Human Capital, Productivity, and Labor Allocation in Rural Pakistan

Marcel Fafchamps, † *and Agnes R. Quisumbing* ††

July 1997

Last revised in March 1998

Abstract[1]

This paper investigates whether human capital affects the productivity and labor allocation of rural households in four districts of Pakistan. We find that households with better educated males earn higher off-farm income and divert labor resources away from farm activities toward non-farm work. Education has no significant effect on productivity in crop and livestock production. The effect of human capital on household incomes is partly realized through the reallocation of labor from low productivity activities to non-farm work. Female education and nutrition do not affect productivity and labor allocation in any systematic fashion, consistent with the marginal role women play in market oriented activities in Pakistan. As a by-product, our estimation approach also tests the existence of perfect labor and factor markets; this hypothesis is strongly rejected.

---

† Department of Economics, Stanford University, Stanford, CA 94305-6072. Tel.: (650) 723-3251. fafchamp@leland.stanford.edu. †† International Food Policy Research Institute, 2033 K Street, NW, Washington DC 20006. Tel.: (202) 862-5650. a.quisumbing@cgnet.com.

[1] We benefitted from conversations and comments from Harold Alderman, Elizabeth King, Takashi Kurosaki, Bénédicte de la Brière, Dean Jolliffe, Guilherme Sedlacek, two anonymous referees, and the Journal editor, and from participants at seminars at IFPRI and in the University of California at Irvine. The research assistance of Sumiter Broca and Niny Khor is gratefully acknowledged. We acknowledge financial support from the United States Agency for International Development, Office of Women in Development, Grant Number FAO-0100-G-00-5050-00, on Strengthening Development Policy through Gender Analysis, and thank IFPRI for making the data available.

The role of human capital in the development process has attracted a lot of attention since the seminal contributions of Schultz (1961), Becker (1964), and Welch (1970). Recently, growth theorists such as Romer (1986, 1990), Lucas (1988, 1993), Stokey (1988, 1991) and others (e.g., Azariadis and Drazen (1990), Ciccone (1994)) have shown that the accumulation of human capital can sustain long-term growth. These theories have received support from the empirical work of economic historians such as Fogel (1990) and from macroeconomic regression analysis emphasizing the positive role of education on growth (e.g., Mankiw, Romer and Weil (1992), Barro and Sala-i-Martin (1992, 1995)). Microeconomic evidence on this issue is both abundant and varied (see Jamison and Lau (1982), and Psacharopoulos (1984, 1989) for surveys). Although there is little doubt that better educated workers earn higher wages in the modern sector, whether education raises farm productivity remains a contentious issue. A widely-cited survey by Lockheed, Jamison and Lau (1980) summarizes 39 equations from 18 different studies in 13 countries, concluding that education has a positive effect on farm productivity. Phillips (1987) argues that these results vary substantially by geographic region. Studies from Asia support the positive and significant relationship between education and farm efficiency, but the evidence from Latin America and Africa is mixed. The purpose of this paper is to revisit this issue using a panel of rural households from Pakistan.

This paper's contribution to the literature arises from its joint treatment of two issues which have usually been treated separately: the relationship between human capital and productivity, and the choice of farm and off-farm work. While a number of studies, e. g. Jamison and Lau (1982) and the sources cited therein, examine the effects of human capital on output and outcomes, such studies do not consider the allocation of labor between farm and off-farm activities. Unlike in the works of Huffman (1980), Huffman and Lange (1989), Kimhi (1996a, 1996b), the former strand of the literature seldom considers the endogeneity of labor inputs. Following Newman and Gertler (1994), Jolliffe (1996), and Yang (1997), this paper considers not only how human capital raises productivity but also how households with different human capital endowments allocate labor to different activities.[2] Indeed, if returns to, say, education are highest in a particular activity, better educated households should reallocate their manpower to that activity. This paper also moves beyond studies that focus on either crop production (e.g., Jamison and Lau (1982) and the studies reviewed therein) or wages (e.g., Alderman et al. (1996b), Haddad and Bouis (1991), Sahn and Alderman (1988)) and examines all the market-oriented activities of the household. This enables us to decompose the effect of human capital on total household income into a labor reallocation effect and activity-specific productivity effects. Our analysis also encompasses several complementary measures of human capital, enabling us to better disentangle the effects of education from other dimensions of human capital such as nutrition and innate ability.[3] Finally, our study contains several methodological innovations that ensure that the results are robust and as free as possible from endogeneity and omitted variable bias.

---

[2] Newman and Gertler (1994) estimate a structural model of wages, marginal returns to farm work, and marginal rates of substitution for different demographic groups within the household, taking into account the jointness of production and consumption among rural landholding households in Peru. Jolliffe (1996) estimates the returns to education in farm and off-farm work, and finds that they are much higher in the latter, thus affecting the allocation of labor in Ghanaian farm households. Yang (1997) considers selectivity of better educated household members into off-farm activities in China, and finds that schooling does not contribute to physical efficiency in farming but raises off-farm wages. The best educated person in the household, however, may make farm management decisions while participating in off-farm work.

[3] The inclusion of several dimensions of human capital is a growing trend in the literature. For example, Haddad and Bouis (1991), Thomas and Strauss (1997), and Foster and Rosenzweig (1994) include individual-level calorie intake, height, and BMI in addition to education in their studies of wage determinants in the rural Philippines and urban Brazil. Alderman et al. (1996a) examine the effects of cognitive skills, BMI, and height in addition to experience and education in their work on men’s wage labor in rural Pakistan.

The paper is organized as follows. We begin in section 1 by introducing the conceptual framework underlying our work and discussing various econometric issues. The data is presented in section 2. Regression results are examined in sections 3 for income and 4 for labor. We find that households with better educated males earn higher off-farm income and divert labor resources from farm activities toward non-farm work. Education has no significant effect on productivity in crop and livestock production. The effect of human capital on household incomes is partly realized through the reallocation of labor from low to high productivity activities, i.e., non-farm work. Female education and nutrition do not affect productivity and labor allocation in any systematic fashion. This is in line with the marginal role women play in market oriented activities in Pakistan. As a by-product, our estimation approach also tests the existence of perfect labor and factor markets: this hypothesis is strongly rejected. Finally, we find evidence of fixed cost in undertaking income generating activities. Conclusions are presented at the end.

Section 1. Conceptual Framework

We begin by presenting a simple conceptual framework for evaluating the effect of human capital on productivity and labor allocation. Consider rural households who derive their livelihood from several competing income generating activities indexed by a. To each of these activities is associated a production function:

$$Y_a = g_a(L_a, X_a, T_a, Z) \tag{1}$$

where Y_a denotes income, L_a denotes labor, X_a is a vector of variable inputs, and T_a stands for tools, equipment, and other semi-fixed factors. Z is a vector of human capital characteristics of the household. Human capital may affect Y_a in a variety of ways (Jamison and Lau (1982): better nutrition increases physical strength and potentially increases labor output per unit of time (Ray (1998)); better education improves management and may raise technical and allocative efficiency (Huffman (1977)); leadership is likely to improve labor supervision skills (Frisvold (1994)). To the extent that human capital raises productivity, we expect a significant positive relationship between Y_a and Z. This possibility can be investigated by examining whether Z raises output Y_a, after controlling for inputs and factors. Human capital may raise the productivity of different inputs differently: the ability to better supervise workers and reduce shirking should raise effective labor, not add to capital or land. The same can be said about nutrition. In contrast, better management skills could raise the productivity of all inputs and factors of production. To test whether human capital is not Hicks-neutral, one can verify whether Z raises the effectiveness of L_a and T_a differently in the production of Y_a (Chambers (1988)). Human capital may increase allocative efficiency without affecting technical efficiency -- i.e., better educated or smarter individuals may choose more profitable levels of inputs. In this case, Z should affect Y_a minus input costs but not necessarily Y_a itself. Similarly, better managed households may be better at taking advantage of economies of scope between activities and hence choose a better mix of things to do (Barrett (1997)). Z might then affect the total net income of the household without necessarily affecting the Y_a production function individually.

The productivity effects of human capital can also be investigated by observing how it affects household labor and input decisions. Let household choices be represented as an optimization problem whereby available manpower $\overline{F}$ is allocated between leisure and production to maximize joint utility:[4]

[4] A collective model of the households does not seem required here given the extremely limited involvement of women in market oriented activities in rural Pakistan (e.g., Alderman and Chishti (1991), Brown and Haddad (1995), Sathar and Desai (1996)).

$$\underset{L_a,\, F_a,\, X_a}{Max} \quad U(S + \sum_a [Y_a - p\, X_a - w\, (L_a - F_a)],\, \bar{F} - \sum_a F_a) \tag{2}$$

subject to production functions (1) and to non-negativity constraints:

$$L_a - F_a \geq 0 \text{ and } F_a \geq 0 \quad \text{for } all\ a \tag{3}$$

$U(.)$ is the household's utility function defined over income and leisure. S stands for unearned income, p for the price of inputs, and w for the market wage rate. F_a stands for family labor in activity a. If markets for labor, inputs, and output are perfect, production decisions can be separated from preferences (e.g., Singh, Squire and Strauss (1986)). Profit maximization then dictates that the return to variable inputs be equated with their price:

$$\frac{\partial Y_a}{\partial X_a} = p \tag{4}$$

$$\frac{\partial Y_a}{\partial L_a} = w \tag{5}$$

Solving the above system of equations yields labor and input use equations $L_a^D = h_a(w, p, T_a, Z)$ and $X_a^D = f_a(w, p, T_a, Z)$. The effect of Z on labor and inputs can be studied by totally differentiating (4) and (5) to yield:

$$\frac{d\,L}{d\,Z} = \frac{Y_{LZ}\, Y_{XX} - Y_{LX}\, Y_{XZ}}{Y_{LX}^2 - Y_{LL}\, Y_{XX}} \tag{6}$$

where we have dropped the a subscript to improve readability. Y_{LX} denotes the partial derivative of Y with respect to L and X, and similarly for other terms. A similar expression can be derived for dX/dZ. Marginal returns to individual inputs are, as usual, assumed to be decreasing, i.e., Y_{LL} and Y_{XX} are negative. The denominator of equation (6) is the second order condition, which must be negative at an interior optimum. Equation (6) thus shows that, if Y_{LZ}, Y_{XZ}, and Y_{LX} are all non-negative, labor use must go up with Z. In other words, if human capital raises the marginal productivity of either labor or variable inputs or both, then it should also raise labor use provided variable inputs increase marginal returns to labor. The same holds for variable inputs X. We have no *a priori* reason to suspect that variable inputs reduce marginal returns to labor in the farm and non-farm activities of rural Pakistani households. Consequently we expect labor and variable input use to go up if human capital raises their productivity.

