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Population and Human Resources
Department
The World Bank
August 1990
WPS 468

Does the Structure of Production Affect Demand for Schooling in Peru?

Indermit Gill

The more important the services sector, the more likely girls are to get more education. The more important industry, the more likely boys are to get more education. Both sexes get more schooling as the supply price of schooling falls, but girls gain more than boys do.

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This paper — a product of the Women in Development Division, Population and Human Resources Department — is part of a larger effort in PRE to determine if and how women's productivity (and thus family welfare) are improved when women are given more access to education, training, credit, health care, and other public resources. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Maria Abundo, room S9-123, extension 36820 (55 pages, including tables).

Analyses of gender differences in investments in human capital typically emphasize family resources as the determining factor. These studies usually find that investments in male offspring are greater, that these differences narrow as the level of household wealth increases, and that equity is also affected by the composition of household wealth (proxied by the amount the mother earns and/or her educational level).

Gill addresses one drawback of these analyses: they do not explicitly consider the factors that determine the *demand* for schooling and health — other than tastes — and why this differs for men and women. Gill uses the regional structure of the economy, proxied by the shares of services and industry in regional gross domestic product (GDP), as an indicator of the demand for educated workers. By examining whether the level of schooling as a function of shares of services and industry differs for men and women, he looks for gender bias in the demand for schooling. Gill estimates schooling demand functions for males and females using household data from the Peruvian Living Standards Survey, and provincial data from the Peruvian census.

Gill's primary findings are:

- As services and industry increase as a share of GDP, relative to agriculture's share, the demand for schooling increases for both boys and girls. (Both industry and services reward education more than agriculture does. Parents form expectations about the sector their children are likely to work in as adults and choose levels of schooling accordingly.)

- As services' share in GDP increases compared to agriculture (holding industry's share constant), girls' demand for schooling increases more than boys' demand for schooling.

- An increase in industry's share in GDP relative to agriculture (holding services' share constant) is more closely associated with an increase in the demand for schooling of boys than of girls.

- A decrease in the supply price of schooling increases the level of schooling attained by both sexes, but the gain is larger for women.

- Increases in wealth, all else being equal, are associated with increases in both sexes' demand for schooling.

What are the policy implications of these findings? Some ways to increase educational levels, especially those of women, include (on the supply side) lowering the supply price of schooling — improving access to secondary schooling, for example — and (on the demand side) expanding the services sector. The demand- side prescription contradicts the World Bank and IMF policy advice that developing countries foster the growth of tradables to service their external debt.

Produced by the PRE Dissemination Center

The Structure of Production as a Determinant of the Demand for Human Capital in Peru

by
Indermit Gill

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Analyses of gender differences in investments in human capital typically emphasize family resources as the determining factor. (See Schultz and Rosenzweig (1982), Gertler and Alderman (1989) for investment in health, and King and Bellew (1989) for investment in schooling.) These studies approach the problem as one of investment by parents in the human capital of male and female children. These studies usually find that investments in male offspring are greater, that these differences narrow as the *level* of household wealth increases, and that the *composition* of household wealth (proxied by either the amount earned by the mother and/or her education level) affects equity as well.

There are two major drawbacks in these analyses. First, the empirical segments confound the effects (a) of a gender bias inherent in the utility function of parents, (b) of gender differences in market returns to human capital, and (c) of gender differences in appropriability of returns to investments by parents in children. This paper does not address this issue. Second, these analyses contain no explicit consideration of the factors determining the *demand* for schooling and health, other than tastes, and why this differs for males and females. It is the second shortcoming

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The author is grateful to Barbara Herz, Emmanuel Jimenez, Shahid Khandker, Thomas Mroz, John Newman, Pats Pattabiraman, Maurice Schiff, T. Paul Schultz and Jacques van der Gaag for helpful discussions, and to Marcia Schafgans and Ricardo Lago for help with the data.

that this paper seeks to rectify.[1]

In this paper I use the regional structure of the economy, proxied by the shares of services and industry in regional gross domestic product (GDP), as an indicator of the demand for educated workers. By examining whether the level of schooling as a function of shares of services and industry differs for men and women, we can detect gender bias in the demand for schooling.

Based on the theoretical framework developed in Gill and Khandker (1990), I estimate schooling demand functions for males and females using data for Peru in the 1980s. A separate estimate covers households and provinces (called "departments" in Peru). Household data are from the Peruvian Living Standards Survey (PLSS); information on the provinces is based on census data. Findings confirm the results obtained in Gill and Khandker using country-level data for about 100 countries in 1965 and 1987. The primary findings are:

- As services and industry increase their shares of GDP, relative to the share of agriculture, the demand for schooling of both males and females increases.
- As the share of services in GDP increases compared to agriculture (holding the share of industry constant), the demand for schooling by women increases more than the demand for schooling by men.

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[1]It should be mentioned here that the absence of explicit consideration of demand-side factors in the market for labor is a weakness of much of neoclassical labor economics.

- An increase in the share of industry relative to agriculture (holding the share of services constant), is more closely associated with an increase in the demand for schooling of men than of women.
- A decrease in the supply price of schooling increases the level of schooling attained by both sexes, but the gain is larger for women.
- Increases in wealth, *ceteris paribus*, are associated with increases in the demand of both sexes for schooling.

The plan of the paper is as follows: Section 2 introduces the basic theory. A representative family is assumed that has an adult couple and one female and one male child. The issue of fertility is thus entirely sidestepped. Parents are assumed to be the decision-makers regarding investments in human capital of children. They do so because the attained utility of their children matters to them. Attained utility depends upon the income of children as adults and income in turn depends upon the human capital was invested in them by their parents. The demand for schooling of children is focussed upon. Schooling is demanded differentially in different sectors of the economy: industry and services reward education more than agriculture.[2] Parents form expectations about the sector of the economy

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[2]Schultz (1975) argues that this demand for education reflects the higher rates of change in industry. Mincer and Higuchi (1988) and Gill (1989) find that sectoral rates of technical change in the U.S. economy between 1960-1985, were related positively to the rates of return to education. Welch (1970) found similar relationships in U.S. agriculture. These results imply that the rates of return to schooling, and therefore the demand for educated workers, would be highest in industry (especially manufacturing), lower in trade and services, and lowest in agriculture.

that their children are likely to work in as adults, and choose levels of schooling for each child accordingly.

In the basic model, parents use their own time allocation as a proxy for the time-allocation patterns that their children will choose. In section 3 this last assumption is amended. Parents form expectations of time-use of children as adults based on both their own work experience and the general pattern in the region of residence, as well as the probability of migration to other regions. Section 3 also discusses the implications of adding sector-specific work experience (job training) as an additional component of human capital.

Section 4 uses household data from the PLSS to test the implications of the theoretical framework developed in sections 2 and 3. The advantages of using household data are that the schooling attainment of children is directly observed, and the effects of intrahousehold factors on the demand for schooling of boys and girls can be accounted for by including household information such as the education and occupation of parents.

In section 5, I test the implications of the theory using provincial data for 25 departments in Peru in the 1980s. Illiteracy rates are used as a proxy for investment in schooling. I conduct tests to ensure that department illiteracy rates are satisfactory measures of department schooling attainment. The findings confirm the main implications of the theory, and add to the evidence from household analysis.

Section 6 discusses the policy implications of the study. The policy implications are of two types: Supply-related and demand-related.

Supply-related policy prescriptions are those targeted towards lowering the supply price of schooling, such as improving the access to secondary schooling. Demand-related policies aim at increasing the demand for education: The main policy recommendation entails the expansion of the services sector. This contradicts policy advice given by the World Bank and the IMF that developing countries foster the growth of tradables to service their external debt. Another policy implication emphasizes the importance of information about the rates of return to schooling in the market and the home sector.

2. THE THEORETICAL FRAMEWORK

Human capital is assumed to consist of two components: schooling and health.[3] Parents value only their own consumption and the attainable utility -- that is, the full income -- of their children as adults. Assume that a couple has only one female and one male child.[4] The parents' utility function is

$$U = U(C, R_f, R_m) . \tag{1}$$

where C is the quantity of a general consumption good consumed by the parents, and R_f and R_m are the "full" incomes of the girl and boy respectively when they are adults.

R depends on the human capital of children. Human capital has several observable components, e.g., schooling, health and job training. I assume here that schooling (S) is the only form of human capital. The terms human capital and schooling will be used interchangeably unless otherwise indicated. Thus the returns to human capital functions for the girl and the boy are

$$R_f = R_f(S_f) \tag{2a}$$

$$R_m = R_m(S_m) \tag{2b}$$

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[3]The theoretical framework for this paper departs considerably from previous theoretical attempts to analyze gender differences in investments in human capital, such as Gertler and Alderman's (1989) analysis of investments in health.

[4]The issue of fertility is thus sidestepped. See Becker and Tomes (1976) for a theoretical discussion of fertility and quality-quantity tradeoffs, and Schafgans (1990) for an empirical treatment using Peruvian data.

The budget constraint of the household is

$$Y = C + P_s(S_f + S_m) \tag{3}$$

where P_s represents the price of schooling, and the price of the consumption good has been normalized to equal 1.

