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ABSTRACT

Girls lag markedly behind boys in education in many developing countries, which may slow economic growth and increase inequity. This paper uses indicators of the output of the education production process, cognitive skills, to characterize and to investigate the determinants of the large educational gender gap in rural Pakistan. Local school availability accounts for about a third of the total cognitive achievement gender gap and over two-fifths of that in numeracy, which implies that policies that increased local school availability for girls could reduce substantially the gender gaps in cognitive skills. To further reduce these gender gaps will require policies that focus on the demand side of the market, where, our results suggest, the response to modest changes in incentives may be high.

I. Introduction

Girls lag markedly behind boys in schooling in many developing countries even though this gender gap has been declining in recent years (King

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and Hill 1993; Behrman 1993; World Bank 1993). For all low-income countries as defined in World Bank (1993), for example, the number of girls per 100 boys enrolled in primary school was only 78 in 1990, though this represented an increase from 52 in 1965. Girls tend to receive less schooling than boys, particularly in rural areas, low-income countries, and in South Asia.

The effect of schooling on productivity is central in the so-called "new economic growth models," and many empirical estimates of the rates of return to schooling are high.[1] Since the rates of return to schooling are estimated generally to be no lower for women than for men, and the social benefits to changes in household behavior induced by educated women are also believed to be high, there is a presumption that lower investments in the education of girls than of boys slow economic growth in addition to increasing inequity.

Pakistan, the country on which we focus our empirical analysis, provides an extreme example of this gender gap. At independence, Pakistan's female primary school enrollment rate was 16 percent of the male rate (Government of Pakistan, 1991). By 1965, at 32 percent, it was among the ten lowest in the world. While the ratio of female to male enrollments in primary school increased markedly from 1965 to 1991, at 52 percent it remained well below the average of 77 percent for all low-income countries and below the levels of other major Asian countries. Indeed it was among the four lowest in the world, and Pakistan's ratio of female to male enrollments in secondary school of 41 percent was one of the seven lowest in the world (World Bank 1994). Female enrollments in rural Pakistan have been even lower absolutely and relative to the male rate, as we discuss below.

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—others include preschool ability, school quality, 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. Likewise 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—a presumption that is supported by the few available studies of the relation between cognitive achievement and wages in developing countries (Boissiere, Knight, and Sabot 1985; Glewwe 1990, 1992; and Alderman, Behrman, Ross, and Sabot 1996—the last of which is for rural Pakistan).

1. The "new economic growth models" are surveyed in Behrman (1990a), Pack (1994), and Romer (1994). Empirical studies and surveys that claim to find high returns to schooling include Barro (1991), Behrman (1990a, 1990b), Birdsall and Sabot (1993), Birdsall, Ross, and Sabot (1994), Colclough (1982), Knight and Sabot (1987, 1990), Psacharopoulos (1985, 1988), and Schultz (1988). If anything, estimated rates of return to investment in schooling in developing countries tend to be higher for girls than for boys (see Behrman [1990c] and Schultz [1993] for reviews, and Birdsall and Sabot [1991], Behrman and Deolalikar [forthcoming], Deolalikar [1993], and Khandker [1990] for some additional studies). There is, in addition, evidence of higher returns to female than to male schooling in household production activities (Behrman 1990c; Mensch, Lentzner, and Preston 1985; King and Hill 1993; Schultz 1993).

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To our knowledge, for the first time for a developing country,[2] in this paper we use indicators of an output of the education production process, cognitive skills, to characterize and to investigate the determinants of the educational gender gap. Our data indicate a large and significant gender gap in cognitive skills in rural Pakistan, which presumably results in a larger gender gap in productivity and in the command over resources. For example, for the cohort aged 20–24 in 1989 we find that the gender gap in cognitive achievement is 74 percent. That is, the mean score for women on a test of cognitive skills is only 26 percent of the male score—15.2 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 favor 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 several things: wage discrimination in labor 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. (There may, however, be high returns to schooling daughters if, for a given quality marriage, schooling reduces dowries sufficiently [Rao, 1993].)

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. Indeed, Haddad, Carnoy, Rinaldi, and Regel (1990, p. 10) claim that the available evidence "suggests that family economic conditions are more important than school-related variables . . . in explaining this gap . . ." Schultz (1993) also stresses the importance of household demand in the explanation of the gap in schooling enrollments generally in developing countries, while Burney and Irfan (1994) stress its importance in the case of Pakistan.

The gender gap, however, also could originate on the supply of the market for education. 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 (though *The Economist* [1994] reports that very recently coeducational schools have increased in rural Pakistan). Parents might send their girls to school if only a school were available.

Both the social costs of the gender gap and the prospects for public policy having an ameliorative impact are likely to vary markedly with the extent to which the immediate source of the gender gap is school availability and thus more

2. Others (Thias and Carnoy 1972; Carnoy, Sack, and Thias 1974) have observed that there are gender differences in cognitive achievement in developing countries, but have not endeavored to decompose the gender gap according to its determinants.

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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, which was specially designed for this study, permits us to go beyond previous analyses of the gender gap in schooling. It contains, inter alia, measures of school availability, schooling output, preschool ability, and other inputs into the education production process. We use these data first to document the educational gender gap in rural Pakistan. We then estimate a set of behavioral relations underlying this gender gap and use these estimates 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 to start school (conditional on school availability) were the same for boys and girls? By how much would it be reduced if the cognitive achievement of boys and girls who start school were the same?

II. Educational Gender Gaps in Rural Pakistan

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 7,000 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 Sind (the only province not represented, Baluchistan, has a small proportion of the rural population). Human capital modules, on which we draw heavily for this study, were administered in the spring of 1989, the 10th round of the survey. These modules contain inter alia measures for individual respondents of the variables needed to estimate the determinants of educational gender gaps: family background, school availability, prices, educational attainment, preschool reasoning ability, and postschooling cognitive achievement.