The situation is somewhat different if labor markets are imperfect. In this case, de Janvry, Fafchamps and Sadoulet (1991) have shown that household choices can be represented as a system of labor demand and supply with endogenous shadow cost of labor w^*. The factors that influence w^* can be identified by noting that utility maximization yields a household labor supply of the form:

$$\sum_a F_a = F(w^*, S + w^* \bar{F} + \sum_a \Pi^a(w^*, T_a)) \qquad (7)$$

where $\Pi^a(.)$ is the profit function associated with activity a. If leisure is a normal good, the derivative of $F(.)$ with respect to w^* is positive and that with respect to income is negative. With these assumptions, factors that raise income also raise the shadow cost of labor w^*: to see why, totally differentiate (7) with respect to w^* and, say, unearned income S while keeping total labor use $\sum_a F_a$ constant. We get:

$$\frac{d\,w^*}{d\,S} = -\frac{F_Y}{F_w} \qquad (8)$$

which is positive if the partial derivative of family labor supply with respect to income and wage F_Y and F_w are negative and positive, respectively. Other factors that reduce family labor supply exert a similar upward pressure on the shadow wage w^*. The allocation of family labor to activity a thus depends, through w^*, on household manpower $\bar{F}$, unearned income S, and productive assets in other activities T_a (e.g., Evenson (1978), de Janvry, Fafchamps and Sadoulet (1991)). Reduced forms for the labor and input use equations $L_a^D = h_a(w^*, p, T_a, Z)$ and $X_a^D = f_a(w^*, p, T_a, Z)$ can be estimated by replacing w^* with a function of the household's manpower stock $\bar{F}$, unearned income S, and all its productive assets.

Comparing the models with and without perfect markets also yields a number of testable predictions.[5] First, if markets are perfect and $w^* = w$, labor and input in activity a should depend only on wages, prices, and semi-fixed factors in that activity, not on unearned income and on household characteristics such as household size and composition. These ideas are at the basis of tests of perfect markets and allocative efficiency conducted by Benjamin (1992) and Udry (1996). Second, if markets are perfect, productive assets T_a should only have an income effect on household labor supply and the sign of T_a and non-earned income in the labor supply equation should be the same. In contrast, if markets are imperfect, T_a may raise returns to labor and hence family labor supply even when non-earned income S lowers it. Finally, if markets are perfect and economies of scope are absent, factors that raise returns to labor in one activity should have no effect on labor use in another activity. Consequently, if schooling increases returns to labor in off-farm but not farm work, this should reduce labor use in farm work only if markets are imperfect.[6]

---

[5] Although we focus here on imperfections in the labor market, it is well known that efficient allocation of productive resources -- and hence separability between production decisions and consumption preferences -- only requires that $N-1$ markets be perfect, where N is the number of productive factors; see for instance Udry (1996) and Gavian and Fafchamps (1996). In rural Pakistan, land transactions are even less frequent than labor transactions so that it is natural to think of land as a semi-fixed factor and to focus the discussion on labor markets.

[6] In case we find evidence of market imperfections, it would be interesting to uncover the source of the imperfection. Our data on rural Pakistan indicate that most surveyed households are self-sufficient in labor and supply very little agricultural labor to the market. This situation is not unusual in poor developing countries (e.g., Cleave (1974), Fafchamps (1993)). One possible explanation suggested in the theoretical literature is the need to supervise hired workers (e.g., Eswaran and Kotwal (1986), Dutta, Ray and Sengupta (1989), Feder (1985), Frisvold (1994)). This idea can be formalized by postulating that the effectiveness of labor depends on the share of total labor supplied by the household itself, i.e., by letting:

Section 2. Characteristics of Surveyed Households

The data on which our analysis is based come from 12 rounds of a household survey conducted by the International Food Policy Research Institute (IFPRI) in four districts of Pakistan between July 1986 and September 1989 (see Nag-Chowdhury (1991) for details). A panel of close to 1000 randomly selected households in 44 randomly selected villages were interviewed a total of 12 times at roughly 3 to 4 months intervals on a variety of issues ranging from incomes, agricultural activities, and labor choices to anthropometrics, education, land, and livestock (see Adams and He (1995), Alderman and Garcia (1993)).[7] Responses to these questions were combined by the authors to generate a consistent data set containing annual information about household composition, income, assets, inherited land, human capital, and labor. All asset variables refer to the beginning of the year.

The basic characteristics of the surveyed households are presented in Table 1. The median household size is 8 people, half of which are adults. Sources of income are quite varied. Crops account for about one fourth of average income; livestock accounts for another 15%. Non-farm earned income -- a mix of wages and self-employment income from crafts, trade, and services -- represents 30% of average income; rental income and remittances amount to another 30%. Agricultural wage income is negligible among

---

$$L_a^* = L_a \left(\frac{F_a}{L_a}\right)^{\gamma_a} \tag{9}$$

where L_a^* denotes effective labor and L_a is total labor in man-days. Parameter γ_a measures the importance of supervision: if $\gamma_a = 0$, hired labor is as effective as household labor; if $\gamma_a > 0$, household labor is more effective than hired labor, suggesting that labor supervision is problematic for hired-in workers. Whether issues of labor supervision are the reason behind market imperfections can thus be investigated by adding an F_a/L_a term to the production function equation and testing whether its coefficient is positive and significant.

[7] Two additional rounds of surveys were subsequently conducted on the same households in 1990 and 1991 but differences in questionnaire design prevented data integration.

sample households. As already noted by Alderman and Garcia (1993) and by Adams and He (1995), livestock and non-farm income are more equally distributed than crop income, rental income, or remittances. On average, households own 8 acres of land, half of which is either canal or well irrigated. The median is much smaller, however, indicating that land is unequally distributed. The data also shows large differences among households in inherited land and in the amount of land owned by the father of the head. These two variables, in addition to the education of the father and mother of the household head, are used throughout as proxies for family background.

Each year is divided into two distinct cropping seasons, kharif and rabi, which differ in terms of rainfall and cropping patterns. The main crop during the drier rabi season, from mid-October to mid-April, is wheat, whereas the main crop during kharif, from mid-April to mid-October, is rice. To avoid aggregation bias, we treat each season separately. Hired labor -- mostly male -- accounts on average for as little as 2.6% and 8.5% of total labor devoted to cultivation in the kharif and rabi seasons, respectively. 91% of kharif farmers and 89% of rabi farmers do not use any hired labor. The use of outside help is somewhat higher at harvest time: it accounts for 21.5% and 23.6% of total labor for kharif and rabi, respectively. Households spend roughly as much time herding as they do in crop production. Surveyed households do not report employing any wage worker for either herding or non-farm activities. Although surveyed households use some hired labor for crop production, they spend very little time hiring themselves out as laborers. The sample may thus underrepresent farm laborers who are the poorest segments of rural society.[8] Wage work in non-farm activities is common, though. Male

[8] Panel surveys have a tendency to underrepresent wage laborers who are typically more mobile than farming households and have a higher probability of dropping out of subsequent survey rounds. The resulting attrition bias is not explicitly addressed in this paper due to the absence of suitable instruments,

members of the household do 84% of the crop work, 99% of herding, and 95% of non-farm work. This is largely a consequence of *purdah*,[9] a system of secluding women, restricting them from moving into public places and enforcing high standards of female modesty upon them. This system limits women's mobility outside the home and restricts their participation in market work.[10] Women work mostly in or around the home.

Human capital variables are presented in Table 2. They include: experience proxied by age and age squared; education measured in years of schooling; innate ability measured by Raven's test scores; childhood nutrition measured by height; and current nutritional status measured by the body mass index or BMI.[11] As measure of experience we use age and age squared rather than years of post-schooling wage work because, unlike in Alderman et al. (1996b), rates of school attendance are extremely low among older adult males and among adult females. Age and age squared are also more appropriate to capture life-cycle effects. Years of schooling is a measure of formal investment in human capital. Raven's (1956) Colored Progressive Matrices Test involves the recognition of changes in patterns across a series of four pictures. It was initially developed to measure abstract thinking ability among illiterate children and has been widely used as a proxy for intelligence among illiterate adults in developing countries (e.g., Knight and Sabot (1990)). While abstract thinking ability, or ability to learn, is different from formal

---

but it should be kept in mind when interpreting the results.

