schools through the political process.
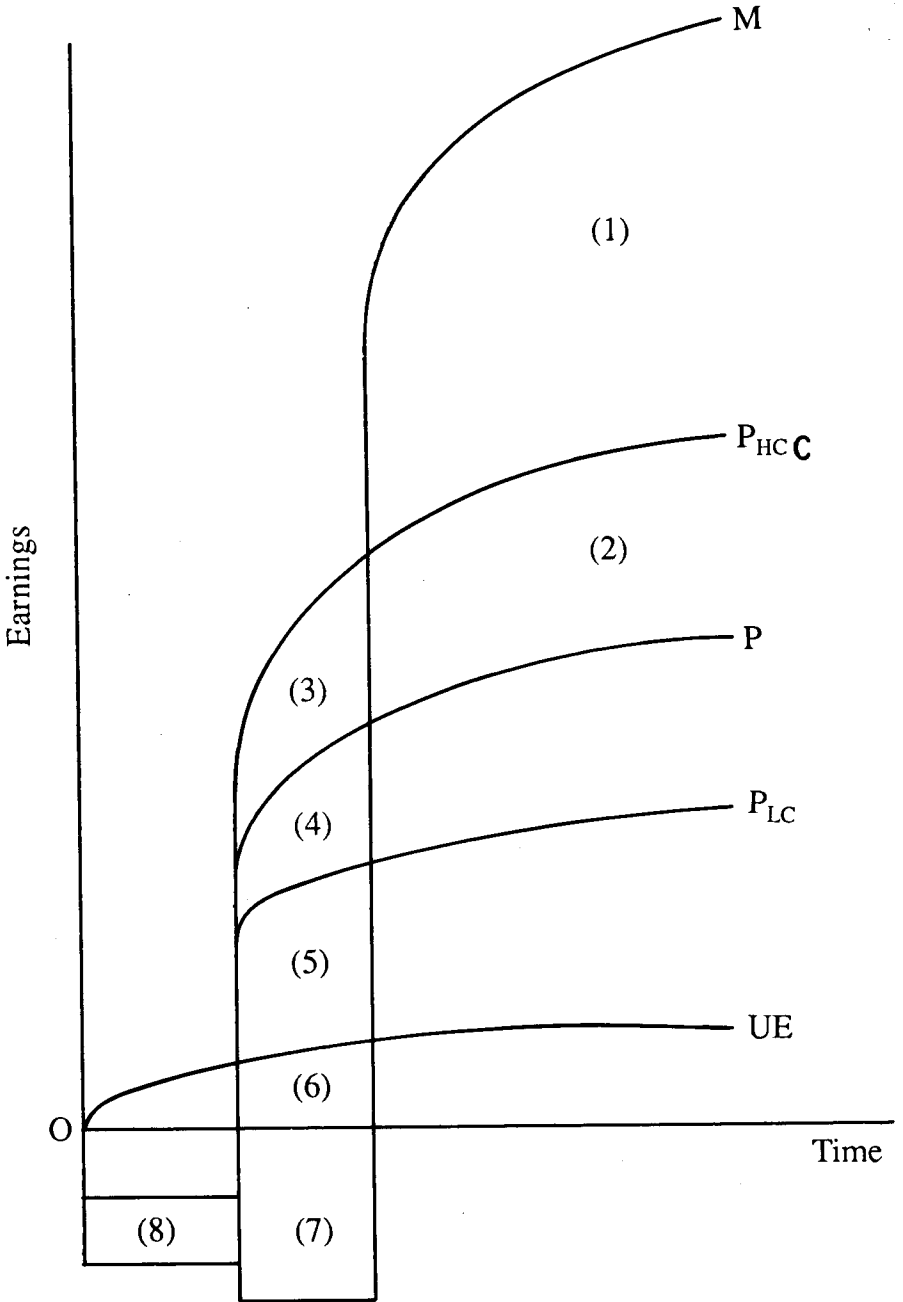
Fig. 1. **Social Returns to High Quality Primary Schooling Compared with the Returns to Middle Schooling**

have more cognitive skills than workers with only average quality primary schooling, and so O-M lies above O-P. Likewise, O-Phq lies above O-P because workers who attended high quality primary schools are presumed to have greater cognitive skills than workers who attended average quality primary schools. The area (1) + (2) thus signifies the gross returns to middle school for the graduate of an average quality primary school who otherwise would enter the labour market and the area (2) + (3) signifies the gross returns to high quality primary school for a student who otherwise would attend an average quality primary school.