There are two main sectors of employment: home and the market. The rates of return to human capital are sector-specific. Thus overall returns to schooling depend upon the extent to which time is allotted between the household and the market (all nonhousehold) activities. In this paper market activities are subdivided into agriculture, services and industry, identified as follows

0 = Household
1 = Agriculture
2 = Services
3 = Industry

Total returns to human capital are a time-weighted sum of returns in each sector. I assume Cobb-Douglas return functions

$$R_f = t_{f0}S_f^{\alpha} + (t_{f1}S_f^{\beta} + t_{f2}S_f^{\gamma} + t_{f3}S_f^{\delta}) \tag{4a}$$

$$R_m = t_{m0}S_m^{\alpha} + (t_{m1}S_m^{\beta} + t_{m2}S_m^{\gamma} + t_{m3}S_m^{\delta}) \tag{4b}$$

where t_{fi} and t_{mi} is the fraction of time devoted devoted to activity i by female and male children respectively *when they are adults*,[5] and

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[5]Alternatively, t_i can be interpreted as the *probability* of the child being employed in sector i as an adult.

$$\sum_{i=0}^{3} t_{fi} - \sum_{i=0}^{3} t_{mi} = 1. \qquad (5)$$

The following assumptions are made:

(i) $t_{f0} \geq \bar{t}_0$: Everybody gets married and has children, and women spend more time at home than men. This could be because bearing and rearing children is more demanding of women's time. (See, for related examples, Becker 1985). This raises the issue of endogeneity, since women may *choose* not to have children. In that case, from the viewpoint of this theory, the difference between men and women disappears. Alternatively, it can be explained as a cultural or institutional constraint. In any case, because of time constraint (5), women generally have less time for market activities than men.

(ii) $\beta < \gamma \leq \delta$: The rates of return to schooling are high in the industrial and service sectors and low in the agricultural sector.[6] However, these rates of return do not depend upon the sex of the workers: There is no sex discrimination in the marketplace.[7] Since the productivity of schooling at home, α, is not easily or

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[6]Although I do not have measures of the rates of return to schooling in agriculture compared to the other two sectors, there is strong evidence for Peru that supports this assumption. Schafgans (1990) finds that labor force participation of both men and women in agriculture declines with education, and participation in the nonagricultural wage sector (sectors 2 and 3 in this paper) increases as the education of workers increases.

[7]The point is not that there is *in fact* no discrimination against women. The rationale for this assumption is simply that discrimination (either at home or in the market) is a very difficult concept to quantify. Since the focus of this paper is empirical, I abstract from assertions that are unverifiable either in principle or in practice.

directly observable, nothing is assumed about the magnitude of α relative to β, γ, and δ.

It is important to remember that t_{fi} and t_{mi} are not choice variables for the parents. These are time-allocation decisions by children when they become adults.[8] The only choice variables in the current framework are S_f, S_m, and C. Parents may *impute* the values of t_{fi} and t_{mi} from their own experiences and expectations of market conditions when their children will work. This point will be discussed later.[9]

Parents maximize their (one-period) utility function given in equation (1) subject to the budget constraint (3). The first order conditions for maximization are :

$$\frac{\partial U}{\partial R_f} \cdot [\, t_{f0}\alpha\, S_f^{\alpha-1} + (\, t_{f1}\beta\, S_f^{\beta-1} \quad t_{f2}\gamma\, S_f^{\gamma-1} + t_{f3}\delta\, S_f^{\delta-1})] \;-\; \lambda P_S = 0 \qquad (6a)$$

$$\frac{\partial U}{\partial R_m} \cdot [\, t_{m0}\alpha\, S_m^{\alpha-1} + (\, t_{m1}\beta\, S_m^{\beta-1} + t_{m2}\gamma\, S_m^{\gamma-1} + t_{m3}\delta\, S_m^{\delta-1})] \;-\; \lambda P_S = 0 \qquad (6b)$$

$$\frac{\partial U}{\partial C} \;-\; \lambda \;=\; 0 \qquad (6c)$$

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[8]This assumes that there is no bargaining about transfers from the children to the parents. Suppose instead that contracts bind children to support their parents when they are old. Then parents may in fact decide t_{fi} and t_{mi} as well.

[9]Notice that there is a self-fulfilling nature to the parents' decision. If parents choose the schooling levels under the assumption of a set of t_{fi} and t_{mi}, and if they are correct about the rates of return to schooling in each sector, children cannot do better than allocate their time exactly as their parents expected.

$$Y - C - P_S(S_f + S_m) = 0 \tag{6d}$$

We can solve for the demand functions for S_f, S_m and C. The schooling demand functions will be of the form

$$S_f^* = S(Y, P_S, \bar{t}_0, t_1, t_2, t_3) \tag{7a}$$

$$S_m^* = S(Y, P_S, t_0, t_1, t_2, t_3) \tag{7b}$$

where t_i, $i = 0,1,2,3$ are combinations of t_{if} and t_{im} for each i. Note that since both parents have the same utility function, only aggregate t_i enter the schooling demand functions. These can be written as

$$S_f^* = S_f(Y, P_S, t_1, t_2, t_3) \tag{8a}$$

$$S_m^* = S_m(Y, P_S, t_1, t_2, t_3) \; . \tag{8b}$$

Equations (8a) and (8b) incorporate the additional constraint faced by women, $t_{fo} \geq \bar{t}_0$ (that they must spend at least a fixed fraction $\bar{t}_0$ of their time at home), in the functional form, $S_f(.)$. Since females are expected to marry and become mothers, the functional form of schooling demand will differ from that of males. Other than this restriction, however, there is no difference between boys and girls.

The signs of $\partial S_f^* / \partial P_S$ and $\partial S_f^* / \partial Y$ (and $\partial S_m^* / \partial P_S$ and $\partial S_m^* / \partial Y$) are predicted by standard consumer theory as being negative and positive respectively, if quality of children is a normal good. Assuming that parents value the happiness of male and female children equally,[10] the theory

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[10]Following Becker (1981), parents are altruistic toward their children.

predicts that these coefficients will be roughly equal in magnitude if the curvature in the utility function is small. That is, if the second derivatives, $\partial^2 S_f^* / \partial P_S^2$ and $\partial^2 S_f^* / \partial Y^2$ (and $\partial^2 S_m^* / \partial P_S^2$ and $\partial^2 S_m^* / \partial Y^2$) are close to zero. If these coefficients are different for males and females, and since we know that mean levels of S_f are small compared to S_m, this is indicative of curvature in the utility function.

However, the theory as it stands contains no predictions regarding the magnitudes of $\partial S_f^* / \partial t_1$, $\partial S_f^* / \partial t_2$ and $\partial S_f^* / \partial t_3$ relative to $\partial S_m^* / \partial t_1$, $\partial S_m^* / \partial t_2$ and $\partial S_m^* / \partial t_3$ respectively. More structure is needed to determine whether, for example, an increase in the time spent by parents in sectors 2 and 3 (relative to sector 0 and/or 1) increases or decreases the demand for children's education and whether these magnitudes of response are different for females than for males.

3. SOME THEORETICAL EXTENSIONS

The theory predicts that within a region, as a sector with a relatively high rate of return to education increases its share in total employment, demand for the education of children in that region will rise.[11] The limitations of the framework are:

(1) The theory contains no implications for the gender composition of this increase in demand for schooling: It assumes that if an education-intensive sector (say, industry) increases in importance, the demand for schooling of boys and girls will rise symmetrically. The theory is now extended to allow for systematic differences across sex to such shifts in the demand curve for schooling.

(2) The theory assumes that the *local* structure of the economy (t_1, t_2, and t_3 of the parents) determines the demand for education. This raises the question of how parents form expectations regarding their children's future. Issues such as the likelihood and ease of migration may be significant, and these factors may not be gender-neutral. Also, since the rate of return to schooling in the home sector, α, is not observed directly (that is, in terms of wages), perceptions regarding α may be related to household attributes such as the education of the mother.

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[11] If the industrial sector increases in importance, relative to services and/or agriculture, we expect schooling to rise. Similarly, if the service sector's share rises *relative to agriculture, with no change in the share of the industrial sector,* then the demand for education will unambiguously increase. However, if the share of industry declines at the same time that the share of services rises, the effect on aggregate schooling demand is ambiguous.