[9] See Ibraz (1993) and Jefferey (1979). Although *purdah* is now seen by many Pakistanis as a religious obligation prescribed by Islam, it was practiced by Muslims and Hindus alike before the partition of India. In his study of Punjab in the 1920's, for instance, Darling (1925) notes that Hindu Rajputs were the most dedicated to the practice, 'a status symbol for which they pay dearly [in terms of wasted manpower and reduced profits]'.

[10] Because of *purdah*, respondents are likely to have underreported female participation in market oriented work.

[11] See Strauss and Thomas (1995) for a comprehensive review of attempts to account for various dimensions of human capital in measuring labor markets, health, and nutrition outcomes.

instruction, it can be affected by schooling. Since parents may choose to educate only those children with academic potential, years of schooling is likely to be correlated with innate ability. Raven's test scores thus reflect both innate ability and schooling. The explanatory power of Raven's test, conditional on years of schooling, is its ability to measure innate ability.[12]

Height and body mass index (BMI) proxy health and nutrition aspects of human capital. The BMI is defined as weight (in kilograms) divided by height (in meters) squared, a commonly used measure of fitness and nutritional status. Combined with other simple anthropometric measurements such as height, it has been shown to be a good predictor of muscular mass and physical strength among populations of developing countries (e.g., Conlisk et al. (1992)). Height, when evaluated for adults, captures the cumulative effects of childhood and adolescent nutrition as well as genetic endowments. Unlike BMI, it is not subject to short-term fluctuations. In this paper, we use only adult height to minimize endogeneity, i.e., the possibility that taller parents may have taller offspring. We also investigate the possible endogeneity of current BMI by using lagged BMI in the sensitivity analysis.[13]

---

[12] Years of schooling also influences achievement as measured in test scores, e.g., Glewwe and Jacoby (1994). The impact of test scores on rural labor market outcomes in Pakistan has been investigated by Alderman et al. (1996b). We do not use the math and reading scores because of the much lower number of valid observations.

[13] We also experiment with self-reported days of illness as a measure of health status. While it is true that illness episodes may affect both the amount and efficiency of labor supplied, self-reported illness has been argued to be contaminated by self-reporting biases, with higher-income or more educated individuals more likely to report being ill (e.g., Sindelar and Thomas (1993)). Illness episodes may also be correlated with factors which affect individuals' long-term productivity; a large literature on illness shows that the probability of illness is higher among less wealthy and less educated families (e.g, Akin, Guilkey and Popkin (1992)). For these reasons, we treat the available information on sick days with caution. Labor allocation regressions with illness days are available at the following website: http://www-leland.stanford.edu/~fafchamp.

Two separate sets of human capital variables are constructed for each household. In the first set, individual characteristics are averaged by gender over all household members 20 years old and above, irrespective of their relationship to the head of household. The second set contains only information about the head of household and his wife.[14] By construction, the second set exists only for households with both a head and at least one wife.[15] The reason for constructing this second set is twofold. First, using average human capital of adult males and females may mask variations within these categories. Indeed, the head of the household and his wife are likely to have more decision making power than other household members. Second, household averages may be subject to endogeneity bias: the prosperity and genes of the parents may be reflected in their offspring, thereby opening the door to a reverse causation between productivity and household-based human capital averages. Although less vulnerable to such problems, husband and wife human capital are only partial measures and therefore subject to measurement error. Moreover, if marriage market selection exists, characteristics of husbands and wives are likely to be correlated (e.g., Foster (1995)). Since neither measure is perfect, our analysis is conducted using both and we regard results about human capital as robust when they are present in both formulations. Following Jolliffe (1997) and Yang (1997), an alternative measure, the schooling of the most educated male or female in the household, is also used in the sensitivity analysis.

The two sets of variables are summarized in Table 2. The average head has spent 2.8 years in school; the median is zero. Female members of the household have a much lower level of education than males. 40% of males have no education, vs. 86% for

[14] In case of polygamous households, we take the average over all wives.
[15] There are less than 1% female-headed households in the sample.

females. They also get a significantly lower score on Raven's test of progressive matrices, a test supposed to measure innate ability irrespective of literacy level. This may be attributed to socially acquired attitudes by which women 'try less hard' to perform than men, compounded by less familiarity with formal tests due to their lack of schooling (e.g., Alderman et al. (1996a)). The correlation coefficient between years of schooling and Raven's test score is fairly low, however: .43 for men, .28 for women. The sample population is short and, with average BMI's as low as 20.4 for males and 21 for females, only marginally well fed. Although women are less educated than men and rank lower in Raven's test, they have a higher BMI: the t-test statistic for equality of means between male and female BMI's is highly significant (6.99 with 1776 degrees of freedom for male and female averages; 6.81 with 1441 degrees of freedom for head and wife). This is a common result due to the fact that women are shorter and have more body fat as a proportion of body weight (e.g., Gibson (1990)); it does not indicate that women in the sample are better fed than men. The nutritional status of males and females within the same household appear unrelated: the coefficient of correlation between average male and female BMI's is .17. Women report less days lost to sickness, but we suspect that this may be due to self-reporting bias: women spend most of their time within the home where being sick is less disruptive and less noticeable. In contrast, men do all the work outside the home where their ability to work would suffer from reduced mobility and where sickness is harder to accommodate within one's routine.

Section 3. Testing the Productivity of Human Capital

We now test whether human capital raises productivity in any of the four activities in which the surveyed farmers are involved: kharif and rabi crop production; livestock raising; and non-farm work. We proceed in two steps. In this section, we estimate production functions for the four activities and examine whether human capital has a significant effect on productivity. In section 4 we turn to labor allocation and estimate labor demand and supply equations.

Crop Income

Our choice of a suitable functional form for the production functions is guided by two considerations: adequacy and parsimony. Consider crop production first. Since our main concern is to estimate the effect of human capital on productivity, we focus on a simple Cobb-Douglas formulation with three essential inputs: land, labor, and farm tools. No crop output can be obtained when any of these inputs is absent.[16] In contrast to land, tools, and labor, inputs such as fertilizer, draft power, or pesticides are not essential since some output can be obtained without them. Non-essential inputs can be thought of as raising the effectiveness of essential inputs. For instance, expenditures on fertilizer and other chemical inputs X_a are likely to raise the productivity of land. To the extent that certain characteristics of land are in fixed supply and cannot be substituted for by chemical inputs, X_a is expected to raise the productivity of land in a decreasing fashion. A simple parameterization that captures all these ideas is to assume that the contribution of land to total output can be represented as $A_a\,(1+X_a)^{\delta_a}$: if $\delta_a = 0$, X_a does not add to effective land; if $\delta_a > 0$, land measured in efficiency units rises with X_a. A similar reasoning can be followed for human capital variables Z and for other non-essential inputs.

[16] Observations for which crop income is reported but no labor or cultivated acreage are treated as cases with missing labor or land information; they are excluded from the regression analysis. Observations with no recorded crop output are also omitted from the regressions: we suspect that many of them are pasture and fodder crops harvested by the animals themselves, and should thus be regarded as observations with unrecorded output.

Aggregation of different qualities of inputs must also be dealt adequately. Crops can be produced on rainfed or irrigated land. Although land itself is essential for crop production, neither rainfed nor irrigated land are individually essential. Yet the productivity of land is likely to vary across land types. We decompose land into rainfed and irrigated and we define land in rainfed-equivalent units as $A_a^R + (1+\beta_a)\, A_a^I$ where A_a^R and A_a^I denote rainfed and irrigated cultivated acreage, respectively, and where β_a expresses the efficiency of irrigated land relative to rainfed land: if $\beta_a > 0$, A_a^I is more productive than A_a^R; if $0 > \beta_a > -1$, A_a^I is less productive than A_a^R; if $\beta_a < -1$, A_a^I is counterproductive, i.e., it subtracts from output. Estimation is greatly simplified by noting that, for any number x close to 0, $1+x$ is nearly equal to e^x. Effective land can thus be written approximatively as $A_a\, e^{\beta_a A_a^I/A_a}$. A similar approach can be used for other aggregation problems among highly substitutable inputs.

After adding the labor supervision term (see footnote 6, Section 1), the crop production function becomes:

$$Y_a = \alpha_a\, L_a^{\alpha_{aL}} \left(\frac{F_a}{L_a}\right)^{\gamma_a\, \alpha_{aL}} A_a^{\alpha_{aA}}\; e^{\alpha_{aA}\, \beta_a\, A_a^I/A_a}\; T^{\alpha_{aT}}\; (1+X_a)^{\alpha_{aX}}\; (1+B)^{\alpha_{aB}}\; e^{\lambda_a Z} \qquad (10)$$

where Y_a is the total value of crop output, A_a is planted acreage, B is the number of bullocks owned, and greek letters stand for parameters to be estimated. Given that Y_a cannot be negative and follows an approximatively log-normal distribution, it is natural to postulate multiplicative disturbances. Equation (10) is estimated by ordinary least squares after taking logs of both sides.