The area (4) + (5) + (6) signifies the opportunity cost of attending middle school, while (7) represents the direct costs. Since our concern is with the policy choice between increasing quantity and improving quality our focus is on social and not on private rates of return. Therefore the direct costs include both those borne by the household and those borne by the government. (8) represents the incremental expenditures necessary to transform an average quality primary school into a high quality primary school. To estimate rates of return to improving quality and to increasing quantity we require measures of each of these various components of benefits and costs.

Since our presumption is that a student who attends an improved quality primary school would not have been in the labour market, but rather would have attended an average quality primary school, there is no opportunity cost associated with investing in quality improvement. The opportunity costs of investment in education are often a substantial proportion of total costs so their absence in this case is likely to have an important influence on the rate of return to improving quality relative to the rate of return to increasing quantity.

8. ESTIMATES

Preliminary estimates are available at this time for relations (1) and (2) which we now discuss. Then we turn to various simulations using these estimates, and to preliminary estimates of rates of return to improving quality and increasing quantity, and assessments of their implications for educational investment strategy.

A. Impact of School Quality on Cognitive Achievement

We have estimated a linear approximation to the cognitive achievement production function in relation (1). We focus exclusively in this section on school specific effects. The school dummy variables allow us to answer the following question: controlling for level of schooling and for individual and family background characteristics, does the school attended have an independent impact on the individual's level of cognitive achievement? Our presumption is that the school dummy variables will capture differences in quality, irrespective of their source. To assess the sources of differences in school quality it is our intention in subsequent

drafts to estimate production functions with the observed school quality indicators mentioned above.

Table 5 presents the estimate of the production function for all males with between five and eight years of school for home data are available. The 282 respondents in this category attended 31 schools, so 30 school dichotomous variables are included. This relation is consistent with a little over a fifth of the sample variance. As expected, the quantity of schooling is positively, and significantly, related to cognitive achievement. An additional year of schooling increases the aggregate score on our tests of literacy and numeracy by 2.8 points, or 17.5 percent of the standard deviation.

The estimate indicates that the affect on cognitive achievement of the variables measuring individual and family characteristics are also consistent with our priors: an additional point on the test of pre-school ability significantly[54] increases the cognitive achievement score by 0.45 points; if the respondent's father had middle school or more education cognitive achievement is significantly (at the ten percent level) increased by 2.8 points. Having a father with middle school education is thus equivalent in its affect on cognitive achievement of an additional year of schooling. The affect of ability is also large relative to the affect of school quantity: a six point increment on the ability test (on which the standard deviation of the mean of 21 is 6.6) equals the affect of a year of schooling.

F tests indicate that the set of school dichotomous variables, and the subsets of those signifying primary school and those signifying middle school all are significantly nonzero at the one percent level. Thus among respondents with the same ability, family background and quantity of schooling, there remains a relationship between cognitive achievement and school attended. This suggests that, consistent with our priors, school quality influences how much children learn.

Further, eight of these school variables have significant independent coefficients, ranging in magnitude from −11.5 to 10.8, as compared with the mean cognitive achievement score of 24 and a range of 0 to 57. These coefficients suggest that the affect of school quality on learning can be quite large. Given two respondents with the same personal characteristics and quantity of schooling, the cognitive skill test score of the one that attended school 80 would be 23 points, or roughly 1.5 standard deviations, greater than the score of the one that attended school 72. This implies that raising the quality of school 72 to that of school 80 would be equivalent of more than eight years of additional schooling in its impact on the cognitive skills of graduates.

Table 6, gives the predicted cognitive achievement for respondents who

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[54]We use the term significantly to refer to the standard five percent level unless otherwise indicated.