Experience as a Factor of Production

The only distinction between men and women is that, in general

$$\sum_{i=1}^{3} t_{fi} < \sum_{i=1}^{3} t_{mi} \qquad (9)$$

since $t_{f0} \geq \bar{t}_0 > t_{m0}$; women must spend more time at home than men. Suppose now that experience in sector 3 (time allocated to sector 3 activities) adds to the returns to schooling in that sector, but the other sectors' rates of return to schooling are not dependent on the time spent. That is

$$\delta = \delta(t_3), \quad \delta' > 0 \qquad (10)$$

So the returns to schooling functions (equations (4a) and (4b)) are rewritten as

$$R_f = t_{f0}S_f^{\alpha} + [\, t_{f1}S_f^{\beta} + t_{f2}S_f^{\gamma} + t_{f3}S_f^{\delta(tf3)}] \qquad (11a)$$

$$R_m = t_{m0}S_m^{\alpha} + [\, t_{m1}S_m^{\beta} + t_{m2}S_m^{\gamma} + t_{m3}S_m^{\delta(tm3)}] \qquad (11b)$$

Combined with restriction (9), equations (11a) and (11b) imply that males will allocate more time to the industry sector than *equally schooled* females because, holding educational attainment constant, women spend less time in market activities than males. This implies that men have a comparative advantage in working in market sectors where the returns to schooling increase with time spent.[12]

For example, assume there are two levels of education: high and

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[12]Alternatively, the comparative advantage of women in services may simply be due to the fact that services provide more opportunities to work close to home than does industry (Smith and Stelcner 1990).

low. Industry and services use only workers with high levels of education, while agriculture uses workers with low levels of education (regardless of sex). Workers with high levels of schooling will work in the other two sectors. Assume that experience is rewarded in industry and not in services (a simplification). More schooled workers with higher amounts of allocable market time (males) will be employed in industry. More schooled females will work in the services sector, where the returns to schooling do not depend on experience.

One consequence is that an increase in the industrial sector's share of GDP will raise the demand for education by both males and females, but more for males. Conversely, a rise in the service sector's share in total employment will increase the demand for schooling by both male and females, but more for females. These are testable implications of the theory.

Forming of Expectations

The model assumes that parents, in deciding how to educate their offspring, base the decision on the amount of time the parents spend on four areas: household activities, agriculture, services, and industry, and the rates of return to schooling in each of these sectors. For example, they expect daughters to allocate time the same way as the mother, and sons to follow their father's patterns. They further expect that the relative rates of return to schooling in each sector will remain unchanged. In the context of Peru in the 1980s this assumption is likely to be incorrect, since a

large flow of migrants moves between rural and urban areas.

This sub-section modifiies the theory to allow for migration. Parents have some information about potential work opportunities for their children (other than their own occupations) and incorporate this information into the decision on their children's education. So, for example, parents may use the *average* levels of t_{fi} and t_{mi} in the region or country to determine the probability of employment of female and male children in sector i. Parents may use t_i (averaged over both sexes) in deciding how much to educate their children. This may entail migration by children when they are adults; this migration may or may not be gender-neutral.

Vector Z is added as an argument in the two schooling equations

$$S_f^* = S_f(Y, P_S, t_1, t_2, t_3, Z) \qquad (12a)$$

$$S_m^* = S_m(Y, P_S, t_1, t_2, t_3, Z). \qquad (12b)$$

where Z represents both "infrastructural" variables (Z_1) that represent the ability of adults to migrate, and household-specific variables (Z_2) that represent the ability of the parents to decode information regarding potential opportunities for children. Z includes both factors that determine the degree to which employment in each sector is perceived as possible (t_{fi} and t_{mi}, for i = 0,1,2,3) and factors that determine the accuracy with which parents observe the true rates of return to schooling (α, β, γ and δ).

In the empirical sections, both equations (8) and (12) will be estimated to see whether or not these variables Z have independent and

gender-variant effects on investment in schooling. These equations were estimated both by ordinary least squares (OLS) and two-stage least squares (TSLS) techniques to account for possible endogeneity of household income. The results were very similar. In this paper only the TSLS results are reported.

4. HOUSEHOLD LEVEL EMPIRICAL EVIDENCE

Analysis at the household level has several advantages. First, since the theoretical model is one of household decisions, empirical testing should be done at the household level. Second, it is possible to quantify the effect of intrahousehold distribution of potential or actual earnings (for instance, the education or earnings of the mother compared to the father's) on investment in the human capital of children. Third, the measure of investment is more reliable for the households than the illiteracy rates used in the next section, and the primary and secondary school enrollment rates used in Gill and Khandker (1990).

The sample should ideally consist of households in the PLSS that have at least one male and one female child of school age. But when the sample was restricted to such households, the number of observations dropped significantly.

Definition of Dependent Variable: Schooling Shortfalls

The problems in comparing schooling levels of boys and girls are:

- Each boy and girl is likely to have different levels of access to schooling, such as household income, distance from school, quality of schools available, and so on.
- The boy and girl being compared are likely to differ in age, and hence on this account alone would differ in years of completed schooling. Thus we need to use a measure of educational attainment adjusted for age.
- A related complication is that time or cohort effects will be confused

with the true schooling differentials. Suppose, for example, that the government makes primary school attendance compulsory for all children between 5 to 10 years of age in year t. Then comparing the adjusted schooling attainment of a girl who is 10 years old in year t+5 with a boy who is 15 in the same year is likely to understate the actual difference in the schooling of girls. Conversely, comparing a boy who is 10 in year t+5 with a girl who is 15 in the same year will overstate this difference. It is important to weed out these cohort-specific effects.

To resolve the first problem, we have included family characteristics in the regression. Regarding the second problem, the comparison is not between attained schooling but *shortfalls* in schooling attainment of boys and girls. This shortfall, for a child j, is defined as

$$(\text{Age}_j - 5) - (\text{Schooling in Years})_j = (\text{Schooling Shortfall})_j, \text{ for } j = f,m.$$

That is, the shortfall is equal to potential schooling (age-5) minus actual schooling (alternatively, the highest grade completed).[13] The nice thing about this measure is that it is a familiar one: it is identical to Mincer's (1974) definition of potential work experience for adults. The only

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[13]Within the household, it is also possible to compare the quality of schools attended by male children versus the quality of schools attended by female children. For example, in the PLSS, it is possible to determine whether the child attended a private or a public school. Indices of quality of schooling of and school-related expenditure on male and female offspring can be incorporated to make the schooling differential variable better approximate differential investment in schooling rather than differential schooling attainment.

difference is in its application. We deal with the third problem by estimating cohort-specific schooling equations, estimating separately for each of five age groups: 6-15 years, 16-25 years, 26-35 years, 36-45 years and 46-65 years.[14]

Definitions of Independent Variables

Y: *Household income* is proxied by using total (food and nonfood) expenditures in the household. The advantages of using expenditures rather than income are that: (a) expenditures are less subject to errors in reporting, since they are reported by component. Each component (food, clothing, and so on) is less likely to be systematically under- or over-reported; and (b) total expenditures are a better proxy for permanent income, which is generally the relevant budget constraint.

The disadvantages are that: (a) since expenditures on schooling are a component of the total, the issue of endogeneity of a right-hand side variable becomes a problem; and (b) schooling levels and

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[14]Ideally, to purge cohort effects from the comparison of male and female schooling levels, the following procedure should be adopted. The *average* schooling shortfall for male children in each cohort group is first calculated. Then the difference of the schooling shortfall of each child i, male *and* female, from the average schooling shortfall of male children in the cohort that child i belongs to, is defined as

$$(\text{Schooling Shortfall})_j - \sum_{k=1}^{M(t)} (\text{Male Schooling Shortfall})_k / M(t) = S_j ,$$

$j = m, f$; and $k = 1, 2, \ldots\ldots, M(t)$

where j denotes the male children in the cohort, t, that i belongs to, and M(t) is the number of males in cohort t.

household income may be jointly determined by other variables, and this results in simultaneous equations bias. (See Schultz 1989 for a discussion of this problem for fertility decisions.)

To overcome these problems, the estimation is done in two stages. The first stage consists of estimating household expenditures per adult from the following regression

$$\begin{aligned}\text{Expenditures/Adult} = {} & \xi_0 + \xi_1 \text{Age} + \xi_2 \text{Age}^2 + \xi_3 \text{Schooling} \\ & + \xi_4 \text{Schooling}^2 + \xi_5 \text{Training} + \xi_6 \text{Public School?} \\ & + \xi_7 \text{Landholding} + \xi_8 \text{Unearned Income} \\ & + \xi_9 \text{Rural} + \epsilon \end{aligned} \tag{13}$$

Age, **Schooling** and **Training** are the age, education, and training of the head of the household and the spouse, **Public School?** is a binary variable that asks whether the head and spouse attended a private or a public school, **Rural** is a region dummy which equals 1 if the region of residence is rural, and 0 otherwise, **Landholding** is the total area of land sown or rented out by the household, and **Unearned Income** is the sum of all income other than wage and salaries. The fitted values used are from a regression that excludes **Landholding**, because the sample was reduced to one-third of its size when landholding was included. The full regression results are in Appendix I.

t_i: The structure of the economy, or the time spent in each of the three market sectors, t_1, t_2, and t_3, is proxied by their *Share in Departmental GDP*.

t_1 = Share of agriculture (farming, fishing and forestry),

t_2 = Share of services (personal and business services, health care, hotels, tourism, and so on),

t_3 = Share of industry (manufacturing, mining, construction, and so on),

averaged over 1979-85. Ideally, I would also have experimented with the share of each sector in department *employment*, but data were not available. It may be more appropriate to use sector shares in income, since it is the earning power of children that parents are concerned about, not hours worked. Using sectoral shares in departmental GDP as proxies for t_i assumes that within each sector, the labor intensity of production does not change as sectoral output changes.