There are twelve human capital variables used in the estimation, 6 for males and 6 for females. As discussed in Section 2, they are: age and age squared, years of schooling, Raven's test score, height, and BMI.[17] To control for possible omitted variable bias in the

[17] Sickness days are not included because much of their effect is already captured by the labor variable.

human capital variables, we add four variables that control for family background. They are: the land owned by the head's father; the land inherited by the household; the education of the head's father; and the education of the head's mother. Including these variables should reduce fears that observed correlation between human capital and productivity in fact captures the effect of family background. For instance, individuals whose father was farming or who inherited more land probably received more exposure to farming (e.g, Rosenzweig and Wolpin (1985)) and thus may enjoy higher returns farm productivity thanks to returns to specific experience. Similarly, if children from landed households are better fed and educated than those from landless families but family background is not controlled for, human capital variables may capture the effect of exposure to farming, not that of human capital itself. Returns to education might also be overestimated if parents' education is ignored from the analysis.

Estimation results for kharif crop output and rabi crop output are reported in the first two columns of Table 3. We also estimate a combined (annual) crop output regression to investigate the possibility that human capital increases a household's ability to allocate resources among seasons without raising its productivity within each season separately. Results are presented in the last column. Two sets of regressions are run in each case, one using the average human capital of the household, the other using only the human capital of the head and his wife. The latter set offers a less complete representation of the human capital of the household, but it is not subject to the omitted variable bias that would arise if better able couples have both higher incomes and better fed, better educated children. For the sake of brevity, however, these results are not shown here.[18] Village fixed effects

[18] Complete results are available at the web site http://www-leland.stanford.edu/~fafchamp.

are included in all regressions to control for systematic differences due to soil, weather, and market conditions. To minimize the bias naturally resulting from correlation between harvesting labor and yield -- a good harvest requires more labor to gather crops in the field -- harvesting labor is excluded from the labor variable. Labor thus includes only the reported labor for land preparation, irrigation, and cultivation. Robust standard errors with household clustering are reported to correct for the possible correlation between disturbances within each household. The number of households is reported at the bottom of the table.

Results indicate that human capital variables are, in general, non-significant. Households with taller adult males appear to achieve higher output in the kharif season; higher BMI of adult males is associated with higher output in kharif and rabi. These effects, however, do not carry over to total crop output. Age and Raven's test scores are non-significant in all regressions, suggesting that experience and innate ability are not important determinants of crop output in the survey areas once we control for schooling. Better educated males obtain a lower output in the rabi season, but the effect of schooling on total crop output is positive and marginally significant. The effect vanishes, however, if only the education of the head of household is considered (not shown). These results suggest that, if schooling has an effect on crop output, it is achieved essentially by neglecting the drier rabi season, not by raising productivity *per se*. Father's schooling is positively associated with rabi output, but only when the head's own schooling is negatively significant. Taken together, our results are consistent with evidence indicating that returns to schooling are low in Third World agriculture (e.g., Rosenzweig (1980), Jolliffe (1996)) but are in contrast with the conclusions reached by Jamison and Lau (1982). Estimates of the supervision parameter γ_a are positive but not significant in any of the regressions, suggesting that, if supervision costs are present, they are not large. This result is in contrast to the findings reported by Frisvold (1994) who finds that supervised labor in rural India is significantly less productive than family labor.

Since our findings regarding the lack of effect of human capital on crop output contradict the conclusions of Jamison and Lau (1982) and run contrary to much of the recent literature on human capital and growth, we conduct an extensive sensitivity analysis. First, we examine whether households with more human capital choose more efficient combinations of purchased inputs even though they face the same production function: if smarter farmers are better able to equate marginal returns with marginal input costs, their net income from crop production should be higher even though their production function is the same (e.g., Chambers (1988)). To check for this possibility, we replace total crop revenues with crop income net of variable costs as the dependent variable. Imputed labor costs are not included since more than 90% of (non-harvest) crop labor is provided by the household. Since net crop income can be negative, the assumption of multiplicative errors in equation (10) is replaced with additive errors and equation (10) is estimated via non-linear least squares. Results[19] (not shown) generally confirm previous results: factors of production have the expected sign and are highly significant, but schooling has no effect on net crop incomes.

Second, we investigate whether the non-significant effect of schooling is due to the fact that the management gains from schooling are a household public good: as long as a single member of the household is educated, he or she can help the others make better production decisions (e.g., Jolliffe (1997)). To test this hypothesis, we replace average

[19] Detailed results are available at the following web site: http://www-leland.stanford.edu/˜fafchamp.

schooling with the maximum education level attained by an adult male or female member of the household. Results (not shown) do not change: schooling either has a negative (rabi) or non significant (kharif, combined) effect on output. Third, we reestimate crop output regressions with household random effects to control for possible omitted variable bias, i.e., that there exist household specific disturbances correlated with human capital that bias the estimated coefficient of human capital on output. Results are qualitatively unaffected. We repeat the exercise with household fixed effects; in this case, none of the human capital variables is significant.[20] Fourth, we reestimate equation (10) by instrumental variables using the determinants of household labor supply (see section 4) as instruments; they include family composition, owned land, livestock assets, and non-earned income. The resulting production function estimates (not shown) tend to be smaller and less significant for all factors of production, suggesting that our instruments, although highly significant, are not sufficiently precise. Human capital variables are, in general, non-significant, except for height of adult males in kharif.

Fifth, we investigate whether the reported effect of BMI on crop output may be due to endogeneity bias -- better harvest means more food available and hence better nutrition. To reduce the potential bias, we reestimate the crop production function with lagged BMI, which implies losing one third of the observations. Results show no significant relationship between lagged adult BMI and crop output. This suggests that endogeneity bias may be responsible for the spurious correlation between BMI and crop output reported in Table 3. Schooling is negatively significant in rabi, non-significant otherwise. Sixth, we

[20] When household fixed effects are included, village fixed-effects and household-level time invariant such as family background variables are dropped. Variations in average human capital from year to year reflect variations in household composition more than anything else.

investigate whether human capital is non-neutral in the sense that it raises the effectiveness of certain inputs more than others. To do so, we reestimate equation (10) with interaction terms between essential inputs and key human capital variables. Results do not invalidate previous results. In the rabi season, male schooling is shown to raise the efficiency of land but to decrease total productivity even more, so that the total effect is negative, as in Table 3. Annual crop output is not affected by male schooling.

Finally, it is possible that our estimates of the productivity of human capital are biased because certain individual traits which are correlated positively with output are correlated negatively with education or nutrition. To understand why, suppose, for instance, that individuals who derive most of their income from non-farm activities neglect farming in ways that are hard to measure, e.g., by planting or irrigating late, supervising labor less effectively, and in general applying less care to their fields. If better educated males work more off farm, an omitted variable bias arises that depresses the estimated effect of schooling on crop productivity. To correct this bias, we use the labor allocation regressions to identify the omitted variable and control for its effect on productivity.[21] The details of the procedure are given in Appendix 1. Results (not shown) are virtually identical to those reported in Table 3, except that schooling is no longer significant in the total crop output regression. Other human capital results are essentially unchanged. As anticipated, non-farm residuals are negative in all regressions, hence suggesting that households who invest more labor in non-farm work than predicted by the labor choice regression spend less ’quality time’ in their fields. The effect is

[21] This parallels work by Pitt, Rosenzweig and Hassan (1990) which uses residuals from a health production function in their analysis of intrahousehold food distribution, and Behrman, Birdsall and Deolalikar (1995) in their analysis of marriage market outcomes in India.

significant only in one of the kharif regressions, however.

Livestock, Non-Farm, and Total Income

We now turn to non-crop activities of the household. A production function is estimated for livestock. Essential inputs into livestock production are livestock itself and labor. Different categories of livestock are aggregated using the same approximation as for crop land, i.e., their contribution to output is decomposed into a size effect -- the number of animals -- and a herd composition effect -- $e^{\sum_i \beta_i N_i/N}$ where N_i is the number of animals in category *i*, N is total livestock, and β_i is a parameter to be estimated. Land is treated as a non-essential input since households can purchase fodder from the market; it is, however, expected to raise the productivity of livestock thanks to better and cheaper access to crop residues and fodder (see Fafchamps and Kurosaki (1997) for evidence). The livestock production function boils down to:

$$Y_b = \alpha_b L_b^{\alpha_{bL}} B^{\alpha_{bB}} e^{\sum_i \beta_i N_i/N} (1+A_o)^{\alpha_{bA}} e^{\alpha_{bI} A_o^I/A_o} e^{\lambda_b Z} + \varepsilon \qquad (11)$$

where A_o and A_o^I denote total and irrigated owned land, respectively. The labor supervision term is ignored since all herding is performed by household members. Livestock income Y_b is net of production costs and capital losses. Some 21% of livestock income observations are negative as a result of animal losses due to theft or disease. Postulating multiplicative errors is thus inappropriate. Instead, we postulate additive disturbances ε and estimate equation (11) via non-linear least squares. Households with no livestock are excluded from the regression. The same 12 categories of human capital variables are used as in the crop regressions.

Background variables are included to minimize omitted variable bias. An equivalent production function is estimated for non-farm production. To approximate non-farm capital, we use data on inventories used by the household in its trading activities. The estimated equation is thus:

$$Y_n = \alpha_n L_n^{\alpha_{nL}} K^{\alpha_{nK}} e^{\lambda_n Z} + \varepsilon \qquad (12)$$

where K denotes non-farm inventories.[22] Non-farm income Y_n is net of production costs. To control for the possibility that returns to human capital may differ in farm and non-farm labor, the negligible amounts of off-farm agricultural wages and labor recorded in the data are excluded from Y_n and L_n. Since 22% of non-farm income observations are null or negative, we again postulate additive errors ε and estimate (12) by non-linear least squares.