To characterize here the gender gaps in schooling in rural Pakistan, we focus on the age range of 20–24, which is the youngest group for whom we have information on completed school of all respondents (since students often start school when they are fairly old and there is considerable grade repetition). For intertemporal comparisons, we also present here data for the cohort aged 30–44. Table 1 presents the means and standard deviations of key variables related to gender differences in education, grouped by gender and cohort. Table 2 gives the gender gaps in schooling attainment and cognitive achievement (all defined as the percentage difference between values for males and females relative to the values for males).

A. Starting School

For the cohort aged 20–24, the proportion who started school was over four times as high for men as for women (58 versus 14 percent). Among those who had a

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Table 1
Means and Standard Deviations, by Gender and Age

	20–24 Age Cohort		30–44 Age Cohort	
Variable	Men	Women	Men	Women
Primary school available	97.7%	44.0%	81.5%	14.9%
Middle school available	89.6%	41.4%	61.4%	11.6%
Travel time, primary school	27.310	26.451	24.965	28.330
	(21.60)	(7.77)	(9.43)	(5.81)
Travel time, middle school	38.322	19.744	35.527	20.000
	(20.48)	(2.26)	(11.83)	(0.00)
Primary school book cost	50.307	60.957	56.475	65.864
	(20.08)	(13.51)	(16.16)	(11.88)
Middle school book cost	213.624	223.271	223.597	238.163
	(45.13)	(39.37)	(35.77)	(29.54)
Started school	58.4%	13.6%	33.2%	2.4%
Schooling attainment	5.329	1.183	3.275	0.277
	(4.80)	(2.97)	(4.67)	(1.44)
Numeracy score	7.486	1.524	4.822	0.243
	(8.26)	(4.23)	(7.70)	(1.64)
Literacy score	7.757	2.419	5.221	0.638
	(8.78)	(6.31)	(8.28)	(3.37)
N	152	178	251	317

Note: Standard deviations in parentheses.

primary school available, the proportion of boys who started was about twice as high as the proportion of girls (60 percent = 58.4/97.7 versus 31 percent = 13.6/44.0). Both the gender gaps in starting school (33 versus 2 percent) and in starting school conditional on there being a school available (41 percent versus 16 percent) were much greater for the cohort aged 30–44 than for the cohort aged 20–24. This positive trend is continuing: For the cohort aged 10–14, the proportion of girls starting school rose to 38.8 percent versus 74.2 percent for boys.

B. Schooling Attainment

For the cohort aged 20–24 the gender gap in schooling attainment was 4.1 grades, or 78 percent of the mean schooling attainment level for males. Though schooling attainment was considerably greater for both men and women in the younger cohort than in the older cohort and the gender gap relative to the mean male schooling attainment level decreased (from 92 to 77 percent), the gender gap in schooling attainment in absolute terms in fact increased from 3.0 grades for the older cohort to 4.1 grades for the younger cohort. If the comparison is limited to those who had schools locally available, the gender gaps in schooling attainment

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Table 2
Gender Gaps in Schooling Attainment and Cognitive Skills

	Schooling Attainment	Numeracy Score	Literacy Score	Cognitive Skills
20–24 age cohort				
Full sample	77.8%	79.6%	68.8%	74.1%
Conditional on availability of primary school	66.1%	67.0%	45.8%	56.3%
Conditional on starting school	12.0%	16.3%	−37.4%	−10.7%
30–44 age cohort				
Full sample	91.5%	95.0%	87.8%	91.2%
Conditional on availability of primary school	77.5%	90.7%	69.3%	79.6%
Conditional on starting school	22.6%	70.1%	−4.3%	32.5%

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are smaller (66 and 78 percent for the two cohorts), but still substantial. Therefore part, but hardly all, of the overall gender gap in schooling attainment is associated with local school availability. If the comparison is limited to those who started school, the gender gap in schooling attainment is much smaller (12 and 23 percent for the two cohorts), which suggests that gender differences in the decision whether or not to start school are an important part of the gender gap in schooling attainment.

C. Cognitive Achievement

Our measure of cognitive achievement was generated by administering (in the regional language) to every person in our sample more than ten years old and with at least four years of schooling, tests of literacy and numeracy specially designed by the Educational Testing Service.[3,4] Among those who took the cognitive skills tests, the distribution of the scores was truncated, exhibits substantial variance, and appears to be normally distributed. For the cohort aged 20–24 the gender gaps in cognitive achievement were substantial (74 percent), and larger for numeracy (80 percent) than for literacy (69 percent). For the older cohort the gender gap was even greater in relative terms: 91 percent overall, 95 percent for numeracy and 88 percent for literacy. But while the level of cognitive skills of women rose between these two generations absolutely and as a proportion of the skill level of men, the gender gap in absolute terms actually widened from 9.1 to 11.5 points overall, from 4.6 to 6.0 in numeracy, and from 4.6 to 5.4 in literacy.

These gender gaps are for all members of these two age cohorts. They are smaller for the subsamples of those who had schools available (56 and 80 percent, respectively, for the younger and older cohorts, for the total cognitive achievement scores) and are smaller yet for those who start school (– 11 and 33 percent for the two cohorts, with the negative value implying higher cognitive achievement scores for females than for males who started school). For the cohort aged 20–24 (though not the older cohort) the gender gaps in cognitive achievement (and particularly in the literacy component) drop more than those in schooling attainment if the comparison is limited to those who had schools locally available or those who started school. Thus the gender patterns in the schooling attainment variable that usually have been the focus of schooling gender comparisons differ

3. Since tests were administered only to those with at least four years of schooling, scores had to be inputed 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.) The means and standard deviations for cognitive achievement in Table 1 include the scores for these individuals. Respondents with one to three years of school and qualified respondents who failed to take the test are kept in the sample for the estimates of the starting school demand relations in Section IV, but not for the cognitive achievement demands.