P_s: Changes in P_s are proxied by a *rural-urban dummy* variable. I assume that the price of schooling is lower in urban than in rural regions. This could be because the average distance to school in rural regions is greater than that in urban regions.[15] Thus within each department, the parameter P_s varies with region of residence.

Z_2: The estimation in this section uses household data from the PLSS for subset Z_2 variables, as follows:

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[15]Alternatively, it could be because rural areas are generally agricultural, and urban areas are more industrial. If children's labor is more valuable in agrarian economies, then the price of schooling would include the higher opportunity cost in rural areas. This effect confounds the structure of the economy with the rural-urban decomposition, and is ignored here.

(1) *Highest level of education completed by Mother*

(2) *Highest level of education completed by Father*

(3) *Mother's Longest Occupation*

(4) *Father's Longest Occupation*

The level of education of the parents is measured as follows:

-1 = Never attended, 0 = None, 1 = Initial, 2 = Primary, 3 = Regular secondary, 4 = Technical secondary, 5 = Postsecondary Non-university, 6 = University.

The occupation of the parents is measured as follows:

1 = Did not work, 2 = Missing and not elsewhere classified, 3 = Agriculture, Fishing and Forestry, 4 = Sales vendors, 5 = Service workers, 6 = Production & Transportation, 7 = Clerical, 8 = Professional and Government.

The education levels of the mother and father are included to capture information-processing abilities of the household. Educated parents are likely to be better informed about the true rates of return to their children's education. The occupation of each parent is included to test whether parents base their expectations for their children on their own experiences, or whether the crucial determinant is the general structure of production in the region of residence (as proxied by province t_i ratios).[16]

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[16]The education of the mother relative to that of the father, when their wages or incomes are not included, may also indicate the extent of female control of the household budget Y. Occupations of the mother and father are more likely to proxy share in *actual* earned income of the household. Education, when occupation is included, better proxies *potential* earned income. To the extent that the "bargaining position" of females depends on the income-earning capability of the mother, and not income actually earned, the mother's schooling will have an independent effect on

Results of the Schooling Regressions

The general form of the estimated equations is

$$S_f^* = S_f(Y, P_S, t_1, t_2, t_3, Z) \text{ for females,} \quad (14a)$$

$$S_m^* = S_m(Y, P_S, t_1, t_2, t_3, Z) \text{ for males.} \quad (14b)$$

Since the t_i as measured add up to 1, only two of the three shares can be included in a regression. The aim is to examine the relative increases in the demand for schooling as education-intensive sectors grow in importance, and particularly whether industrial growth raises the demand for boys' education more than girls'. To hold the share of services constant while increasing the share of industry, we must include both the high education sectors in the regression, and omit the low education sector.

Another aspect of the problem of multicollinearity is that the share of agriculture in GDP (the omitted class) and the degree of urbanization are highly (negatively) correlated. Since the share of agriculture is equal to 1 minus the sum of the shares of services and industry, this leads to high degree of multicollinearity in the above regressions. To overcome this problem, I use a four-way classification, with government services as the fourth category. The results below are computed with two classes, industry and nongovernment services, and two omitted classes, agriculture and government services. Since the share of

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gender equity in child investments. Studies have also found that the father's education has significant positive effects on the schooling of children. (See for example, Moock and Leslie 1986.) The education of both parents is hypothesized to have a positive effect on the schooling of both sons ans daughters.

government services is about .07, it is not a very important category quantitatively, but it helps to overcome the multicollinearity problem.[17]

The regressions estimated for females are:

$$S_f = \phi_0 + \phi_1 \text{Household-Income} + \phi_2 \text{Share-of-Industry} + \phi_3 \text{Share-of-Services} + \phi_4 \text{Urbanization} + \phi_5 \text{Father's Education} + \phi_6 \text{Mother's Education} + \phi_7 \text{Father's Occupation} + \phi_8 \text{Mother's Occupation} + \epsilon_f \quad (15a)$$

and for males are:

$$S_m = \mu_0 + \mu_1 \text{Household Income} + \mu_2 \text{Share-of-Industry} + \mu_3 \text{Share-of-Services} + \mu_4 \text{Urbanization} + \mu_5 \text{Father's Education} + \mu_6 \text{Mother's Education} + \mu_7 \text{Father's Occupation} + \mu_8 \text{Mother's Occupation} + \epsilon_m \quad (15b)$$

The primary hypotheses to be tested are:

H1. $\phi_1 < 0$, $\mu_1 < 0$: Schooling of the girl and the boy are normal goods.

H2. $\phi_1 < \mu_1$: Since levels of schooling of girls are lower to begin with, this would imply that equity in human capital investments across sexes is a normal good.

H3. $\phi_2 < 0$, $\mu_2 < 0$: Demand for schooling increases as the share of

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[17]To test whether multicollinearity was severe, I used the singular value decomposition technique advocated by Belsley and others (1980). This test is essentially a measure of the sensitivity of coefficients to changes in the matrix of independent variables. This sensitivity is summarized as (square root of) the ratio of the largest eigenvalue of the X'X matrix to the smallest, and is called a "condition index." Condition indices of less than 30 are considered good, and those between 30 to 100 are considered to be indicative of moderate to strong multicollinearity (see Judge and others 1985). The largest condition index for the regressions in this paper was about 26.

industry increases at the expense of agriculture, holding the share of services constant.

H4. $\phi_2 > \mu_2$: Men have a comparative advantage in industry, since it rewards work experience as well as schooling. So when the share of industry rises holding the share of services constant, the demand for male schooling rises by more than the demand for female schooling.

H5. $\phi_3 < 0$, $\mu_3 < 0$: Demand for schooling increases as the share of services rises at the expense of agriculture, holding the share of industry constant.

H6. $\phi_3 < \mu_3$: Women have a comparative advantage in services, since the rate of return to schooling in the services sector is independent of the time spent working in this sector. So when the share of services rises, holding the share of industry constant, the demand for female schooling rises by more than the demand for male schooling.

H7. $\phi_4 < 0$, $\mu_4 < 0$: A fall in the supply price of schooling associated with greater urbanization, holding the demand schedule for schooling constant, will raise schooling investments in both girls and boys.

H8. $\phi_4 \lesseqgtr \mu_4$: The theory has no predictions about the *relative* magnitudes of the responses of male and female schooling to changes in the supply price of schooling.

Table 2 shows the results for the entire sample and separately for each of five age-groups: 6-15 years, 16-25 years, 26-35 years, 36-45 years, and 46-65 years. Schooling decisions of those who are more than 35 years old were made when the structure of the province's economy was different. We

expect to find the strongest results for groups that are finishing school (16-25 years) and that have just finished school (26-35 years).

We expect to see that an increase in the share of services, holding the share of industry constant, will reduce the schooling shortfall of females by more than that of males. For industry, the effect on male schooling should be stronger than the effect on female schooling. The results indicate that for the sample as a whole, increases in the share of services are significantly and negatively correlated with schooling shortfall for females, but not for males. The share coefficient in the female regressions is greater in magnitude for the services sector than for industry. For males, on the other hand, it is the share of industry that is significant (at the 5 or 10 percent level). This is exactly what our theory predicted.

Results by age group show that coefficients for the shares of services and industry are insignificant for the age groups 6-15, 36-45, and 46-65 years. For the group 16-25 years old, the coefficient for the share of services is significant at the 1 or 5 percent level. For the group 26-35 years old, the share of industry and services show strong results. Reassuringly, the correlation between the share of services and schooling seems to be stronger for females than for males. However, the magnitude is greater for the services sector for *both* sexes -- a contradiction of the theory. For each of the age groups, the coefficient for the share of industry is never significant for females. However, for males in the two groups 26-35 and 36-45 years, the coefficient of the share of industry is

significantly negative at the 10 percent level of significance.

For the age-specific estimates, the degree of urbanization decreases the schooling shortfall of females, but not necessarily that of males. Surprisingly, urbanization has a strong unfavorable influence on the schooling shortfall for males in the pooled regressions. In the context of our model, where the rural dummy proxies the price of schooling, this implies that lowering the price of schooling increases the schooling of females more than males.

The education of both father and mother have significant positive effects on schooling. The education of the mother is more closely associated with the schooling of daughters, and the education of the father with the schooling of sons. The occupation of the mother never matters, while the occupation of the father seldom matters, with higher occupation implying a lower schooling shortfall for both female and male offspring. Household income has a strong beneficial effect on all groups except children aged 6-15 years. A surprising finding was that household income has a stronger effect on schooling of male children than female children. Thus while investment in education is a normal good, the data reject the view that gender equity is a normal good *when demand-side factors are included*. That is, increases in household income *per se* will not lower the gender gap in schooling.