Table 5

Cognitive Achievement Production Function Estimates, Individuals with 5 – 8 Years of Schooling in Rural Pakistan

Variable	School-specific Controls	
	Parameter Estimate	t-statistics
Intercept	−8.0	−1.4
Pre-school Ability	0.4	4.3
Years of School	2.8	3.7
Father Middle School or More	2.8	1.8
Dichotomous School Variables		
SCHL3	−5.0	−1.1
SCHL5	−6.6	−1.1
SCHL8	7.6	1.6
SCHL10	9.2	2.1
SCHL16	2.6	0.5
SCHL19	−2.6	−0.4
SCHL22	9.6	2.9
SCHL24	−6.0	−1.4
SCHL26	7.7	1.5
SCHL34	−4.6	−0.8
SCHL46	−0.4	−0.1
SCHL49	−7.1	−1.7
SCHL52	−2.4	−0.8
SCHL62	8.6	2.6
SCHL63	−3.5	−0.5
SCHL67	2.5	0.8
SCHL70	4.0	0.8
SCHL71	−0.6	−0.1
SCHL72	−11.5	−2.5
SCHL75	−10.5	−2.0
SCHL76	−6.4	−1.1
SCHL77	5.8	0.8
SCHL78	−1.1	−0.2
SCHL80	10.8	2.1
SCHL103	4.0	0.6
SCHL1	7.0	2.6
SCHL13	−1.7	−0.5
SCHL23	7.1	1.2
SCHL73	2.5	0.8
SCHL30	−4.0	−1.3
N	282	
$\bar{R}^2$	.21	
RMSE	10.0	
F tests		
Overall	3.3	
All Schools	2.2	
Primary Schools	2.5	
Middle Schools	2.1	

attended the low, average, and high quality schools (holding all other characteristics at their sample means). The predictions are for five (completed primary) and eight (completed middle) years of schooling. The table provides another, less striking, indication of the relative impact on cognitive achievement of improvements in school quality and increases in quantity. Completing a middle school of average quality after completing a primary school of average quality clearly has a substantial impact on cognitive achievement: an increase from 16.7 to 38.6. But there also is a considerable impact within each level of schooling of attending high rather than low quality schools: from 7.5 to 26.9 for primary schools and from 29.4 to 48.8 for middle schools (a range of 19.4 in both cases). Completion of a high quality primary school, in fact, leads to a predicted cognitive achievement only 2.5 points below that of completion of a low quality middle school.

Table 6

Predicted Cognitive Skills at Means Based on Regressions in Part 1 of Table 1

School Types	Predicted Cognitive Skills
Low Quality Primary School	7.5
Average Quality Primary School	16.7
High Quality Primary School	26.9
Low Quality Middle School	29.4
Average Quality Middle School	38.6
High Quality Middle School	48.8

B. Impact of Cognitive Achievement on Earnings

The variables in the earnings relation itself include cognitive achievement, a quadratic in actual work experience, an interaction between such experience and cognitive achievement – the hypothesis being that cognitive achievement is an input into the production of skills on the job – and a selectivity control.

Of these only the interaction between experience and cognitive achievement

is significantly nonzero (though if the coefficient on this interaction term is restrict-ed *a prior* to zero the cognitive achievement and the quadratic in experience have significant coefficient estimates). As hypothesised workers with higher cognitive skills have higher returns to experience.

The relation for receipt of earnings indicate that those with higher cognitive achievement and pre-school ability and those with less illness and irrigated land are significantly more likely to receive wages in the labour market. These are plausible patterns, consistent with relatively high returns to human capital in the paid labour market and with the opportunity costs of participation in that market increasing with access to irrigated land.

C. Social Rates of Return to Improving the Quality of Primary
Schools versus Increasing the Availability of Middle Schools

The benefits of these two alternatives are represented by the discounted present values of the increases in post-schooling lifetime (four decades) earnings implied by (a) improving the quality of primary school from the mean to the high level or (b) extending years of schooling from primary completion to middle-school completion both at mean quality levels.