4. Both tests have been used successfully in research on human capital accumulation and the labor market in East and West Africa (see Knight and Sabot [1990] and Glewwe [1990, 1992]). 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 or depreciation in cognitive skills. Our preliminary estimates indicate that time and experience subsequent to schooling do not affect cognitive achievement.

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from those in cognitive achievement, which we argue is a preferred measure of the *output* of schooling. While these tabulations are suggestive, they provide little insight into the determinants of the gender gaps. In Section IV, we present decompositions of the gender gaps in literacy and numeracy based on school availability and reduced-form estimates of household demand and cognitive achievement relations. These relations depend critically inter alia on the following related variables.

Local school availability. We consider a school to have been available if there was one in the village or sufficiently nearby that costs of travel did not preclude attendance by students from the same village in the same age cohort and of the same gender. Almost all schools in rural Pakistan have been single-sex, so there is the possibility of gender differences in school availability. Our school survey indicated whether a school was available in the village at the time the respondent was of school age. 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. 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.

In the cohort aged 20–24 the proportion of men for whom a primary or a middle school was available at the time they were of age to attend was about twice the proportion of women for whom a school was available (98 versus 44 percent for primary school, 90 versus 41 percent for middle school). The gender gap in school availability thus was considerable for the younger cohort. Nevertheless it narrowed substantially between the two age cohorts. For the cohort aged 30–44 both primary and middle schools were available at school age for over five times as large a proportion of boys than of girls.

Prices of schooling. 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, that is, prices. For both cohorts, books and supplies averaged about 20 percent more for girls than for boys at the primary school level, and about 5 percent more for girls than for boys at the middle school level. In the estimated expenditure functions, gender differences in the costs of books and supplies were significant, controlling for household characteristics and regional effects. We do not know why the costs of books and supplies are greater for girls than for boys. Average class size is smaller for girls than for boys in the villages in our sample; so perhaps girls are not able to capture distributional economies of scale. Since most girls' schools are more recent than schools for boys, there may be fewer used books circulating through the community. To the extent families send a smaller number of girls than boys to school, there are fewer opportunities of reusing books and supplies, raising the cost per girl.

To represent travel time to the nearest available school, we use the average travel time for children currently in school in each village as a proxy for the

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travel time of all respondents. Where there are currently fewer than five children in school for a village, we proxy 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. It was not unusual for boys to travel twice or even three times the median distance in our sample. Few girls travelled more than 30 minutes to primary or middle school. As a result, for the cohort aged 20–24 for whom schools were available when they were of school age, the travel time to primary school was slightly less for girls than boys, and that for middle school was substantially less (at the mean about half as long). For the older cohort for whom schools were available when they were of school age, the same pattern is observed for middle school, while the travel time to primary school was somewhat greater for boys than girls.

III. What Determines School Availability?

The data summarized in Section II suggest that a substantial component of the overall gender gap in cognitive achievement in rural Pakistan is associated with a gender gap in school availability. In this section, we discuss why we believe this gap does *not* reflect local household demand characteristics but is determined by decisions at political levels above the villages.

In rural Pakistan, school establishment decisions are made at levels of government higher than the village level. However, as Rosenzweig and Wolpin (1986), Pitt, Rosenzweig, and Gibbons (1993), and others have emphasized, the local availability of social services provided by higher governmental units may be in response to factors such as political pressures, in which case higher-income villages or those with more political power might be expected to have a higher probability of having schools available, or in response to equity concerns, in which case higher-income villages might be expected to have a lower probability of having schools available. Behrman and Birdsall (1988) and Gershberg and Schuermann (1994) model the allocation of schooling resources among different constituencies as reflecting the implicit constrained maximization of a governmental social welfare function that reflects productivity versus equity trade-offs; their estimates for Brazil and Mexico indicate that governments trade off between productivity and equity in such allocations, but do not weigh equity enough to make compensating larger investments in poorer than in richer areas. If school availability is determined by local demands, as these studies suggest, then it would be inappropriate to attribute the impact of changing school availability on gender gaps to exogenous (from the point of view of households) policy decisions.

We have data from our survey for 43 villages with which to investigate the relation of village characteristics to school availability in rural Pakistan. (Descriptive statistics appear in Table A.1.) Of these 43 villages, 51.2 percent had primary schools in the village[5] for boys aged 10–15 at the time of the survey; 21 percent

5. Children in most of the remaining villages have a school available in a nearby village. However, there is no way to sort out the degree to which village characteristics may have influenced the location of a school in a nearby village.

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had primary schools for girls in the same age cohort. Table 3 presents probit estimates relating primary school availability, by gender, to village characteristics. The probit in column (1) contains effective distance, political influence, household income, and village size measures. (Other specifications also were explored including other variables, such as an indicator of the concentration of land holdings as suggested by Rosenzweig and Evenson [1977], but they did not add to the explanatory power of the relations that are presented here.) The Wald statistic indicates a significant relationship between these variables taken together and the probability of finding a school in the village. If district dummy variables are added (column 2), the village characteristics become insignificant. The Wald statistic for the four village characteristics becomes 6.3 for boys and 6.8 for girls.