Table 1

MEANS AND STANDARD DEVIATIONS OF VARIABLES BY HOUSEHOLDS IN PERU: 1985-86

Variables	Mean	Standard Deviations
Department-Level RHS Variables:		
Share of Industry in Dept.GDP	0.36	0.14
Share of Agriculture in Dept.GDP	0.18	0.13
Share of Services etc.in Dept.GDP	0.39	0.13
Share of Govt. Services in Dept.GDP	0.07	0.03
Degree of Urbanization	66.99	25.49
Household-Level RHS Variables:		
Predicted Household Income	787.26	385.13
Place of Residence (Dummy: 1=Rural, 0=Urban)	0.43	0.49
Household Size	6.48	2.75
Total Landholding (Acres)	9.21	76.01
Individual-Level RHS Variables:		
Father's Education Level	1.48	1.76
Mother's Education Level	0.48	1.68
Father's Occupation	4.28	1.67
Mother's Occupation	2.98	1.63
Individual-Level LHS Variables:		
Female: Education in Years	4.59	4.10
Male : Education in Years	5.49	4.13
Female: Highest Level of Education Completed	1.94	1.69
Male : Highest Level of Education Completed	2.43	1.50
Female: Age in Years	26.70	16.04
Male : Age in Years	26.12	16.13
Female Schooling Shortfall: 6-15 years	2.76	1.92
Male Schooling Shortfall: 6-15 years	2.57	1.73
Female Schooling Shortfall: 16-25 years	7.89	4.35
Male Schooling Shortfall: 16-25 years	7.34	3.75
Female Schooling Shortfall: 26-35 years	18.76	5.84
Male Schooling Shortfall: 26-35 years	16.89	5.28
Female Schooling Shortfall: 36-45 years	31.01	5.67
Male Schooling Shortfall: 36-45 years	29.02	5.76
Female Schooling Shortfall: 46-65 years	46.33	7.03
Male Schooling Shortfall: 46-65 years	44.54	7.13

Table 2

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
			All Age Groups			
Constant	-5.043***	-3.841***	-5.342***	-3.665***	-5.031***	-3.899***
	(0.64)	(0.62)	(0.62)	(0.62)	(0.64)	(0.64)
Industry share	-1.640**	-1.310**	-1.002*	-1.166*	-0.943	-1.172*
	(0.68)	(0.67)	(0.67)	(0.67)	(0.67)	(0.67)
Services share	-3.215***	-1.281*	-2.251***	-1.112	-2.165***	-1.216
	(0.83)	(0.82)	(0.81)	(0.81)	(0.82)	(0.82)
Rural dummy	0.836***	-0.527***	0.233	-0.678***	0.197	-0.715***
	(0.20)	(0.20)	(0.20)	(0.21)	(0.21)	(0.21)
Household income	-0.007***	-0.010***	-0.006***	-0.010***	-0.006***	-0.010***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.419***	-0.304***	-0.388***	-0.302***
			(0.06)	(0.06)	(0.06)	(0.06)
Mother's education			-0.574***	0.007	-0.556***	-0.005
			(0.06)	(0.06)	(0.06)	(0.06)
Father's occupation					-0.129**	0.022
					(0.06)	(0.06)
Mother's occupation					-0.015	0.085*
					(0.05)	(0.05)
Age group	11.251***	11.181***	11.091***	11.116***	11.096***	11.120***
	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Adjusted R^2	0.885	0.899	0.892	0.900	0.892	0.900
Sample size	4281	4024	4281	4024	4281	4024

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 2 (Continued)

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
	Population Aged 6 to 15 years					
Constant	0.765	2.768**	1.448	3.378***	1.595	3.209***
	(1.40)	(1.41)	(1.38)	(1.00)	(1.39)	(1.03)
Industry share	2.474	1.201	2.047	1.152	2.518*	1.106
	(1.58)	(1.31)	(1.52)	(1.24)	(1.56)	(1.24)
Services share	1.680	-0.297	3.101*	0.179	3.827*	0.071
	(2.00)	(1.65)	(1.92)	(1.57)	(2.05)	(1.60)
Rural dummy	1.928***	0.168	1.383***	0.142	1.424***	0.125
	(0.49)	(0.40)	(0.49)	(0.38)	(0.49)	(0.38)
Household income	0.001	-0.000	0.000	0.000	0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.042	-0.309**	-0.010	-0.335***
			(0.14)	(0.12)	(0.14)	(0.13)
Mother's education			-0.465***	-0.163	-0.433***	-0.193*
			(0.12)	(0.10)	(0.13)	(0.11)
Father's occupation					-0.129	0.027
					(0.11)	(0.11)
Mother's occupation					-0.056	0.109
					(0.10)	(0.09)
Adjusted R^2	0.092	-0.009	0.191	0.102	0.189	0.101
Sample size	156	170	156	170	156	170

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 2 (Continued)

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
	Population Aged 16 to 25 years					
Constant	14.305***	14.296***	14.038***	14.353***	14.689***	14.039***
	(1.13)	(1.26)	(1.08)	(1.24)	(1.11)	(1.31)
Industry share	-1.173	-0.866	-0.912	-0.355	-0.813	-0.388
	(1.28)	(1.57)	(1.21)	(1.52)	(1.21)	(1.52)
Services share	-5.117***	-4.939***	-4.479***	-4.084**	-4.106***	-4.243***
	(1.61)	(1.70)	(1.52)	(1.66)	(1.53)	(1.66)
Rural dummy	2.333***	1.927***	1.828***	1.383***	1.685***	1.336***
	(0.41)	(0.45)	(0.39)	(0.45)	(0.39)	(0.45)
Household income	-0.003***	-0.004***	-0.002***	-0.004***	-0.001***	-0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.404***	-0.416***	-0.340***	-0.420***
			(0.11)	(0.12)	(0.11)	(0.13)
Mother's education			-0.616***	-0.282**	-0.573***	-0.304***
			(0.10)	(0.12)	(0.11)	(0.12)
Father's occupation					-0.328***	0.031
					(0.11)	(0.11)
Mother's occupation					0.123	0.117
					(0.08)	(0.09)
Adjusted R^2	0.286	0.359	0.366	0.399	0.374	0.399
Sample size	645	445	645	445	645	445

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 2 (Continued)

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
	Population Aged 26 to 35 years					
Constant	26.685***	26.601***	25.919***	26.117***	26.662***	26.230***
	(0.99)	(0.93)	(0.95)	(0.92)	(1.00)	(0.97)
Industry share	-1.384	-1.733*	-0.542	-1.590*	-0.470	-1.384
	(1.12)	(1.01)	(1.07)	(1.00)	(1.07)	(1.00)
Services share	-3.845***	-2.639**	-3.233***	-2.170*	-3.311***	-2.124*
	(1.38)	(1.32)	(1.30)	(1.30)	(1.31)	(1.31)
Rural dummy	1.862***	0.525*	1.130***	0.305	1.029***	0.226
	(0.35)	(0.33)	(0.34)	(0.33)	(0.34)	(0.34)
Household income	-0.006***	-0.008***	-0.004***	-0.007***	-0.004***	-0.007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.538***	-0.303***	-0.471***	-0.272***
			(0.10)	(0.09)	(0.10)	(0.09)
Mother's education			-0.606***	-0.262***	-0.576***	-0.261***
			(0.10)	(0.09)	(0.10)	(0.09)
Father's occupation					-0.245**	-0.121***
					(0.10)	(0.09)
Mother's occupation					0.031	0.093
					(0.07)	(0.07)
Adjusted R^2	0.404	0.500	0.462	0.515	0.464	0.515
Sample size	1148	957	1148	957	1148	957

Note: Dependent variable is schooling shortfall = age - schooling - 5
* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 2 (Continued)

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
	Population Aged 36 to 45 years					
Constant	38.049***	39.942***	36.471***	39.570***	36.795***	39.437***
	(0.97)	(0.84)	(0.93)	(0.85)	(0.97)	(0.89)
Industry share	-0.730	-1.850**	0.073	-1.404*	0.074	-1.448*
	(1.15)	(0.94)	(1.10)	(0.94)	(1.10)	(0.93)
Services share	-0.005	-1.650	1.033	-1.360	1.136	-1.407
	(1.36)	(1.18)	(1.29)	(1.17)	(1.30)	(1.18)
Rural dummy	0.930***	-0.547*	0.346	-0.738**	0.272	-0.734
	(0.35)	(0.30)	(0.34)	(0.31)	(0.34)	(0.31)
Household income	-0.009***	-0.011***	-0.006***	-0.010***	-0.006***	-0.010***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.382***	-0.294***	-0.339***	-0.303***
			(0.09)	(0.09)	(0.09)	(0.09)
Mother's education			-0.778***	-0.095	-0.756***	-0.102
			(0.10)	(0.09)	(0.10)	(0.09)
Father's occupation					-0.174*	0.044
					(0.10)	(0.09)
Mother's occupation					0.088	0.010
					(0.08)	(0.07)
Adjusted R^2	0.435	0.610	0.493	0.617	0.494	0.616
Sample size	1064	1030	1064	1030	1064	1030

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 2 (Concluded)

HOUSEHOLD-LEVEL SCHOOLING REGRESSIONS: PERU, 1985-86

Independent Variables	Equation 1		Equation 2		Equation 3	
	Female	Male	Female	Male	Female	Male
	Population Aged 46 to 65 years					
Constant	54.175***	54.047***	52.687***	54.174***	52.731***	53.386***
	(1.29)	(1.14)	(1.28)	(1.15)	(1.36)	(1.22)
Industry share	-3.200**	-1.246	-2.321	-1.227	-2.353	-1.282
	(1.56)	(1.36)	(1.55)	(1.36)	(1.55)	(1.36)
Services share	-4.428**	1.215	-2.814	1.153	-2.696	0.910
	(1.91)	(1.66)	(1.89)	(1.66)	(1.90)	(1.67)
Rural dummy	0.093	-0.947**	-0.498	-0.993**	-0.430	-0.996
	(0.45)	(0.40)	(0.45)	(0.40)	(0.46)	(0.40)
Household income	-0.008***	-0.013***	-0.006***	-0.012***	-0.006***	-0.013***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.307***	-0.233**	-0.331**	-0.257**
			(0.13)	(0.11)	(0.13)	(0.12)
Mother's education			-0.636***	0.176	-0.647***	0.151
			(0.16)	(0.13)	(0.16)	(0.13)
Father's occupation					0.091	0.191
					(0.14)	(0.13)
Mother's occupation					-0.146	0.127
					(0.11)	(0.10)
Adjusted R^2	0.201	0.381	0.227	0.382	0.227	0.383
Sample size	1264	1418	1264	1418	1264	1418

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard Errors in parentheses.