The production function in Table 5 is used to predict cognitive skills for graduates of average and of high quality primary schools and for graduates of aver-age quality middle schools, while holding other characteristics constant at the sample mean. The earnings function in Table 6, in conjunction with the predicted cognitive skill levels, is then used to predict earnings streams for workers who attended average quality primary schools, high quality primary schools and average quality middle schools. The simulated differences in earnings between graduates of average and high quality primary schools and between average quality primary schools and average quality middle schools are then discounted to obtain the gross returns to improving quality and the gross returns to increasing quantity.[55]

The marginal costs of attending middle school beyond primary school include two components: the opportunity costs of time not spent in the labour force and direct costs. Because primary school leavers usually do not immediately begin wage employment, two rather than three years of foregone employment are used to represent the opportunity costs of middle school in our calculations. The estimated wage function is used to predict these costs. The direct costs for attending middle school of average quality, rather than stopping at primary school completion, were calculated on the basis of information provided by the Pakistan Ministry of Education for average school costs.

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[55]As noted above, we assume that there are no externalities and that wages capture the full benefits of schooling.

As noted above, the marginal costs of improving the quality of primary school from average to high quality do not include the opportunity cost of student time (since no more time is assumed to be required). They do, however, have a direct cost component. Average teacher pay per student plus average non-salary expenditure per student was calculated for schools identified by our production function as being low, average and high quality. Data from our school survey were used for this purpose. The product of the ratio of costs of high to average quality schools and of average costs of primary school, as estimated by the Ministry of Education, yielded our measures of direct costs.

The internal social rate of return to completing an average quality middle school subsequent to completion of an average quality primary school by these calculations is 10 percent. This may be an overestimate for two reasons. First, even if post-primary school leavers do not engage immediately in wage employment, there is likely to be an opportunity cost to their time in terms of own-farm and household productivity so we probably understate the time opportunity cost of post-primary school. Second, the Ministry of Education cost data do not appear to cover fully the capital costs of schools.

The internal social rate of return to improving the quality of primary school from average to high quality by these calculations is 11 percent. This is likely to be an underestimate for three reasons. First, in the calculation of the additional direct costs it is assumed that they are equal over all five years of primary school rather than the same total allocated with lesser amounts in the initial years and greater amounts in later years (and thereby with a lesser present discounted value). Second, this calculation does not incorporate the net gain to be expected because higher quality schooling induces additional schooling, empirical evidence for which is provided in Alderman, Ross and Sabot (1991).

Third, in our analysis we abstract from the influence of increased cognitive achievement on grade repetition. Gomes-Neto and Hanushek found (for a sample of schools in rural Brazil) a negative relationship between repetition and school quality. Repetition is costly as it implies, for example, providing a child with more than the usual five years of school to get the child through primary school. This raises the possibility that the increase in direct costs associated with improving primary school quality may, in part, be offset by the decline in costs resulting from a reduction in repetition. If so, our estimate of the net costs of improving quality are too high.

9. CONCLUSIONS

I consider first the conclusions to be drawn from our analysis of the gender gap. The gender gaps in school enrollments and in cognitive achievements are large in rural Pakistan. Our findings suggest that, contrary to conventional wisdom, these

gaps are, at present, substantially due to gender differences in school supply. The estimates indicate that solely by eliminating the gender gap in primary school supply the gender gap in cognitive achievement for the younger cohort could have been reduced by half or entirely eliminated, depending on the treatment of pre-school ability. Our estimates also indicate that the contribution of gender differences in supply to the gender gap in cognitive skills has increased over time despite the more rapid increase in the supply of rural schools for girls than of boys. Girls do not appear to be at a disadvantage with respect to the quality of their schooling. Moreover, there has been a substantial decline in the gender gap in the demand for schooling. Pakistan is moving towards the point at which, if a school is available, parents are as likely to send their daughters as to send their sons.

That the gender gap in cognitive achievement in rural Pakistan can be lessened substantially or eliminated by increasing primary school supply for girls is good news. Since there is latent demand for schooling for girls, to reduce substantially the gender gap in cognitive achievement, policy need not address biases deeply embedded in incentive structures or household preferences. Rather, the focus can be on biases in public policies governing school supply, which presumably are more amenable to change. Our estimates indicate that there has been a substantial reduction in the gender gap in rural school supply in recent decades, but that for 10–14 year olds in 1989 a large gap – over 45 percent – remained. Therefore, the potential for further reductions in the gender gap in cognitive achievement through policies that eliminate the primary school supply gap is still substantial. Moreover, increasing school supply for girls need not require large capital investments. For example, opening existing boys' schools to girls, either with co-education or with different shifts,[56] could quickly reduce the school supply gap at much lower cost than building new girl's schools.