The implication is that it is interdistrict, not intradistrict, variations in the village characteristics that affect school availability; and that the correlation observed in column (1) is spurious. Column (3) repeats the specification in column (1), but drops villages in the district of Dir; in this reduced sample this specification has no explanatory power. (Similar results [Alderman, Behrman, Ross, and Sabot 1993] are obtained using village averages of responses to the question "Do you want your sons (daughters) to have more education than you?") A possible explanation is that there is greater, unobserved interest in schooling in Dir than in the other districts. This may reflect the fact that since Mogul times the Pathan regions have relied on out-migration (as soldiers first, then as urban laborers) to supplement the meager agricultural income of the area, which likely adds to the perceived returns to schooling. Thus respondents in Dir appear to place a greater value on schooling than do respondents in the other districts that appears to be unrelated to measurable village characteristics—including indicators of income, wealth, and political power—available to us. Once there is control for the whether or not a village is in Dir, the observed village characteristics have no explanatory power. We thus proceed to assume in what follows that local school availability does not reflect local household demand characteristics but is determined by decisions at political levels above the villages.

IV. Household Schooling Demands and the Gender Gap Decomposition

Conditional on school availability, household demands determine school attendance and cognitive achievement—and any resulting gender gaps. To decompose the gender gap in cognitive achievement, we therefore model gender differences in household reduced-form demands for starting school (SD) conditional upon school availability (SA) and for cognitive achievement attained through schooling (CA) with control for selectivity into school:[6]

6. Schooling attainment also is determined by a household reduced-form demand relation. But both Section II and preliminary analyses of the data reported in Alderman, Behrman, Ross, and Sabot (1992) suggest that the contribution to the gender gap in cognitive skills of gender differences in schooling attainment for students who had begun school was small. Therefore we do not present separate relations for schooling attainment.

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Table 3
Probit Estimates of Impact of Village Characteristics on Primary School Availability

	Boys			Girls		
	(1)	(2)	(3)	(1)	(2)	(3)
Distance to Mandi	0.002	0.005	−0.134	0.093	0.146	0.138
	(0.07)	(0.13)	(0.34)	(1.63)	(1.61)	(1.28)
Union council member	0.972*	0.993	0.891	0.935	0.945	1.988
	(2.08)	(1.58)	(1.64)	(1.52)	(1.22)	(1.60)
Mean household income	0.103**	−0.148	−0.034	0.076	0.194	0.127
	(2.49)	(1.31)	(0.34)	(1.57)	(1.48)	(0.79)
Households	0.001	0.002	0.002	−0.004	−0.006	−0.007
	(0.89)	(1.64)	(1.62)	(1.58)	(1.67)	(1.35)
Attock		0.345			0.934	
		(0.50)			(0.92)	
Faisalabad		0.155			0.426	
		(0.20)			(0.35)	
Dir		4.71*			−1.21	
		(2.22)			(0.67)	
Constant	−3.342	1.351	−0.533	−3.412	−6.623	−4.647
N	43	43	33	43	43	33
Prediction ratio[a]	17/22	16/22	7/13	4/9	3/9	1/4
Wald (*df*)	12.13* (4)	20.09** (7)	8.03 (4)	13.24* (4)	15.71* (7)	7.41 (4)

Note: T-statistics in parentheses.
a. Of villages with schools, the proportion correctly predicted by the model.
* Significant at 5 percent significance level.
** Significant at 1 percent significance level.

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(1) $SD = SD(G, PSA, F, A, P, SA_M, V, R)$, conditional on $SA_P = 1$;

(2) $CS = CS(G, PSA, F, A, SA_M, V, R)$, conditional on $SD = 1$;

where SA_P is an indicator that a primary school is available; SA_M is an indicator that a middle school is available; G is gender; PSA is the preschool ability of the individual; F is a vector of family background characteristics including parental education and household income;[7] A is age; P is a vector of prices including travel time and costs of books and of other supplies for schooling; and V and R refer to unobserved village and regional characteristics, including schooling quality.

The determinants in the reduced-form demand relations for starting school (1) and for cognitive achievement (2) include predetermined attributes of the child (G, PSA, A), of the parents (F), of the village and region (V, R, P). Because there has been increasing emphasis in the economic literature on the role of school quality in developing countries and school quality may vary among villages and by gender, we control for school quality by gender-village interactions ($G * V$).[8] We also examine the impact of equating school quality by gender in our simulations in Table 6 (see the related third counterfactual question discussed with regard to this table). The expected benefits of schooling are assumed to be primarily the increments to expected marginal product, which is a function of cognitive achievement. The determinants of household demands for cognitive achievement (2) also include the inverse Mills ratio from the schooling demand probits to control for the potential bias introduced into the estimates of the cognitive skills reduced-form demand equation resulting from the selection regarding which children start school.[9]

To estimate relations (1) and (2) we use respondents with the relevant data for whom a school was locally available when they were of age to start school. Balancing the advantages of having a larger sample against the desire to have one which is relatively young so that it reflects recent experience, we limit these

7. If schooling were viewed only as an investment, if capital markets were perfect, and if there were no transaction costs for child labor (so that a household with more land did not have an incentive to have more children to help work the land), parental income or wealth would not enter this relation. However, prices may be conditioned on household wealth or income due to credit market imperfections and transaction costs that favor household use of own child labor, and there may be consumption benefits from schooling. Therefore we include income in F.