5. PROVINCE LEVEL EMPIRICAL EVIDENCE

Evidence from provincial data confirms the findings of the previous section. Because literacy and income data are based on the census, the results do not reflect any sampling bias in the PLSS. In the last section the focus was on household level variables (the subset Z_2). In this section I experiment with various infrastructural parameters (Z_1), indicating the degree of development of transport and communications in each province or department.

Using data from the department level is tantamount to assuming that households within a department are identical with respect to the parameters they face: income (Y), the rates of return to schooling in the three sectors (α, β, γ, and δ), and the time-allocation parameters (t_i). However, each department has two regions, rural and urban. As in the previous section I assume that the price of schooling (P_S) is lower in urban than in rural regions.

Definitions of Dependent Variable: Illiteracy Rates

$S_{f,m}$: The census data do not provide gender-specific schooling attainment or enrollment by age group for each department. Since illiteracy rates are available at the required level of disaggregation, I use cohort-specific illiteracy rates as a proxy for investment in schooling in the department. Clearly, literacy rates are a gross approximation for schooling levels. There are two defenses for this procedure: First, the study focuses on the *differences* in human capital between males and females. Even though illiteracy rates do not reflect absolute

levels of human capital of each sex, they may provide reliable estimates of relative levels. Second, total illiteracy rates are highly negatively correlated with initial, secondary, postsecondary, and vocational enrollment ratios across departments (see Table 3). University level enrollment ratios are weakly negatively correlated with illiteracy rates, but this is not surprising. Somewhat puzzling is the finding that primary school enrollment ratios are *positively* correlated with illiteracy rates. This is probably due to the fact that high actual primary school enrollment relative to the number that should be enrolled may indicate that students have fallen behind in the curriculum.

Definitions of Independent Variables

Y: Departmental *gross domestic product per capita* is used as the measure for household income.

t_i: The structure of the economy, or the time spent in each of the three market sectors, t_1, t_2, and t_3, is proxied by their *Share in departmental GDP*. These variables are defined as in the previous section:

t_1 = Share of Agriculture (farming, fishing and forestry),

t_2 = Share of Services (personal and business services, health care, hotels, tourism, and so on),

t_3 = Share of Industry (manufacturing, mining, construction, and so on),

averaged over 1979-85.

P_s: Changes in P_s are proxied by the *Degree of Urbanization* (percentage of total department population living in urban areas) in 1985. The degree of urbanization is a continuous variable. Therefore P_s $(0 \leq P_s \leq 100)$ is a continuous variable. I also experimented with a rural-urban dummy variable ($P_s = \rho, \upsilon$, where ρ and υ are the price of schooling a child in rural and in urban areas respectively). This is done by estimating male and female schooling regressions separately for rural and urban schooling levels across departments. However, income per capita, Y, and the potential work opportunities by sector, t_i, are still department-level: department GDP figures are not available separately for each region. Thus it is assumed that t_i do not vary across regions within a department, but P_s does. This assumes that, within a department, it is costless for *an adult* to migrate from rural to urban urban regions (or vice versa), but the cost of sending *a child* to school from rural to urban regions is very high.

Z : The vector of department-level infrastructural variables Z_1 include *Roads per Square Kilometer*, and *Post Offices per Square Kilometer*. I also experimented with *Telegraph Offices per Square Kilometer*, *Telephone Lines per Capita*, and some other variables. Since household specific variables Z_2 are only available in a household-level survey, this section only employs department-level infrastructural variables (subset Z_1) in the schooling regressions.

Description of the Data

Table 4 shows the means and standard deviations of the dependent and all the independent variables used in the illiteracy regressions. Industry's share is the largest, but is also relatively more variable across departments than the share of services (as evidenced by values of the coefficients of variation of 0.54 and 0.36 respectively). The share of agriculture in GDP (CV= 0.61) is also highly variable across sectors. It seems that the share of industry increases most rapidly at the expense of the share of agriculture.

Average illiteracy rates for all ages and for both sexes are higher in rural areas. The aggregate gender differential (female illiteracy divided by male illiteracy) is lower for rural (2.52) than for urban areas (3.54). Given the values of the standard deviations, this difference appears to be statistically significant. A plausible (demand-side) explanation of this finding is that agricultural activities are less education-intensive for women *and* men. That is, the predominance of a sector with low education intensity in a region will result in low demand for education in that region, but, under reasonable assumptions, in higher equity across sexes in investment in schooling. Since the supply price of education is probably lower in urban areas, and if the lower price prompts a greater response from girls than boys, the ratio between male and female illiteracy rates should be *lower* in urban areas. This points out a weakness of studies that focus only on shifts in supply of schooling, and highlights the importance of studying the determinants of shifts in the schooling demand curve.

Table 3

CORRELATION BETWEEN ENROLLMENT RATIOS AND ILLITERACY RATES: PERU, 1985-86

ENROLLMENT RATIO	TOTAL	COHORT GROUP (IN YEARS)					
(by school group)		15-19	20-24	25-29	30-34	35-39	40+
Initial	-.596	-.538	-.552	-.430	-.597	-.616	-.587
Primary	.694	.694	.691	.327*	.691	.711	.691
Secondary	-.815	-.881	-.847	-.639	-.829	-.851	-.812
Postsecondary	-.669	-.696	-.672	-.516	-.682	-.714	-.658
University	-.402*	-.444	-.439	-.332*	-.394*	-.406*	-.412
Other	-.725	-.663	-.689	-.483	-.731	-.751	-.736

Notes: 1. All correlations except those marked by an asterisk are significant at the 5 percent level. All correlations are significant at the 10 percent level. The test used to determine statistical significance of the correlation is the t-statistic :

$$t = [(n-2r)/(1-r^2)]^{0.5}.$$

n is the number of observations, r is the computed correlation coefficient, and (n-2) is the number of degrees of freedom.

2. The number of observations is 23. Lima and Callao, and Loreto and Ucayali are aggregated to maintain conformity with available GDP accounts.
3. Enrollment Ratios are calculated as ratios of total enrollment in the department to total population. For an idea of how much age-distributions differ across department, see column 5 of Table in the Appendix.

Sources: For illiteracy rates, enrollment and population, *Peru: Compendio Estadistico, 1987*, Systema Estadistico Nacional, Instituto Nacional de Estadistica.

Table 4

MEANS AND STANDARD DEVIATIONS OF VARIABLES BY DEPARTMENT, 1981-82

Variables	Means and Standard Deviations			
	Mean	S.D.		
RHS Variables:				
Per Capita GDP (Current Prices)	174.46	148.65		
Share of Industry in Dept.GDP	0.37	0.20		
Share of Agriculture in Dept.GDP	0.23	0.14		
Share of Services etc.in Dept.GDP	0.33	0.12		
Share of Govt. Services in Dept.GDP	0.07	0.03		
Degree of Urbanization	55.66	21.76		
Roads per 1000 Square Kilometers	785.06	2258.45		
Post Offices per 1000 Sq. Km.	2.82	1.92		
	Urban		Rural	
	Mean	S.D.	Mean	S.D.
LHS Variables:				
Female illiteracy rate: All ages	18.67	10.84	46.22	16.76
Male illiteracy rate: All ages	5.44	3.12	19.43	9.09
Female/Male illiteracy ratio: All	3.54	0.87	2.52	0.51
Female illiteracy rate: 15-19 years	3.80	2.24	18.42	11.20
Male illiteracy rate: 15-19 years	1.62	0.74	6.96	3.55
Female/Male illiteracy ratio: 15-19	2.45	0.83	2.55	0.63
Female illiteracy rate: 20-24 years	5.85	3.99	26.19	14.42
Male illiteracy rate: 20-24 years	1.62	0.89	7.58	4.47
Female/Male illiteracy ratio: 20-24	3.81	1.47	3.93	1.44
Female illiteracy rate: 25-29 years	8.75	5.67	34.50	17.13
Male illiteracy rate: 15-19 years	1.95	1.09	10.25	5.93
Female/Male illiteracy ratio: 25-29	4.96	2.31	3.84	1.42
Female illiteracy rate: 30-34 years	13.88	9.04	44.94	18.56
Male illiteracy rate: 30-34 years	3.04	1.83	14.40	8.22
Female/Male illiteracy ratio: 30-34	5.01	2.30	3.72	1.77
Female illiteracy rate: 35-39 years	22.08	12.77	55.89	17.56
Male illiteracy rate: 35-39 years	4.52	2.54	19.83	9.93
Female/Male illiteracy ratio: 35-39	5.27	2.07	3.23	1.17
Female illiteracy rate: 40+ years	37.72	17.76	69.69	17.04
Male illiteracy rate: 40+ years	12.00	6.54	34.01	12.95
Female/Male illiteracy ratio: 40+	3.34	0.88	2.17	0.44

Notes: Means are Unweighted averages.