We also estimate a total net income regression of a form similar to those of equations (11) and (12). It includes all semi-fixed assets such as owned land, farm tools, livestock, and non-farm capital. Total labor is included as well as the share of labor devoted to crops and livestock, respectively. Since total income can be negative, equation (12) is estimated by non-linear least squares. Year and village fixed effects are included.

Estimation results for livestock, non-farm, and total income are summarized in Table 4. Village fixed effects are included in the regression but omitted from the Table. Factors of production are in general significant and have the right sign in all regressions, with the exception of inventories used for trade (a proxy for non-farm capital) which has a negative and significant sign in the total income regression. Many share parameters are

[22] In an attempt to construct a more comprehensive measure of non-farm capital, we also compute an alternative measure of non-farm capital as the sum of inventories plus the value of durables such as vehicles, refrigerators, and sewing machines, which are known to serve as the basis for numerous non-farm businesses in rural Pakistan. Because household durables are also consumption goods, however, this measure is subject to the risk of spurious correlation with income. Results using this alternative measure of non-farm capital must thus be interpreted with extreme caution.

significant as well, suggesting the presence of heterogeneity among inputs. Bullocks are significantly more productive than cattle, sheep and goats less. Year and village dummies often are significant, again emphasizing the existence of systematic income differences across space and time.

Regarding human capital, the strongest result concerns the effect of male education on non-farm and total income: it is positive in all four regressions and highly significant in three. One additional year of education is associated with an increase of non-farm earned income between 2.8 and 4.6%; the larger estimate is from the specification using only the human capital of the head and wife. One year of schooling is also estimated to raise total income by 8.9%, if average human capital is used -- but by 0.4% if only the education of the head of household is used as regressor. Female education is not significant or is negative in most of the regressions, although it is significant and positive in the total income regressions using wife's human capital (not shown) where it is estimated to increase total income by 3.6%. This suggests that the coefficient estimate may be subject to omitted variable bias. Male and female height and BMI are significant and positive in several of the regressions, suggesting that better fed households achieve higher incomes. To summarize, production regressions indicate that male education has a strong positive effect on non-farm and total income, but no or little effect on crop output. Better fed households in general achieve higher incomes, but the effect is not present in all regressions, and may reflect endogeneity of BMI. Experience, innate ability, and female education do not appear to have any robust effect on incomes.

Section 4. Human Capital and Labor Use

We now examine how human capital affects labor used in four activities: kharif and rabi crop production, herding, and non-farm work. We also examine total family labor supply. The labor and input use equations $L_a^D = h_a(w^*, p, T_a, Z)$ and $X_a^D = f_a(w^*, p, T_a, Z)$ discussed in Section 1 form the basis of our estimation strategy. Since the shadow cost of labor w^* is not observable, we include factors that influence total labor supply when markets are imperfect, namely: household size and composition; non-earned income; family background; and productive assets in other activities.[23] For kharif and rabi, the dependent variable L_a is the sum of family and hired labor. In the case of herding and off-farm work, it consists exclusively of family labor since the hiring of labor by the household was not observed in these activities. Around 37 percent of kharif and rabi labor observations are zeroes; the corresponding percentages for herding and off-farm work are 45 percent and 38 percent, respectively. The dependent variable is thus a censored variable. Latent labor use L_a^* is assumed to follow:

$$1 + L_a^* = \theta_a \, \bar{F}^{\theta_{am}} \, e^{\sum_m \beta_{am} \bar{F}_m / \bar{F}} \, O^{\theta_{aB}} \, e^{\theta_{ao} O^I/O} \, T^{\theta_{aT}} \, K^{\theta_{aK}} \, B^{\theta_{aB}} \, e^{\sum_c \theta_{ac} B_c/B} \, S^{\theta_{aS}} \, e^{\sum_u \theta_{au} S_u/S} \, e^{\theta_{aZ} Z} \, e^{\varepsilon} \qquad (13)$$

for $a = \{k, r, h, n\}$, with actual labor $L_a^* = L_a$ if $L_a > 0$. A similar equation is assumed to represent latent labor supply $F^* \equiv \sum_a F_a$. The θ's are parameters to be estimated and the disturbance term ε is assumed to be normally distributed. Variable $\bar{F}_a$ stand for the number of household members in different age/sex categories and $\bar{F} \equiv \sum_m \bar{F}_m$;[24] As with other share variables, the parameters of each of the age/sex categories indicate the

[23] Jacoby (1993) uses a different approach and derives shadow wages from marginal products estimated from a farm production function.

[24] The categories are: adult males and adult females aged 20 to 65; children aged 0-5; youth aged 6-19; and old aged 66 and above.

efficiency of that category relative to the excluded category, adult males. O is total owned land; O_I is owned irrigated land; T is farm tools; B_c is the total number of livestock in category c and $B \equiv \sum_c B_c$; S_u stands for three categories of unearned income, remittances, rental income, and pensions, with $S \equiv \sum_u S_u$; unearned income is expected to have a negative effect on labor supply.[25] Z as before denotes a vector of human capital variables and family backgroun variables. We focus our discussion on specifications without reported illness days, given the caveats regarding self-reported illness. Year and village fixed effects are included to control for location and year specific changes in climatic and market environment.

We first test whether equation (13) can be estimated using a simple tobit regression. To do so, we apply the likelihood ratio test proposed by Greene (1997), p. 970. Except for total labor, test results are all well above the χ^2 critical values. The simple tobit model is thus inappropriate: the decision to participate in a particular activity is different from the decision of how much labor to allocate to that activity, given participation. These test results are consistent with threshold effects created by fixed costs: if households must incur certain costs up front before initiating a particular income generating activities, the decision to undertake that activity will differ from that of how much labor to allocate to it conditional on having undertaken it.

Equation (13) is thus estimated using the two-step Heckman estimator used for selection models (see Maddala (1983) and Greene (1997) for details).[26] Year and village

[25] Shares variables are set to zero whenever their denominator is zero.

[26] We experienced difficulties estimating the corresponding maximum likelihood estimator due to the presence of a large number of village fixed effects.

fixed effects are included but not shown. Family background variables -- father's landholdings, inherited land, and father's and mother's education -- are used as identifying restrictions. They are preferable to unearned income since rents, pensions, and remittances may be influenced by past labor supply or asset accumulation decisions. Given that virtually all households have some kind of market oriented activity, the selection issue does not arise in the case of total family labor. Estimates are reported in Table 5 for crop labor and in Table 6 for herding, non-farm, and total labor. Similar results are obtained for the human capital of husband and wife but are not reported for the sake of brevity. Sigma stands for the estimated standard deviation of the residuals in the labor equation; Rho is the estimated correlation coefficient between the residuals in the selection and labor equations.

For crop labor (Table 5), education of adult males has a negative effect on the decision to farm during the drier rabi season, and an additional negative effect on labor use in both seasons; these results indicate that better educated males opt out of farming. Household size is not a significant determinant of whether the household farms in either season, but it has a paramount influence on the amount of labor allocated to crop production, hence providing evidence against perfect labor markets. If factor markets were complete, production decisions should indeed be separable from household characteristics affecting total labor supply (e.g., Benjamin (1992)). Ownership of bullocks affects the decision to farm, but not labor use; this again is consistent with imperfect factor markets. Indeed, one would expect households who do not own their own draft animals to be reluctant to engage in crop production if rental markets for draft animals are imperfect and unreliable (e.g., Rosenzweig and Wolpin (1993)). Ownership of bullocks thus appears a sunk cost required for successful farming.

Turning to herding and non-farm work (Table 6), we see that males with a high BMI are more likely to work in the nonfarm sector, although higher BMI does not affect days worked. However, the selection of higher BMI males into nonfarm work may reflect lower energy intensity in that activity than in farm work (Higgins and Alderman, 1997). Taller males are more likely to herd, and are more likely to work more in the nonfarm sector. Both results are consistent with the higher productivity achieved by better fed males in non-farm work and by taller men in herding (see Section 3). Together, these results indicate that nutrition has an effect on productivity and that rural households adjust their labor allocation accordingly.[27] It is remarkable that returns to nutrition, like those on education, are highest in non-farm activities; households with better educated males are less likely to herd, but are more likely to work in non-farm activities.

Unlike results regarding the human capital of adult males which are very robust, those concerning females are quite sensitive to model specification. Given the small amounts of female labor provided to crops, herding, or non-farm work, we interpret this lack of robustness as indicative of omitted variable bias and discount the results accordingly. Better-educated females are less likely to work in the farm and nonfarm sectors, although, conditional on participation, better educated females provide more time in non-farm work. The number of females participating in nonfarm work, however, is very low. Better-fed women also work less during the rabi season, and work less in the nonfarm sector. Given the marginal role that women play in market work (e.g., Brown and Haddad (1995), Alderman and Chishti (1991) and Section 2), female human capital variables

[27] This result is to be compared with that of Foster and Rosenzweig (1993) who find a positive and significant effect of calorie consumption on piece-rate harvest wages. In a later paper, Foster and Rosenzweig (1996) examine worker selection into piece-rate and time-wage contracts and find that more productive workers are likely to select piece-rate contracts.

probably capture wealth effects in a country where social prestige is attached to observing female seclusion or *purdah* (e.g., Jefferey (1979), Darling (1925)). Wealthy families are more likely to marry better educated women, feed them better, and work less because they can afford to lose an additional wage earner. Another possibility is that wealthier households educate their daughters better.