8. School quality is emphasized in econometric studies of the impact of schooling in developing countries by Behrman and Birdsall (1983), Behrman, Birdsall, and Kaplan (1994), Glewwe and Jacoby (1993, 1994), Hanushek, Gomes-Neto, and Harbison (1994), Hanushek and Lavy (1992, 1994), and Harbison and Hanushek (1993), among others. We do not include school quality measures directly because such measures are available only for a subset of our sample. For that subset, the analysis in Alderman, Behrman, Khan, Ross, and Sabot (1996) indicates that school quality appears to be higher in some respects for girls (for example, lower student-teacher ratios) and higher in other respects for boys (for instance, teachers with better knowledge of mathematics). For the decomposition of the gender gap below in Table 6, our procedure assumes that additional schools would be available with quality equal to the average quality by gender of existing schools in order to answer our first two counterfactual questions, but equates quality for males and females in the exploration of the third counterfactual question.

9. This control is identified only by functional form since models of household behavior imply that the same right-side variables appear in all the reduced-form demand relations.

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estimates to members of the sample aged 10–25 (almost no one starts school after age 10 so there is not a censoring problem). Because we have school quality data only for a subset of respondents in this group, we use village-level dummy variables to control for differences in school quality in estimating relations (1) and (2). The dummy variables are jointly significant. Estimates of these relations using the smaller sample but incorporating quality indicators are consistent with those reported below (Behrman, Ross, Sabot, and Tropp 1994).

Descriptive statistics for the subsample aged 10–25 are given in Table A2, with discussion in Appendix A of variables not already discussed in Section II. We note here (and discuss further in Appendix A) that our measure of preschool ability has a gender gap favoring males, the origin of which appears to be due to preschool acculturation, though we cannot be absolutely sure. Dropping this variable from the analysis in the estimates presented in Appendix A does not change our basic results.

Table 4 gives probit estimates by gender of the decision to start school (equation (1)). Wald statistics indicate that both relations are significant, but that they differ. In both relations, book costs (which are highly correlated with such other out-of-pocket costs as school uniforms so that they apparently proxy for all out-of-pocket costs) have significantly negative effects which do not differ significantly by gender. The significantly negative effects of travel time to primary school are over twice as large for women as for men. (For women, travel time to middle school is perfectly collinear with the village-level dummy variables; hence we excluded it from this equation and that in Table A3.) The only significant parental schooling effects are that, if the father attended middle school, daughters were more likely to start school (mothers' schooling is excluded from the equation because, conditional on availability, all respondents whose mother completed primary school started school, making the effect unestimable in a probit). Only for males do preschool ability, the quadratic in age, and household income have significant effects (all positive, though with nonlinearities in the first two of these).

Table 5 gives estimates of the cognitive achievement reduced-form relations for numeracy and literacy. A Wald test does not permit rejection of the null hypothesis that the slope coefficients (other than the additive gender indicator and the regional and village-level interactions) are the same for men and women.

With estimates of Equations (1) and (2), we can decompose the gender gap in cognitive achievement and then answer the questions raised above. We predict female cognitive achievement by multiplying expected female cognitive skills for women who started school by the expected probability that the woman attended an available primary school multiplied by the probability that a primary school was available at the time the woman was of school-going age:

$$(3)\quad CA^F = SA_P^F E[SD^F]E[CA^F],$$

where SA_P^F is the proportion of women in the sample for whom a primary school was available, and the expected values are calculated by setting the variables in relations (1) and (2) to the sample means for women. Male cognitive achievement is predicted analogously. The extent to which the ratio $(CA^M - CA^F)/CA^M$ exceeds zero.

Table 6 gives a series of simulations that explore the determinants of the gender

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Table 4
School Attendance Probits, by Gender, for Respondents 10–25

	Men (1)		Women (2)	
Preschool ability	−0.046		0.027	
	(0.74)		(0.23)	
Preschool ability^2	0.003		0.002	
	(1.99)		(0.50)	
Age	0.129		0.065	
	(1.72)		(0.52)	
Age^2	−0.006		−0.002	
	(2.68)		(0.47)	
Household income	0.027		0.038	
	(3.20)		(1.58)	
Father primary school or more	0.067		−0.148	
	(0.29)		(0.40)	
Father middle school or more	0.111		1.286	
	(0.32)		(2.73)	
Middle school available	−4.284		−3.813	
	(2.09)		(0.34)	
Travel time to primary school	−0.049		−0.118	
	(5.03)		(8.34)	
Travel time to middle school	0.028			
	(2.84)			
Primary school book cost	−0.062		−0.053	
	(8.65)		(3.40)	
Middle school book cost	−0.022		−0.021	
	(2.37)		(0.43)	
Constant	8.214		8.311	
N	745		384	
Wald statistic (*df*)	462.1	(46)	371.8	(26)

Note: *T*-statistics in parentheses. Coefficients for village-level dummy variables omitted.

gaps in numeracy, literacy, and total cognitive achievement. The first row of this table gives base simulations in which all the variables are at their sample means. These simulated values are close to the means observed in the data, though there are some slight differences due to nonlinearities. The subsequent rows present the implications of decomposing the gender gap into its components by, in turn:

a) equating the availability of primary school by setting SA_P to the sample mean for all respondents;

b) equating the demand to start school by setting $E[SD^F]$ to the sample mean; and

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Table 5
Cognitive Skills Regressions for Respondents 10–25