When we examine the patterns across cohorts, we find a small difference for the younger age groups (15 to 29 years) in this ratio across regions, and a significantly larger difference for people 30 years and older. One interpretation of this finding is that over time, the gender differences in urban areas have narrowed more rapidly than in rural areas. Again, a demand side explanation seems plausible. The rapid growth of services in urban areas can account for greater equity even if the supply price of schooling is constant over time, if women have a comparative advantage over men in working in services (see section 3).[18] It is difficult to rule out a supply-side explanation here. It may be that the supply price of schooling has fallen relatively more in urban than in rural areas over time, and that female schooling has a higher price elasticity than male schooling, analogous to Gertler and Alderman's (1989) arguments for health.

Results of the Schooling Regressions

The general form of the estimated equations for females and males respectively is

$$S_f = \phi_0 + \phi_1 \text{Per-Capita-GDP} + \phi_2 \text{Share-of-Industry} + \phi_3 \text{Share-of-Services} + \phi_4 \text{Urbanization} + \epsilon_f \qquad (16a)$$

$$S_m = \mu_0 + \mu_1 \text{Per-Capita-GDP} + \mu_2 \text{Share-of-Industry} + \mu_3 \text{Share-of-Services} + \mu_4 \text{Urbanization} + \epsilon_m \qquad (16b)$$

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[18]Note that men may still have an *absolute* advantage in *both* industry and services.

The first three slope coefficients in each equation measure demand shifts, while the last coefficient measures supply price effects. Since S stands for illiteracy rates, a negative coefficient implies a favorable effect on education levels. In this section, I refer to the absolute magnitudes of the coefficients when using the phrases "greater than" or "less than."

Table 5 reports the results of the regressions. The first two rows report the results of the regressions (16a) and (16b). The results for the sample as a whole indicate no significant support for hypotheses H1 to H6 listed in section 4. The only significant variable is urbanization, although the signs of the other coefficients conform with the theory.

The insignificance of results using a sample of all ages is not surprising. Schooling decisions of age groups 35 years and above were made two decades ago. The structure of the department's economy and hence the demand for schooling is likely to have changed since then. It is more sensible to look at the relationship between the illliteracy of younger cohorts and department income, demand structure, and degree of urbanization. The relationships are likely to be strong for the youngest cohort group, and to diminish as the age of the cohort increases.

Results support this argument : for all but the oldest groups (35-39 years and 40 years and above) there is reasonably strong evidence that a rise in the share of the services sector, holding the share of industry constant, raises the schooling levels of females and males. As predicted by the theory, the coefficient for females is (2.5 to 5 times)

larger in magnitude, and intermittently significant at the 10 percent level of significance for a one-tailed test. The coefficient for industry's share is always greater in magnitude for females but never significant. This evidence, combined with the fact that the variance of the share of industry is in fact larger than that of the service sector, is evidence consistent with the view that a rise in the share of services in GDP leads to greater increases in the education of women than an equivalent increase in the share of industry. The coefficient for the degree of urbanization is always negative for both females and males, always greater in magnitude for females, and statistically significant at the 5 percent level for a one-tailed test.

Given the high degree of multicollinearity between the share of industry and the rate of urbanization, the high standard errors of the coefficients are not surprising. To increase the degrees of freedom (a common solution for multicollinearity), the female and male schooling equations are estimated separately for rural and urban regions, thus allowing the omission of the urbanization variable. This is roughly equivalent to treating the urbanization variable as a binary variable. It is a test of the alternative view that, within a department, it is costless for *an adult* to migrate from rural to urban regions (or vice versa), but the cost of sending *a child* for schooling from rural to urban regions is very high. The estimated equations for urban areas are

$$\text{Urban } S_f = \phi_0 + \phi_1 \text{Per-Capita-GDP} + \phi_2 \text{Share-of-Industry} + \phi_3 \text{Share-of-Services} + \epsilon_{uf} \qquad (17a)$$

$$\text{Urban } S_m = \mu_0 + \mu_1 \text{Per-Capita-GDP} + \mu_2 \text{Share-of-Industry} + \mu_3 \text{Share-of-Services} + \epsilon_{um} \quad (178b)$$

and for rural areas

$$\text{Rural } S_f = \phi_0 + \phi_1 \text{Per-Capita-GDP} + \phi_2 \text{Share-of-Industry} + \phi_3 \text{Share-of-Services} + \epsilon_{rf} \quad (18a)$$

$$\text{Rural } S_m = \mu_0 + \mu_1 \text{Per-Capita-GDP} + \mu_2 \text{Share-of-Industry} + \mu_3 \text{Share-of-Services} + \epsilon_{rm} \quad (18b)$$

The results for urban areas are rows 3 and 4; for rural areas, rows 5 and 6 in Table 5.

Regressions for groups aged 15-19, 20-24, and 25-29 years confirm the theory. The coefficients for the share of services in GDP are significant and larger in magnitude for females than for males, and larger in rural than in urban areas. The coefficients for the share of industry in GDP are generally insignificant for female schooling, and generally significant for *urban* male schooling. This seems to confirm the hypothesis that industry rewards schooling more than the main omitted class, agriculture, and that men have a comparative advantage in industry. Women, on the other hand, have a comparative advantage in services. The sign and magnitude of the coefficient for GDP indicate that female schooling increases by more than male schooling when income increases, and that the increases are larger for both females and males in rural areas.

Regressions that include variables proxying Z_1, roads per square kilometer, telephone lines per capita, and post offices per square

kilometer, were also estimated. The coefficients were insignificant, and the coefficients for per capita GDP, shares of services and industry, and urbanization were left largely unchanged.[19]

The major limitation of this analysis is that the shares of each sector in a department may be jointly determined with education levels of men and women. For example, services may require more educated women than educated men, so provinces that have relatively more educated women will tend to have a larger share of services in GDP. The issue of causality between share of services and the demand for education of women is left unresolved. This is a crippling limitation for purposes of deciding policy.

I address this issue by estimating regressions by cohorts. Assuming that the sectors' shares in GDP are relatively stable across departments, the correlation between schooling and sectoral share should be stronger for younger cohorts if a higher share of services and industry *leads to* a higher demand for education. On the other hand, if education intensive activities are concentrated in areas with high exogenous education levels, this would imply uniformly strong correlations between education levels and structure of the economy across *all* age groups. The regressions discussed above indicate that the correlations are weak for older cohorts, implying support for the view that causality runs from economy structure to schooling levels, and not vice versa.

The results in this section are similar to those found in Gill and

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[19]These results, which are not reported here, are available from the author.

Khandker (1990) for a sample of about 100 countries in 1965 and 1987. Migration is likely to be more frequent within a country than across national boundaries. The similarity of results by country and by province implies that the possibility of cross-department migration does not seem to be a significant factor in schooling decisions. This issue needs more examination, though, before any conclusive statement can be made on the effects of migration on the rates of return to human capital.

Table 5

CROSS-SECTION SCHOOLING REGRESSIONS: PERU, 1985-86

Dependent Variable	Independent Variables					
	CONSTANT	PER CAP. GDP	INDUSTRY SHARE	SERVICES SHARE	DEGREE OF URBANIZN.	UNADJ. R-SQR.
			All Ages			
1.Female Total Illiteracy Rate	73.713	-0.019 (0.02)	9.196 (17.61)	-13.378 (31.28)	-0.647*** (0.15)	.817
2.Male Total Illiteracy Rate	33.479	-0.013 (0.01)	-0.584 (10.42)	-13.979 (18.49)	-0.239*** (0.09)	.714
3.Female Urban Illiteracy Rate	50.189	-0.040*** (0.02)	-8.892 (13.72)	-60.113* (17.42)		.545
4.Male Urban Illiteracy Rate	15.010	-0.012*** (0.00)	-4.410 (3.76)	-16.739*** (4.77)		.587
5.Female Rural Illiteracy Rate	86.408	-0.049* (0.03)	-3.506 (25.73)	-80.723*** (32.67)		.354
6.Male Rural Illiteracy Rate	42.407	-0.030* (0.02)	-4.380 (14.61)	-44.040*** (18.56)		.362

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table V (Continued)