All in all, higher education of adult males is associated with less herding and farm work in both kharif and rabi seasons, but more non-farm labor. This effect is fairly strong: one additional year of schooling leads to 3.3%, 3.4%, and 2.4% less work in kharif, rabi, and herding, respectively, and to 2.0% more labor off the farm.[28] There is, therefore, agreement between the labor allocation and the productivity regressions discussed in Section 3: better educated males are more productive in non-farm work; they respond to this by reallocating their time away from less productive to more productive activities. The net effect of this reallocation on total family labor is non-significant.

Regarding the completeness of factor markets, we note that unearned income has a negative coefficient on the probability of undertaking karif and rabi labor, and decreases the number of days in herding and nonfarm work. Leisure (and, possibly, unobserved home services) is thus a normal good. In contrast, factors of production have a positive effect on labor supply:[29] households with more land and livestock work less off the farm.

---

[28] These numbers are computed using the fact that $E[L] = E[L \mid L > 0]\, Prob[L > 0]$ and, thus, that:

$$\frac{\partial E[L]}{\partial X} = \frac{\partial E[L \mid L > 0]}{\partial X}\, Prob[L > 0] + E[L \mid L > 0]\, \frac{\partial Prob[L > 0]}{\partial X}$$

$\partial E[L \mid L > 0] / \partial X$ is computed from estimated coefficients using $E[L \mid L > 0]\; \partial E[log(L) \mid L > 0] / \partial X$

[29] Strictly speaking, Tables 5 and 6 estimate labor demand regressions. Since there is no hired in labor in herding and non-farm work, however, labor demand and supply are identical. There is a small difference between family labor and total labor use in crop activities due to hired labor, but hired laborers account for such a small proportion of total cultivation labor that the results obtained using family labor supply instead of total labor use are virtually identical to those in Table 5.

As pointed out in Section 1, such configuration of parameters could only arise if factor markets are incomplete. Finally, we find that larger households spend more time in herding and non-farm activities and are more likely to engage in non-farm work. This is in line with income diversification strategies for risk smoothing: as the household adds members, it diversifies its income base (e.g., Binswanger and McIntire (1987), Bromley and Chavas (1989)).

Further evidence that better educated households opt out of farming can be found by observing how cultivated acreage and expenditures on variable inputs vary across households. Tobit regression results are presented in Table 7. They confirm that better schooled households put significantly less emphasis on farming. Long term nutrition as measured by height is positively associated with crop production: taller individuals put systematically more emphasis on crops. This result is not surprising given that working in the fields is a strenuous activity for which returns to physical strength are high. Other results of interest indicate that livestock ownership has a strong significant effect on the use of variable inputs and on cultivated acreage, thereby suggesting that economies of scope between livestock and crops exist in rural Pakistan. Households with higher non-earned (but non rental) income spend less on variable inputs. This suggests that credit constraints are not a serious obstacle to expenditures on variable inputs. Indeed, if most households faced a binding liquidity constraint, households who receive extra cash through remittances and other non-earned income would spend more on variable inputs than other households. Rather, households fortunate enough to have an external source of income tend to deemphasize crop production.

Before we conclude, it is instructive to examine the influence that human capital has on income, as predicted by estimated model parameters. Human capital has two separate effects: a direct productivity effect $\frac{\partial Y_a}{\partial Z_h}$ which is the focus of much of the empirical literature on human capital (e.g., Jamison and Lau (1982)), and an indirect labor reallocation effect $\frac{\partial Y_a}{\partial L_a} \frac{\partial L_a}{\partial Z_h}$ which we studied here (see also Jolliffe (1996)). The combined contribution of human capital to total income is the sum of the two effects over all the activities undertaken by the household:

$$\frac{\partial Y}{\partial Z_h} = \sum_a \left[\frac{\partial Y_a}{\partial Z_h} + \frac{\partial Y_a}{\partial L_a} \frac{\partial L_a}{\partial Z_h}\right] \tag{14}$$

Table 8 uses equation (14) to construct estimates of the contribution to income of one additional year of schooling for all the adult males of the household. The labor reallocation effect is computed using the formula given in footnote (28). Results illustrate the paramount role played by labor reallocation: without it, one extra year of schooling for all adult males in the household raises annual income by 1.4%. The reallocation of labor away from low productivity farming to high productivity non-farm work raises income by an additional 0.4%.[30] In other words, one fifth of the contribution of schooling to income happens through labor reallocation, a phenomenon that until now has received very little attention. In non-farm income alone, the labor reallocation effect is stronger: one third of the increase in non-farm income due to better education results from households shifting labor resources away from farming. In contrast, the total labor supply effect is quite small: as shown in Table 8, increased labor supply in response to higher marginal return to labor thanks to schooling raises total income by only 0.1%, compared to a direct effect of 8.9%. Most of the labor allocation effect on income is thus due to a pure reallocation among competing activities, not to an increase in family labor supply.

[30] This figure rises to 1.7% if simple tobit estimates are used instead of Heckman two-step estimates.

Conclusion

In this paper, we have examined how various facets of human capital affect the productivity of rural households in Pakistan. We showed that human capital can be analyzed not only through its direct effects on output and incomes, but also via its indirect effects on labor allocation. Results indicate that education raises off-farm productivity and induces rural Pakistani households to shift labor resources from farm to off-farm activities. This effect is strong, robust, and demonstrated via both the direct and indirect methods. One additional year of schooling for all adult males raises household incomes by 8.9%. One fifth of this additional income is achieved by reallocating labor away from farming and toward non-farm work. Because we have controled for background characteristics and innate ability, we can reasonably conclude that it is the skills acquired in school that raise the productivity of adult males in rural non-farm work, not their innate intelligence or the wealth of their parents with which education is often correlated.

Although wife's education does have a positive and significant effect on total income, the effect of female human capital on productivity is not robust. The beneficial effect of education accrues mostly to males. Using market-oriented activities as sole criterion, female education seems to be a wasted investment in rural Pakistan.[31] This is hardly surprising, given that schooling raises labor productivity in activities that are off-limit to women. Purdah thus appears as the major culprit for low returns to female education. These low returns, in turn, probably explain the extreme gender gap that has

[31] It can be argued, however, that there are social gains to female education (e.g., Subbarao and Raney (1995)) even in countries with low female labor force participation. These gains occur through reductions in infant mortality and fertility with increases in female education. A recent study for Pakistan shows that these externalities can be considerable: an additional year of school for 1,000, at an estimated cost of 30,000 US dollars, would increase wages by 20 percent and prevent 60 child deaths, 500 births, and three maternal deaths (e.g., Summers (1992)).

historically been found in Pakistani education (e.g., The World Bank (1996), Sawada (1997)).[32] Other dimensions of human capital such as better nutrition are important too. Height, a proxy for nutrition in childhood and adolescence, was shown to raise productivity and labor effort in livestock production. These effects are again confined to male adults; no systematic and robust relationship was uncovered between female nutrition and market oriented activities in rural Pakistan.

Our analysis provides strong evidence against the perfect labor and factor market hypothesis. This stands in contrast to the work of Benjamin (1992) but agrees with other empirical works (e.g., Gavian and Fafchamps (1996), Udry (1996)). It is also in line with much of the development literature in which incomplete markets are regarded as part of the economic landscape in Third World rural communities (e.g., de Janvry (1981), Feder (1985), Eswaran and Kotwal (1986), Bardhan (1984), Basu (1997)).

One may be tempted to see in our results a micro-economic justification for the recent emphasis on human capital accumulation as an engine of growth (e.g., Romer (1986, 1990), Lucas (1988)). Such interpretation is unwarranted. Our analysis is a partial equilibrium analysis that investigates how better nutrition and education raised household income and affected labor allocation in rural Pakistan. These results were obtained in the context of a rural labor market with a very low supply of educated people and a mediocre nutritional status in general. In such an environment it is not surprising that a few stronger and better skilled individuals prosper by providing a handful of goods and services that require literacy and strength. It would therefore be misleading to take our partial equilibrium numbers and infer from them that the return to schooling at the

[32] Recent evidence nevertheless suggests that the gap has begun to close (e.g., The World Bank (1996)).

national level is as high as 8.9%. With these words of caution, it is nevertheless encouraging to find robust evidence that human capital helps households improve their livelihood.