	Numeracy (1)	Literacy (2)
Preschool ability	−0.491	0.021
	(1.49)	(0.06)
Preschool ability^2	0.016	0.006
	(2.33)	(0.77)
Age	0.205	0.342
	(0.35)	(0.52)
Age^2	−0.003	−0.003
	(0.21)	(0.18)
Household income	0.033	0.162
	(0.85)	(3.69)
Mother primary school or more	−1.301	0.377
	(0.95)	(0.24)
Father primary school or more	0.348	0.195
	(0.35)	(0.17)
Father middle school or more	0.493	−0.042
	(0.44)	(0.03)
Middle school available	4.179	3.111
	(1.35)	(0.89)
Travel time to primary school	0.050	0.035
	(1.38)	(0.85)
Travel time to middle school	−0.001	−0.024
	(0.04)	(0.65)
Primary school book cost	−0.009	−0.002
	(0.22)	(0.05)
Middle school book cost	−0.019	−0.003
	(1.48)	(0.18)
Female	3.941	6.534
	(1.21)	(1.78)
Dir	5.857	0.658
	(1.47)	(0.15)
Badin	−0.972	0.909
	(0.30)	(0.25)
Female, Faisalabad	−3.770	−1.536
	(1.10)	(0.40)
Female, Dir	−4.392	−6.718
	(1.07)	(1.45)
Female, Badin	−7.169	−7.525
	(1.35)	(1.26)
Constant	13.791	3.436
	(1.75)	(0.39)
Inverse Mills' ratio	−0.356	0.491
	(0.64)	(0.78)
Rbar^2	0.245	0.237
N	316	316

Note: *T*-statistics in parentheses. Coefficients for village * gender dummy variables omitted.

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Table 6
Cognitive Skills Gender Gap Simulations

	Numeracy Score	Literacy Score	Cognitive Skills
Base case gender gaps	85.7%	73.5%	79.4%
Percentage shares in gender gaps closed by:			
(a) Equating availability of primary school	20.3%	44.1%	31.9%
(b) Equating demand to start school	72.6%	74.6%	73.6%
Altering demand to start school by:			
Six-minute shift in time to primary school[a]	22.2%	48.0%	34.2%
Equating primary school book costs	27.5%	59.6%	43.1%
(c) Equating cognitive skills	7.0%	−18.8%	−5.4%
Altering acquired cognitive skills by:			
Equating school costs	23.8%	13.1%	18.9%
Equating direct gender effects	−14.4%	−23.5%	−18.0%

Note: See text for description of how this table was constructed.
a. Three-minute reduction for females and three-minute increase for males.

c) equating the cognitive achievement of those who start school by setting $E[CA^F]$ to the sample mean.

As part of (b) we examine the sensitivity of the demand to start school (relation 1) to shifting travel time and equating primary book costs. As part of (c), we examine the sensitivity of expected cognitive skills (relation 2) to equating all school costs and equating all direct gender effects. We summarize the implications of the simulations by reporting the share of the total gender gaps in cognitive achievement that would be eliminated with only the change indicated in each row. 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 primary school were the same for boys and girls? The simulations indicate that elimination of the gender gap in school availability alone would lessen the gender gap in numeracy by 20 percent, in literacy by 44 percent, and in total cognitive achievement by 32 percent. Thus, gender gaps in school availability account for a substantial proportion of the gender gap in cognitive skills.

Second, by how much would the gender gap in cognitive achievement be reduced if the demand to start school were the same for boys and girls? The simulations indicate that elimination of the gender gap in the demand for starting school alone would lessen the gender gap in numeracy, literacy, and total cognitive achievement by almost three-quarters (72.6 to 74.6 percent). Demand differences thus account for most of the gender gaps in cognitive achievement. But it is important to note that the simulations also imply that the gender gaps in demand could be reduced substantially by changes in some schooling prices—travel times and out-of-pocket expenses. For example, if primary schools were three minutes closer for girls and three minutes further for boys than they actually are, the

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simulations suggest that the gender gap in numeracy would be reduced by over 20 percent, in literacy by almost half, and in total cognitive achievement by over a third. The responsiveness of the gender gap to equating primary book costs (proxying all out-of-pocket costs) is greater still.

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 benefited from the same level of parental inputs during their school years? We have found no evidence that girls, once in school, are at much of a disadvantage with regard to the acquisition of cognitive skills. Indeed a student having the average characteristics of girls in the sample (including a school of average quality for girls) would have an advantage of about 19 percent in literacy that more than offsets the disadvantage of 7 percent in numeracy so they have, if anything, a small advantage (5.4 percent) in overall cognitive achievement. Indeed the apparent superiority of girls in acquiring cognitive skills (perhaps because of gender differences in school quality) ceteris paribus as reflected in the gender effects in the cognitive achievement regressions in Table 5 account for −14.4 percent of the numeracy gap, −23.5 percent of the literacy gap, and −18.0 percent of the total cognitive achievement gap. These negative values mean that the gaps favoring males due to school availability and various demand factors would be even greater than actually observed if there were not gender-related effects favoring girls (due to gender differences in school quality and/or the efficiency of learning) in the cognitive achievement production process. The simulations also indicate that the gender gaps favoring males in cognitive achievement could be reduced through equating all out-of-pocket and travel time costs of attending school and equating middle school availability by 23.8 percent for numeracy, 13.1 percent for literacy, and 18.9 percent for total cognitive achievement.

V. Conclusions

Gender gaps in school enrollments and in cognitive achievements are large in rural Pakistan. Our findings suggest that a substantial portion of these gaps are due to gender differences in local school availability. Solely by eliminating the gender gap in local primary school availability the gender gap in total cognitive achievement for the cohort aged 10–25 could have been reduced by almost a third, and that in literacy by over 40 percent. Though disadvantaged in terms of school availability, however, girls do not appear to be disadvantaged by the quality of their schooling.