CROSS-SECTION SCHOOLING REGRESSIONS: PERU, 1985-86

Dependent Variable	Independent Variables					
	CONSTANT	PER CAP. GDP	INDUSTRY SHARE	SERVICES SHARE	DEGREE OF URBANIZN.	UNADJ. R-SQR.
Population Aged 15-19 Years						
1.Female Total Illiteracy Rate	38.562	-0.012 (0.01)	-7.420 (10.10)	-26.313 (17.94)	-0.237*** (0.09)	.774
2.Male Total Illiteracy Rate	11.364	-0.004 (0.01)	-0.618 (4.04)	-5.171 (7.18)	-0.083*** (0.03)	.658
3.Female Urban Illiteracy Rate	10.945	-0.009*** (0.00)	-2.472 (2.65)	-13.242*** (3.36)		.623
4.Male Urban Illiteracy Rate	3.687	-0.002 (0.00)	-0.947 (1.42)	-3.786*** (1.80)		.280
5.Female Rural Illiteracy Rate	54.960	-0.040** (0.02)	-14.039 (15.80)	-69.955*** (20.06)		.524
6.Male Rural Illiteracy Rate	15.962	-0.015** (0.01)	0.583 (6.02)	-18.415** (7.64)		.396
Population Aged 20-24 Years						
1.Female Total Illiteracy Rate	55.657	-0.013 (0.01)	-13.596 (12.65)	-37.260* (22.46)	-0.237*** (0.11)	.816
2.Male Total Illiteracy Rate	14.941	-0.006 (0.01)	-2.693 (4.54)	-11.878* (8.07)	-0.073* (0.04)	.691
3.Female Urban Illiteracy Rate	20.624	-0.012** (0.01)	-9.157** (4.52)	-27.038*** (5.74)		.655
4.Male Urban Illiteracy Rate	4.951	-0.002 (0.00)	-2.873** (1.14)	-5.568*** (1.45)		.576
5.Female Rural Illiteracy Rate	72.187	-0.048** (0.02)	-19.606 (19.98)	-86.341*** (25.36)		.511
6.Male Rural Illiteracy Rate	18.686	-0.019** (0.01)	0.037 (7.58)	-21.900** (9.63)		.387

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table V (Continued)

CROSS-SECTION SCHOOLING REGRESSIONS: PERU, 1985-86

Dependent Variable	Independent Variab. s					
	CONSTANT	PER CAP. GDP	INDUSTRY SHARE	SERVICES SHARE	DEGREE OF URBANIZN.	UNADJ. R-SQR.
Population Aged 25-29 Years						
1.Female Total Illiteracy Rate	65.174	-0.017 (0.02)	-7.644 (15.14)	-29.348 (26.88)	-0.488*** (0.13)	.825
2.Male Total Illiteracy Rate	19.725	-0.010* (0.01)	-2.674 (5.77)	-15.610* (10.24)	-0.096* (0.05)	.718
3.Female Urban Illiteracy Rate	26.485	-0.021*** (0.01)	-7.588 (6.93)	-32.347*** (8.79)		.585
4.Male Urban Illiteracy Rate	6.026	-0.004*** (0.00)	-2.351** (1.08)	-7.235*** (1.37)		.734
5.Female Rural Illiteracy Rate	85.822	-0.056** (0.03)	-18.634 (23.83)	-97.214*** (30.26)		.483
6.Male Rural Illiteracy Rate	25.492	-0.027** (0.01)	0.314 (9.25)	-29.957** (11.74)		.452
Population Aged 30-34 Years						
1.Female Total Illiteracy Rate	84.684	-0.021 (0.03)	-18.090 (22.99)	-62.375* (40.83)	-0.451** (0.20)	.724
2.Male Total Illiteracy Rate	28.882	-0.011 (0.01)	-6.516 (8.03)	-20.340 (14.26)	-0.156** (0.07)	.738
3.Female Urban Illiteracy Rate	40.319	-0.031** (0.01)	-10.513 (12.05)	-48.771*** (15.30)		.509
4.Male Urban Illiteracy Rate	10.001	-0.005*** (0.00)	-5.422*** (1.78)	-11.570*** (2.25)		.738
5.Female Rural Illiteracy Rate	93.902	-0.059* (0.03)	-11.044 (27.84)	-94.348*** (35.35)		.397
6.Male Rural Illiteracy Rate	37.853	-0.033** (0.01)	-6.396 (12.29)	-43.207*** (15.60)		.470

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 5 (Continued)

CROSS-SECTION SCHOOLING REGRESSIONS: PERU, 1985-86

Dependent Variable	Independent Variables					
	CONSTANT	PER CAP. GDP	INDUSTRY SHARE	SERVICES SHARE	DEGREE OF URBANIZN.	UNADJ. R-SQR.
Population Aged 35-39 Years						
1.Female Total Illiteracy Rate	81.797	-0.015 (0.02)	17.634 (17.97)	4.990 (31.91)	-0.845*** (0.15)	.855
2.Male Total Illiteracy Rate	36.829	-0.012 (0.01)	-5.359 (10.29)	-19.729 (18.28)	-0.235*** (0.09)	.744
3.Female Urban Illiteracy Rate	55.197	-0.046** (0.02)	-8.302 (17.42)	-61.856*** (22.11)		.463
4.Male Urban Illiteracy Rate	12.569	-0.010*** (0.00)	-4.472* (2.71)	-13.281*** (3.44)		.667
5.Female Rural Illiteracy Rate	94.333	-0.057* (0.03)	1.534 (29.64)	-74.458** (37.63)		.294
6.Male Rural Illiteracy Rate	47.133	-0.038** (0.02)	-7.004 (15.87)	-49.919** (20.15)		.416
Population Aged 40 & More Years						
1.Female Total Illiteracy Rate	87.159	-0.018 (0.02)	41.269* (21.93)	18.442 (38.94)	-0.885*** (0.19)	.792
2.Male Total Illiteracy Rate	51.328	-0.017 (0.02)	8.004 (16.89)	-5.877 (30.00)	-0.442** (0.15)	.698
3.Female Urban Illiteracy Rate	80.244	-0.068** (0.03)	2.073 (23.09)	-86.466*** (29.32)		.487
4.Male Urban Illiteracy Rate	27.812	-0.025** (0.01)	-4.198 (8.87)	-27.254** (11.27)		.459
5.Female Rural Illiteracy Rate	94.272	-0.056* (0.03)	26.476 (30.11)	-56.789 (38.23)		.265
6.Male Rural Illiteracy Rate	62.652	-0.044* (0.02)	-0.332 (21.75)	-54.795** (27.61)		.308

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

6. CONCLUSIONS AND POLICY IMPLICATIONS

The main question addressed in this paper is: Do parents consider future labor activities when making schooling decisions for their children? To the extent that current demand for labor and remuneration reflect economic patterns in the future, the answer seems to be that they do.

The main new policy implication that emerges from this paper and from Gill and Khandker (1990) is that the expansion of the service sector raises the levels of schooling of both men and women, but has a larger effect on women. That is, both increased human capital and equity between the sexes are associated with an increase in the service sector's share in GDP, at the expense of agriculture. This is probably an intermediate stage. As this structural transformation continues, the share of the industrial sector begins to play the role that services played at the earlier stage.

This is in marked contrast to policy that emerges from well-known theories of economic growth, including Rostow (1960), Rosenstein-Rodan (1961), and others. It has been argued that in the process of growth, agriculture is the primary stage, industry the secondary stage, and services the tertiary stage. But two points should be kept in mind. First, the policies recommended here are not aimed at economic growth *per se*, but *economic growth with increases in equity across gender*. Second, the nature of the services sector is very different in low-income countries.

This policy also contradicts the World Bank's advice that developing countries need to increase the production of tradables. But at least as far as gender equity in earnings potential is concerned, it would

be better to encourage the expansion of sectors producing nontradables. Another implication of the findings in this paper is that extending schooling facilities significantly raises investment in schooling, and lowers the gender gap as well. The third implication is that information about the rates of return to schooling in home activities will raise the schooling levels of females by more than those of males.

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APPENDIX I: RESULTS OF HOUSEHOLD EXPENDITURE REGRESSIONS, 1985-86

Independent Variables	Equation 1	Equation 2
Constant	86.043 (184.04)	-179.871 (223.50)
Age of Household Head	27.226*** (8.25)	24.423* (13.28)
Age^2 of Household Head	-0.325*** (0.09)	-0.276* (0.15)
Schooling of Household Head	-8.889 (11.66)	-29.887** (14.13)
$Schooling^2$ of Household Head	5.459*** (0.70)	4.941*** (0.82)
Training of Household Head	75.001** (33.51)	61.105* (36.97)
Did Household Head Attend Public School ?	-16.308 (36.20)	35.729 (41.78)
Age of Spouse		10.090 (11.69)
Age^2 of Spouse		-0.141 (0.14)
Schooling of Spouse		47.378*** (15.14)
$Schooling^2$ of Spouse		0.351 (0.97)
Training of Spouse		108.219*** (38.99)
Did Spouse Attend Public School?		-113.510*** (41.23)
Unearned Income	0.008*** (0.00)	0.006*** (0.00)
Rural Dummy	-153.257*** (30.07)	-44.299 (35.87)
Adjusted R^2	0.192	0.244
Sample Size	4377	3325

Note: Dependent variable is total household expenditure per adult
* Significant at 10 percent, ** at 5 percent, *** at 1 percent level.
Standard errors in parentheses.

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