Appendix 1: Correction for Unobserved Productivity Effects

The idea behind the correction mechanism is that households who neglect farming because they are heavily involved in livestock or non-farm activities have large positive residuals in the labor allocation regressions (see section 4). These residuals can be included in the production function estimation to identify the effect of unobserved productivity in non-farm and livestock on crop output, after correction for the fact that labor is a censored variable. Formally, let y_i and ε_i denote the ith observation of the dependent variable and the ith residual in any of the income equations, respectively. Similarly, let z_i and u_i denote the dependent variable and the residuals in the tobit labor choice equation, respectively. The regressors in the y_i and z_i are denoted x_i and w_i, respectively. The residuals are assumed normally distributed. Their standard deviations are written σ_ε and σ_u, respectively; ρ is the correlation coefficient between the two. In case $z_i > 0$, we have:

$$\begin{aligned} E[y_i \mid x_i, u_i] &= \beta' x_i + E[\varepsilon_i \mid u_i] \\ &= \beta' x_i + \rho \frac{\sigma_\varepsilon}{\sigma_u} u_i \qquad (15) \end{aligned}$$

In case $z_i = 0$, we get:

$$\begin{aligned} E[y_i \mid x_i, u_i] &= \beta' x_i + E[\varepsilon_i \mid u_i \leq -\alpha' w_i] \qquad (16) \\ &= \beta' x_i + \int_{-\infty}^{-\alpha' w} \varepsilon_i \, f(\varepsilon_i \mid u_i) \, d\varepsilon_i \end{aligned}$$

which, by application of Theorem 20.4 in Greene (1997), p.975, is equivalent to:

$$= \beta' x_i - \rho \sigma_\varepsilon \frac{\phi\left(\frac{\alpha' w_i}{\sigma_u}\right)}{1 - \Phi\left(\frac{\alpha' w_i}{\sigma_u}\right)} \qquad (17)$$

where $\phi(.)$ and $\Phi(.)$ denote the probability function and cumulative distribution function of a standard normal variable. All production and income regressions are reestimated with selection/effort correction terms constructed by replacing u_i, σ_u, $\phi(.)$, and $\Phi(.)$ in equations (16) and (17) by their predicted values from tobit labor choice regressions.[33] Two selection/effort correction terms are constructed, one for livestock and one for non-farm labor. This approach is similar in spirit to the use of inverse Mills ratio to control for self-selection bias (e.g., Heckman (1976), Maddala (1983)), except that the selection equation is a tobit, not a probit.

[33] As indicated in the next section, the complete tobit results can be found at the following website: http://www-leland.stanford.edu/~fafchamp.

References

Adams, R. H. and He, J. J., *Sources of Income Inequality and Poverty in Rural Pakistan*, Research Report 102, IFPRI, Washington D.C., 1995.

Akin, J. S., Guilkey, D. K., and Popkin, B. M., ‘‘A Child Health Production Function Estimated From Longitudinal Data,’’ *Journal of Development Economics*, 38(2): 323-351, 1992.

Alderman, H. and Chishti, S., ‘‘Simultaneous Determination of Household and Market-Oriented Activities of Women in Rural Pakistan,’’ *Research in Population Economics*, 7: 245-265, Jai Press, Greenwich, CT, 1991.

Alderman, H. and Garcia, M., *Poverty, Household Food Security, and Nutrition in Rural Pakistan*, International Food Policy Research Institute, Research Report Vol. 96, Washington, D.C., 1993.

Alderman, H., Behrman, J. R., Ross, D. R., and Sabot, R., ‘‘Decomposing the Gender Gap in Cognitive Skills in a Poor Rural Economy,’’ *Journal of Human Resources*, 31 (1): 229- 254, 1996a.

Alderman, H., Behrman, J. R., Ross, D. R., and Sabot, R., ‘‘The Returns to Endogenous Human Capital in Pakistan’s Rural Wage Labour Market,’’ *Oxford Bulletin of Economics and Statistics*, 58 (1): 29-55, 1996b.

Azariadis, C. and Drazen, A., ‘‘Threshold Externalities in Economic Development,’’ *Quarterly J. Econ.*, CV: 501-526, 1990.

Bardhan, P., *Land, Labor and Rural Poverty*, Columbia U.P., New York, 1984.

Barrett, C. B., ‘‘How Credible Are Estimates of Peasant Allocative, Scale, or Scope Efficiency? A Comment,’’ *Journal of International Development*, 9(2): 221-229, 1997.

Barro, R. J. and Sala-i-Martin, X., ‘‘Convergence,’’ *J. Polit. Econ.*, 100: 223-251, 1992.

Barro, R. J. and Sala-I-Martin, X., *Economic Growth*, McGraw Hill, New York, 1995.

Basu, K., *Analytical Development Economics: The Less Developed Economy Revisited*, MIT Press, Cambridge, Mass., 1997.

Becker, G. S., *Human Capital. A Theoretical and Empirical Analysis, With Special Reference to Education*, Columbia University Press, New York, 1964.

Behrman, J. R., Birdsall, N., and Deolalikar, A., ‘‘Marriage Markets, Labor Markets and Unobserved Human Capital: An Empirical Exploration for South-Central India,’’ *Economic Development and Cultural Change*, 43 (3): 585-601, April 1995.

Benjamin, D., ‘‘Household Composition, Labor Markets, and Labor Demand: Testing for Separation in Agricultural Household Models,’’ *Econometrica*, 60(2): 287-322, March 1992.

Binswanger, H. P. and McIntire, J., ‘‘Behavioral and Material Determinants of Production Relations in Land-Abundant Tropical Agriculture,’’ *Econ. Dev. Cult. Change*, 36(1): 73-99, Oct. 1987.

Bromley, D. W. and Chavas, J., ‘‘On Risk, Transactions, and Economic Development in the Semiarid Tropics,’’ *Economic Development and Cultural Change*, 37(4): 719-736, July 1989.

Brown, L. and Haddad, L., *Time Allocation Patterns and Time Burdens: A Gendered Analysis of Seven Countries*, International Food Policy Research Institute, Washington, D.C., 1995.

Chambers, R. E., *Applied Production Analysis*, Cambridge University Press, New York, 1988.

Ciccone, A., *Human Capital and Technical Progress: Stagnation, Transition, and Growth*, Department of Economics, Stanford University, Stanford, January 1994. (mimeo).

Cleave, J., *African Farmers: Labor Use in the Development of Smallholder Agriculture*, Praeger, 1974.

Conlisk, E. A., Haas, J. D., Martinez, E. J., Flores, R., Rivera, J. D., and Martorell, R., ‘‘Prediction of Body Composition from Anthropometry and Bioimpedance in Marginally Undernourished Adolescents and Young Adults,’’ *American Journal of Clinical Nutrition*, 55: 1051-1059, 1992.

Cragg, J., ‘‘Some Statistical Models for Limited Dependent Variables With Applications to the Demand for Durable Goods,’’ *Econometrica*, 39: 829-844, 1971.

Darling, M. L., *The Punjab Peasant in Prosperity and Debt*, Oxford University Press, London, 1925.

de Janvry, A., *The Agrarian Question and Reformism in Latin America*, John Hopkins University Press, Baltimore, 1981.

de Janvry, A., Fafchamps, M., and Sadoulet, E., ‘‘Peasant Household Behavior with Missing Markets: Some Paradoxes Explained,’’ *Economic Journal*, 101(409): 1400-1417, November 1991.

Dutta, B., Ray, D., and Sengupta, K., ‘‘Contracts With Eviction in Infinitely Repeated Principal-Agents Relationships,’’ *The Economic Theory of Agrarian Institutions*, P. Bardhan (ed.), Clarendon Press, Oxford, 1989.

Eswaran, M. and Kotwal, A., ‘‘Access to Capital and Agrarian Production Organization,’’ *Economic Journal*, 96(382): 482-498, June 1986.

Evenson, R. E., ‘‘Time Allocation in Rural Philippine Households,’’ *Amer. J. Agric. Econ.*, p. 322-330, May 1978.

Fafchamps, M., ‘‘Sequential Labor Decisions Under Uncertainty: An Estimable Household Model of West-African Farmers,’’ *Econometrica*, 61(5): 1173-1197, September 1993.

Fafchamps, M. and Kurosaki, T., *Insurance Market Efficiency and Crop Choices in Pakistan*, Department of Economics, Stanford University, Stanford, March 1997. (mimeograph).

Feder, G., ''The Relation Between Farm Size and Farm Productivity,'' *Journal of Development Economics*, 18 (2-3): 297-314, August 1985.

Fin, T., and Schmidt, P., ''A Test of the Tobit Specification Against an Alternative Suggested by Cragg,'' *Review of Economics and Statistics*, 66: 174-177, 1984.

Fogel, R. W., *The Conquest of High Mortality and Hunger in Europe and America: Timing and Mechanisms*, National Bureau of Economic Research, Cambridge, MA, 1990.

Foster, A., *Analysis of Household Behavior When Households Choose Their Memmbers: Marriage-Selection and Human Capital Allocations in Rural Bangladesh*, Department of Economics, University of Pennsylvania, Philadelphia, December 1995. (mimeograph).

Foster, A. and Rosenzweig, M., *Comparative Advantage, Information, and the Allocation of Workers to Tasks: Evidence From an Agricultural Labor Market*, Department of Economics, University of Pennsylvania, 1996. (mimeograph).

Foster, A. D. and Rosenzweig, M. R., ''Information, Learning, and Wage Rates in Low-Income Rural Areas,'' *Journal of Human Resources*, 28 (4): 759-790, 1993.

Foster, A. D. and Rosenzweig, M. R., ''A Test for Moral Hazard in the Labor Market: Contractual Arrangements, Effort, and Health,'' *Rev. Econ. Stat.*, 76(2): 213-227, May 1994.

Frisvold, G. B., ''Does Supervision Matter? Some Hypothesis Tests Using Indian Farm-Level Data,'' *Journal of Development Economics*, 43(2): 217-238, April 1994.

Gavian, S. and Fafchamps, M., ''Land Tenure and Allocative Efficiency in Niger,'' *American Journal of Agricultural Economics*, 78: 460-471, May 1996.

Gibson, R. S., *Principles of Nutritional Assessment*, Oxford University Press, Oxford, 1990.