The importance of the gender gap in school availability is good news. 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 local school availability, which presumably are more amenable to change. The gender gap in rural school availability has declined in recent decades, but for children aged 10–14 in 1989 a large gap—over 45 percent according to our data—remained. Therefore, the potential for further reductions in the gender gap in cognitive achievement through

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policies that eliminate the local primary school availability gap is still great. Moreover, increasing local school availability for girls need not require large capital investments. For example, existing boys' schools could be opened to girls, either with coeducation or with multiple shifts.[10] Though eliminating the gender gap in local school availability will help, large gender gaps in cognitive skills will remain unless gender gaps in household demand to have children start school also are reduced. Our estimates suggest that this demand is, perhaps surprisingly, quite responsive to incentives—including travel times and out-of-pocket costs. Where prices currently favor boys, such as those related to out-of-pocket costs, closing the gender gap in cognitive achievement by "getting prices right" would seem warranted from an efficiency point of view, although this prescription depends on getting a better understanding of why out-of-pocket costs differ by gender. Because of the greater responsiveness of girls to travel times, reducing travel times for both boys and girls (for example, by making more primary schools truly local) also would lessen the gender gap in cognitive achievement, but this would entail higher public investment in schooling.

Because of the predominance of single-sex schools in rural Pakistan, we are able to distinguish easily school availability from demand-side effects. Supply effects may be more difficult to detect in other contexts. For example, even where schools are coeducational, there may be gender differences in rationing criteria for access. Though difficult, the returns to additional research on gender gaps in school supply, and the political economy of supply, are likely to be high. Our results suggest that, by contributing to gender differences in human capital accumulation, gender differences in school availability help explain gender differences in productivity and welfare.

Appendix 1

Right-Side Variables Used in Reduced-Form Demand Relations

Table A2 gives summary statistics for the variables that are used in the reduced-form demand regressions in Tables 4 and 5 in the text. We now briefly discuss those variables that were not discussed in Section II.

Raven's Test of Preschool Ability (PSA). To obtain an indicator of preschool 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 ten years of age or older. The test is designed so that formal schooling is not supposed to influence performance, though performance may reflect early childhood environment as well as innate capacity. The distribution of CPM test scores is not truncated at either tail; it exhibits substantial variance and appears to be normally distributed. The disaggregated distributions for the North West Frontier Province, the Punjab, and the Sind are very similar. Since

10. 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.

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Table A1
Village Level Descriptive Statistics: Means and Standard Deviations

	Full Sample	District			
		Attock	Faisalabad	Dir	Badin
Village school availability					
Primary school for boys	51.2%	37.5%	66.7%	90.0%	31.6%
Primary school for girls	20.9%	25.0%	16.7%	50.0%	5.26%
Effective distances (km)[a]					
Distance to Mandi	12.3	9.4	13.2	10.5	14.1
	(7.7)	(3.4)	(10.6)	(7.2)	(8.3)
Distance to market	11.9	9.4	9.2	8.2	14.1
	(6.5)	(3.4)	(4.3)	(3.1)	(8.3)
Distance to tehsil Capital	15.9	17.9	13.8	10.3	18.6
	(11.0)	(15.5)	(10.6)	(5.0)	(10.7)
Distance to district Capital	43.6	50.9	49.0	45.3	37.9
	(30.5)	(33.5)	(13.6)	(48.4)	(21.2)
Indicators of political links					
Union council member	46.5%	62.5%	100.0%	50.0%	21.1%
District council member	7.0%	12.5%	0.0%	10.0%	5.3%
Government official	20.9%	12.5%	50.0%	30.0%	10.5%
Member of parliament	2.3%	0.0%	16.7%	0.0%	0.0%
Income, land, and population					
Mean household income (rupees)	24.8	22.8	22.7	34.2	21.4
	(5.8)	(1.7)	(2.3)	(3.0)	(2.7)
Land area (acres)	3057.3	5110.6	1991.7	1513.0	3342.0
	(3355.3)	(6922.5)	(932.8)	(1448.2)	(1636.8)
Population	1866.1	1775.0	4416.7	1591.1	1243.7
	(1814.0)	(1805.3)	(2102.8)	(1975.8)	(779.8)
	323.7	278.8	540.5	109.6	386.8
	(225.0)	(152.1)	(275.3)	(60.8)	(199.9)
Number of villages	43	8	6	10	19

a. To obtain the effective distances the actual distance was doubled if the entire distance was on unpaved roads and increased by a factor of 1.5 if the trip was on a mixture of paved and unpaved roads.

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Table A2
Descriptive Statistics, by Gender and Age, for Respondents 10–25 with Primary School Available

	Men (1)	Women (2)
Started school	71.3%	55.7%
Numeracy score	6.69	2.41
	(7.68)	(5.27)
Literacy score	6.98	3.54
	(8.24)	(7.26)
Preschool ability	20.30	16.29
	(6.47)	(5.45)
Age	16.88	16.81
	(4.55)	(4.88)
Household income (1,000 rupees)	24.75	25.41
	(10.06)	(8.72)
Father primary school or more	27.5%	41.4%
Father middle school or more	14.1%	25.3%
Mother primary school or more	3.5%	3.4%
Middle school available	91.0%	84.6%
Travel time to primary school (minutes)	22.44	19.73
	(18.07)	(11.49)
Travel time to middle school (minutes)	31.90	19.38
	(18.06)	(5.19)
Primary school book cost (rupees)	49.46	54.74
	(20.00)	(19.29)
Middle school book cost (rupees)	214.16	223.54
	(44.70)	(40.00)
Attock	19.1%	32.6%
Badin	29.3%	3.1%
Dir	23.5%	28.9%
Faisalabad	28.2%	35.4%
N	745	384

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 about four points (out of a possible 35) lower for females than for males for the subsample in Table A2. This statistically significant differential on a test designed to be gender-neutral holds with the same magnitude for the other age groups in our sample. Is the gender gap in the CPM test score due to preschool acculturation that inhibits performance on the test for females, a true gap in innate ability, or measurement error? We

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Table A3
School Attendance Probits, by Gender, Omitting Preschool Ability, for Respondents 10–25