I focus now on the conclusions derived from our analysis of the relative returns to improvements in quality and increases in quantity. Not surprisingly, our results suggest that in rural Pakistan increasing the quantity of schooling a child receives raises his cognitive achievement. We also find that among children similar in ability and family background and with the same number of years of schooling, the particular primary school attended has a large impact on cognitive achievement. Variations in school quality influence how much children learn. Increasing the quantity of schooling entails costs. Likewise, the direct costs are more for high than for low quality schools. However, there is no difference between low and high quality schools in the opportunity cost of student time, which is a large proportion of total cost.

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[56]King (1990), in fact, argues that if care for siblings is a demand constraint on schooling for some girls, schools with shifts at nonstandard hours may ease that constraint, and cites some experience consistent with such a possibility in other developing countries.

We have shown that higher cognitive achievement is rewarded with higher earnings in the wage labour market in rural Pakistan, presumably because more skilled workers are more productive. Because they are more skilled, graduates of high quality primary schools earn more than graduates of low quality primary schools. For the same reason, graduates of middle schools earn more than graduates of primary schools. Increasing the quantity and improving the quality of schooling are, therefore, alternative means of increasing the productivity and earnings of the rural labour force.

Our estimates of social rates of return suggest that improving the quality of schooling may be the preferable alternative. Assuming that an increase in expenditures on average quality primary schools to the level for high quality schools results in an increase in cognitive achievement to the high quality level, then our estimated rate of return to improving quality is 11 percent. This exceeds somewhat the rate of return to providing graduates of average quality primary schools with average quality middle school, and there are reasons to believe that this difference is understated.

Our analysis, which has advanced the assessment of the returns to improvement in school quality, should nevertheless be viewed as tentative. It remains for us to take account of the endogeneity of decisions regarding the optimal quantity of schooling and to determine the robustness of the results. A still more important qualification: indiscriminately increasing expenditures on low quality schools is unlikely to have the desired impact on cognitive outputs. Exploiting the richness of our data pertaining to teachers and schools, we must try to identify those particular educational inputs that distinguish high from low quality schools. Finally, it is important to assess the equity implications of the choice between improving quality and increasing quantity. If children from relatively privileged backgrounds disproportionately progress to middle school, then a decision to limit middle school expansion might be biased against the poor. At the same time, however, the children of the poor may disproportionately benefit from improvements in the quality of primary schooling if they are currently concentrated in low quality schools.

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Comments on
"Human Capital Accumulation in Post
Green Revolution Rural Pakistan:
A Progress Report"

First of all I want to congratulate Professor Sabot for his excellent paper which contains a lot of valuable information on a subject which is crucial for development. I read the paper with great interest and I got excited by its results. I must, however, confess that I am not really familiar with the subject. Therefore, my comments, which are comments from a layman's perspective, cannot do justice to the profound professional paper presented by Professor Sabot.

The paper consists of two parts. The first one deals with the gender gap in school attendance and the acquisition of cognitive skills, the second one with the quality of rural schooling and the impact it has on cognitive skills and finally on labour productivity. Each part conveys two important messages. The messages with respect to the gender gap are that it is inadequate supply and not demand, which is responsible for it, and that girls who are given the chance of school attendance perform as well as, if not better than, boys. The two main messages of part two, which refers to the quality of schooling, are that there is a tremendous variation in rural Pakistan which is largely responsible for the variations in cognitive skills acquired and that improving the quality of rural schools is the most efficient way to improve the general level of education and thus to increase human capital formation.

Let me now run through these main messages one by one and make a couple of remarks or raise some questions.

Before coming to the first part of the findings presented in the paper let me mention in passing a minor question which came to my mind when I read the introduction to the gender gap issue. I was surprised by the differences emerging from an international comparison but the explanation that the schooling gap tends to be greater in countries in which Islam is predominant, did not convince me. Indonesia seems to be an example to the contrary. Real insights into the causes of international differences can only be brought about by applying the decomposition model, so convincingly used in the study, to different countries.