	Men (1)	Women (2)
Age	0.128	0.070
	(1.77)	(0.59)
Age^2	−0.005	−0.002
	(2.51)	(0.47)
Household income	0.029	0.024
	(3.61)	(1.07)
Father primary school or more	0.156	−0.146
	(0.71)	(0.43)
Father middle school or more	0.198	1.491
	(0.59)	(3.34)
Middle school available	−4.916	−3.945
	(2.41)	(0.42)
Travel time to primary school	−0.045	−0.113
	(4.84)	(8.21)
Travel time to middle school	0.027	
	(2.88)	
Primary school book cost	−0.061	−0.057
	(8.96)	(3.43)
Middle school book cost	−0.024	−0.023
	(2.64)	(0.56)
Constant	8.531	9.973
	(4.20)	(1.06)
N	745	384
Wald statistic (*df*)	422.2 (44)	374.06 (27)

Note: T-statistics in parentheses.

can make only limited progress in answering these questions. We were unsuccessful in our attempts to attribute the gap to sampling bias, gender differences in familiarity with testing procedures, or pure genetic effects.[11] It may be the case

11. Court (1983) surveys 45 studies using the same tests in dozens of countries and concludes that observed gender differences in a minority of studies "do not justify the production of separate norms for the two sexes." However, none of the studies that he surveys were conducted in Pakistan or in other Islamic societies. We find no support for the hypotheses that the measured gender gap reflects that: (1) High-ability women were less likely than high-ability men to be available when the test was administered. (The proportion of men and women who actually took the CPM test is not significantly different from the proportion of men and women [age 10 or older] in our entire sample, and there is no significant difference for individuals with some schooling or with different completed schooling levels between the proportion of men and women who took the test.) (2) Lack of familiarity with testing, more

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Table A4
Cognitive Skills Regressions Omitting Preschool Ability, for Respondents 10–25

	Numeracy (1)	Literacy (2)
Age	0.150	0.271
	(0.25)	(0.39)
Age^2	−0.000	−0.001
	(0.05)	(0.03)
Household income	0.068	0.184
	(4.04)	(1.69)
Mother primary school or more	−0.885	0.943
	(0.62)	(0.59)
Father primary school or more	0.280	0.262
	(0.27)	(0.23)
Father middle school or more	0.558	−0.045
	(0.47)	(0.03)
Middle school available	−4.325	−3.990
	(1.33)	(1.10)
Travel time to primary school	0.059	0.029
	(1.52)	(0.67)
Travel time to middle school	0.010	−0.006
	(0.28)	(0.16)
Primary school book cost	0.025	0.023
	(0.54)	(0.45)
Middle school book cost	−0.018	−0.007
	(1.35)	(0.44)
Female	1.900	4.799
	(0.56)	(1.27)
Dir	3.104	−1.624
	(0.75)	(0.36)
Badin	−2.178	0.015
	(0.65)	(0.01)
Female, Faisalabad	−1.726	0.220
	(0.48)	(0.06)
Female, Dir	−4.022	−6.723
	(0.94)	(1.41)
Female, Badin	−5.752	−6.688
	(1.04)	(1.09)
Constant	9.187	4.973
Inverse Mills' ratio	−0.419	0.585
	(0.76)	(0.93)
Rbar^2	0.236	0.228
N	316	316

Note: *T*-statistics in parentheses.

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Table A5
Cognitive Skills Gender Gap Simulations without Controlling for Preschool Ability

	Numeracy Score	Literacy Score	Cognitive Skills
Base case gender gaps	81.6%	73.3%	77.3%
Percentage shares in gender gaps due to:			
(a) Equating availability of primary school	27.6%	44.5%	35.7%
(b) Equating demand to start school	63.8%	103.1%	92.9%
Altering demand to start school by:			
Six-minute shift in time to primary school[a]	30.1%	48.7%	39.1%
Equating primary school book costs	37.4%	60.2%	48.5%
(c) Equating cognitive skills	8.5%	−47.6%	−18.6%
Altering acquired cognitive skills by:			
Equating school costs	24.6%	23.6%	24.3%
Equating direct gender effects	−12.9%	−52.4%	−30.5%

Note: See text for description of how this table was constructed.
a. Three-minute reduction for females and three-minute increase for males.

that early childhood acculturation constrains girls more than boys from achieving their potential ability through a process that we cannot capture with the data available to us. Since there is some controversy about this variable and the gender gap that we find in it, we also have undertaken our estimates without it (see Tables A3–A5). The basic results reported in Section IV do not change qualitatively if we eliminate this variable from our analysis.

Family Background (F). The parental schooling variables exhibit substantial gender gaps and the generally low schooling levels of the older generations. 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. To obtain predicted income, we first regressed current household income on parental characteristics including education, employment, and acreage farmed, if any. We then used

common for women than for men, accounts for the gender gap. (The gender difference in scores persists within both the uneducated and educated subgroups.) (3) The gender gap is a pure genetic effect. (Male ability is significantly positively correlated with father's ability, but not mother's; female ability is related to mother's ability, but not father's. If ability were solely inherited, one would expect both correlations with each parent's ability to be significant.) We explore associations of the Raven's scores with other variables observed in our data set in Alderman, Behrman, Khan, Ross, and Sabot (1993). Also see Khan (1993) for a discussion of our Raven's score indicator.

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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.

Village (V) and Regional (R) Dummy Variables. Village and regional dummy variables are included to capture school quality and other unobserved village-level and regional differences. We create a village dummy variable if there are five or more respondents from a village that had a school available. In our estimates in Section IV these dummy variables are allowed to have coefficient estimates that differ by gender because school quality and other factors can differ by gender.

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