The results of the investigation, on which the paper is based, clearly demonstrate that inadequate supply of girls' schools in rural Pakistan is the major reason for the gender gap in school attendance and cognitive skills. The school construction programme in Pakistan has increased the availability of primary schools in rural villages and thus decreased the gender gap, but still the gender gap remains important as the youngest cohort clearly reveals. Why is that so? It would have

been interesting to know the author's opinion on the underlying reasons which might perhaps be a worthwhile subject of political economy.

Another question which might be of interest also from a conceptual point of view is whether supply can be regarded as being completely independent from demand. Can it not be the case that villagers who really want schooling for their daughters, press upon government to establish a girls' school accessible to them? If this happens, it would help to explain the high attendance, which in any case is a healthy sign irrespective of the process by which it is brought about.

The paper states very clearly that after eliminating the gender gap in pre-school ability, girls who attended school tended to perform better than boys. This again is good news. Even if it is not really surprising it is important to have statistical evidence. For this, however, the way in which the elimination of the gender gap in pre-school ability was done, is crucial. It is said in the paper that Raven's Coloured Progressive Matrices were administered for this purpose, an explanation which certainly satisfies the insiders but which leaves all the others a bit in the dark. For them it might have been of interest to get at least a feeling of how this test works. How cognitive skills were measured is briefly described in the paper, but here again the paper is a bit short at least for those who are not really familiar with the subject and its methodology and therefore might have wished to get a little more insight.

Coming now to the second subject of the paper, the importance of the quality of schooling, I was struck by the figures given in Table 6, according to which the coefficients of the dichotomous school variables varied between $- 11.5$ and $+ 10.8$ compared with the mean cognitive achievement score of 24 and a range of 0 to 57. This means that the particular school somebody attends is absolutely decisive for his or her cognitive achievement.

A second thought on the results brought me to the conclusion that they were not surprising, after all. I was reminded of my own primary education in a small rural school in Germany during and immediately after the Second World War. The facilities were modest but fairly standard and certainly did not cause large variations. What really mattered was the performance of the teachers. In those days rural primary schools in Germany were usually single classroom schools run by one teacher. Classes were held in two shifts always comprising different age groups, which required a special skill of the teacher to minimise disturbances originating from this fact and to maximise synergistic effects, which also existed. Some teachers were very skillful in handling this somewhat complicated systems whereas others, less efficient, achieved very poor results.

It seems to me that the situation might be quite similar in rural Pakistan. In the investigation of Professor Sabot and his collaborators it was found that cognitive skills of some of the teachers were very poor which means that the most basic

precondition of an effective school system was not fulfilled. The paper is silent on their ability to teach which is a second precondition not less important than the first one. The dichotomous variables' approach used in the study very impressively emphasises the importance of school quality but it does not exactly specify by which factors this quality is determined. The enumeration of some factors such as the cognitive skills of teachers, availability of all weather buildings, electricity, desks and chairs, blackboards and chalk, books and other material shed some light on the causative factors but falls short of a constraint analysis which would be required to determine the most severe constraints and the costs of removing of them.

Based on my own limited and highly personal experience I would be inclined to assume that it is primarily the quality of teachers which is responsible for the variations found. If this is the case the most crucial measure would be to improve the quality of teachers primarily by careful recruitment and adequate training. These are measures which have a tremendous multiplier effect and do not need to be very costly.

The last finding of Professor Sabot's paper is that improving the quality of primary school from average to high quality yielded a higher internal social rate of return than increasing the availability of middle schools. The result seems quite plausible although the way in which the costs were calculated may give rise to some questions. As is said in the paper, it was done by calculating average teacher pay per student plus average non-salary expenditure per student for schools identified as being low, average and high quality and using the product of the ratio of costs of high to average quality schools found in the survey and the average costs of primary school, estimated by the Ministry of Education, as direct costs of school improvement. There may, perhaps, be no better way of calculating these costs for the purpose of being used in production functions but the question may be asked whether all differences found by this method are costs really necessary to improve the quality of school. Is the quality of teachers adequately captured by this approach?

To raise such questions certainly does not mean to question the results presented by Professor Sabot. These results are very important because they correct some widely spread wrong perceptions and they clearly show in which direction to go in order to improve the educational level in a cost-effective way. To go into the specifics of a constraint analysis would be a step further toward an implementation programme.

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