Glewwe, P. and Jacoby, H., ''Student Achievement and Schooling Choice in Low-Income Countries: Evidence From Ghana,'' *Journal of Human Resources*, 29(3): 843-864, 1994.

Greene, W. H., *Econometric Analysis*, Prentice Hall, Upper Saddle River, NJ, 1997. Third Edition.

Haddad, L. and Bouis, H., ''The Impact of Nutritional Status on Agricultural Productivity: Wage Evidence From the Philippines,'' *Oxford Bulletin of Economics and Statistics*, 53 (3): 45-68, 1991.

Heckman, J., ''The Common Structure of Statistical Models of Truncation, Sample Selection, and Limited Dependent Variables and a Simple Estimator for Such Models,'' *Annals of Economic and Social Measurements*, 5: 475-492, 1976.

Higgins, P. and Alderman, H., ‘‘Labor and Women’s Nutrition: The Impact of Work Effort and Fertility on Nutritional Status in Ghana,’’ *Journal of Human Resources*, 32(3): 577-595, Summer 1997.

Huffman, W. E., ‘‘Allocative Efficiency: The Role of Human Capital,’’ *Quarterly Journal of Economics*, 91(1): 59-79, 1977.

Huffman, W. E., ‘‘Farm and Off-Farm Work Decisions: The Role of Human Capital,’’ *Review of Economics and Statistics*, 62 (1): 14-23, 1980.

Huffman, W. E. and Lange, M. D., ‘‘Off-Farm Work Decisions of Husbands and Wives: Joint Decision Making,’’ *Review of Economics and Statistics*, 71 (3): 471-480, 1989.

Ibraz, T. S., ‘‘The Cultural Context of Women’s Productive Invisibility: A Case Study of a Pakistani Village,’’ *Pakistan Development Review*, 32 (1): 101-125, 1993.

Jacoby, H., ‘‘Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra,’’ *Review of Economic Studies*, 60 (4): 903-921, 1993.

Jamison, D. T. and Lau, L. J., *Farmer Education and Farm Efficiency*, Johns Hopkins University Press, Baltimore, 1982.

Jefferey, P., *Frogs in a Well: Indian Women in Purdah*, Zed Press, London, 1979.

Jolliffe, D., *The Impact of Education in Rural Ghana: Examining Productivity and Labor Allocation Effects*, Princeton University and The World Bank, July 1996. (mimeograph).

Jolliffe, D., *Whose Education Matters in the Determination of Household Income: Evidence from a Developing Country*, Food Consumption and Nutrition Division Discussion Paper No. 39, International Food Policy Research Institute, Washington, D.C., November 1997.

Kimhi, A., ‘‘Farmers’ Time Allocation Between Farm Work and Off-Farm Work and the Importance of Unobserved Group Effects: Evidence from Israeli Cooperatives,’’ *Agricultural Economics*, 14 (2): 135-142, 1996a.

Kimhi, A., ‘‘Off-Farm Work Decisions of Farm Couples: Estimating Structural Simultaneous Equations With Ordered Categorical Dependent Variables,’’ *American Journal of Agricultural Economics*, 78 (3): 687-698, 1996b.

Knight, J. B. and Sabot, R. H., *Education, Productivity, and Inequality: The East African Natural Experiment*, Oxford University Press, New York, 1990.

Lockheed, M. E., Jamison, D. T., and Lau, L. J., ‘‘Farmer Education and Farm Efficiency: A Survey,’’ *Economic Development and Cultural Change*, 29 (1): 37-76, October 1980.

Lucas, R. E., ‘‘On The Mechanics of Economic Development,’’ *J. Monetary Econ.*, 22: 3-42, 1988.

Lucas, R. E., ‘‘Making a Miracle,’’ *Econometrica*, 61(2): 251-272, March 1993.

Maddala, G., *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, Cambridge, 1983.

Mankiw, N. G., Romer, D., and Weil, D. N., ‘‘A Contribution to the Empirics of Economic Growth,’’ *Quarterly J. Econ.*, CVII: 407-437, 1992.

Nag-Chowdhury, D., *Pakistan Rural Household Survey. Documentation of Primary Files*, International Food Policy Research Institute, Washington, D.C., August 1991.

Newman, J. and Gertler, P., ‘‘Family Productivity, Labor Supply, and Welfare in a Low Income Country,’’ *Journal of Human Resources*, 29 (4): 989-1026, 1994.

Phillips, J. M., ‘‘A Comment on Farmer Education and Farm Efficiency: A Survey,’’ *Econ. Development & Cult. Change*, 35(3): 637-644, April 1987.

Pitt, M. M., Rosenzweig, M. R., and Hassan, M. N., ‘‘Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries,’’ *Amer. Econ. Rev.*, 80(5): 1139-1156, December 1990.

Psacharapolous, G., ‘‘Returns to Education: A Further International Update and Implications,’’ *Journal of Human Resources*, 20 (4): 583-604, 1989.

Psacharopoulos, G., ‘‘The Contribution of Education to Economic Growth: International Comparisons,’’ *International Comparisons of Productivity and Causes of the Slowdown*, J. W. Kendrick (ed.), Ballinger Publishing Company, Cambridge, MA, 1984.

Raven, J., *Guide to the Coloured Progressive Matrices (Sets A, Ab, B)*, Lewis, London, 1956.

Ray, D., *Development Economics*, Princeton University Press, Princeton, NJ, 1998.

Reardon, T., ‘‘Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa,’’ *World Development*, 25(5): 735-747, May 1997.

Romer, P. M., ‘‘Increasing Returns and Long-Run Growth,’’ *Journal of Political Economy*, 94 (5): 1002-1037, October 1986.

Romer, P. M., ‘‘Endogenous Technological Change,’’ *J. Polit. Econ.*, 98 (5) pt.2, 1990.

Rosenzweig, M. R., ‘‘Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labor Supply in a Developing Country,’’ *Quarterly Journal of Economics*, 94 (1): 31-56, February 1980.

Rosenzweig, M. R. and Wolpin, K. I., ‘‘Specific Experience, Household Structure, and Intergenerational Transfers: Farm Family Land and Labor Arrangements in Developing Countries,’’ *Quarterly J. Econ.*, 100, Supplement: 961-987, 1985.

Rosenzweig, M. R. and Wolpin, K. I., ‘‘Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income

Countries: Investments in Bullocks in India,'' *J. Polit. Econ.*, 101(2): 223-244, 1993.

Sahn, D. and Alderman, H., ''The Effects of Human Capital on Wages, and the Determinants of Labor Supply in a Developing Country,'' *Journal of Development Economics*, 29 (2): 157-183, 1988.

Sathar, Z. and Desai, S., *Work Patterns in Rural Pakistan: Intersections Between Gender, Family, and Class*, Population Council Working Paper No. 90, Islamabad, Pakistan, 1996.

Sawada, Y., *Income Risks, Gender, and Human Capital Investment in Rural Pakistan*, Department of Economics, Stanford University, Stanford, July 1997. (mimeograph).

Schultz, T. W., ''Investment in Human Capital,'' *Amer. Econ. Rev.*, LI(1): 1-17, March 1961.

Sindelar, J. and Thomas, D., *Measurement of Child Health: Maternal Response Bias*, Economic Growth Center Discussion Paper No. 633, Yale University, 1993.

Singh, I., Squire, L., and Strauss, J., *Agricultural Household Models: Extensions, Applications and Policy*, World Bank, Washington, D.C., 1986.

Stokey, N. L., ''Learning by Doing and the Introduction of New Goods,'' *J. Polit. Econ.*, 96(4): 701-17, 1988.

Stokey, N. L., ''Human Capital, Product Quality, and Growth,'' *Quarterly J. Econ.*, 106: 587-616, 1991.

Strauss, J. A. and Thomas, D., ''Human Resources: Empirical Modeling of Household and Family Decisions,'' *Handbook of Development Economics*, T.N. Srinivasan and Jere Behrman, Eds., North Holland, Amsterdam, 1995.

Subbarao, K. and Raney, L., ''Social Gains From Female Education: A Cross-National Study,'' *Economic Development and Cultural Change*, 44 (1): 105-128, 1995.

Summers, L., *Investing in All the People: Educating Women in Developing Countries*, EDI Seminar Paper 45, The World Bank., Washington, D.C., 1992.

The World Bank, *Improving Basic Education in Pakistan: Community Participation, System Accountability, and Efficiency*, The World Bank, Washington, D.C., 1996.

Thomas, D. and Strauss, J., ''Health and Wages: Evidence on Men and Women in Urban Brazil,'' *Journal of Econometrics*, 77(1): 159-185, March 1997.

Udry, C., *Efficiency and Market Structure: Testing for Profit Maximization in African Agriculture*, Department of Economics, Northwestern University, Evanston, June 1996. (mimeograph).

Welch, F., ''Education in Production,'' *Journal of Political Economy*, 78 (1): 35-39, 1970.

Yang, D. T., ''Education and Off-Farm Work,'' *Economic Development and Cultural Change*, 45 (3): 613-632, 1997.

Table 1. Sample Summary Statistics

Household composition:	Nber obs.	Sample mean	Median	Standard deviation
Total household size	2509	8.7	8	4.3
Adult males (20-65)	2509	2.0	2	1.2
Adult females (20-65)	2509	1.8	1	1.1
Young (6-20)	2509	3.1	3	2.3
Children (0-5)	2509	1.6	1	1.6
Old (>65)	2509	0.3	0	0.6
Income (in 1986 Rupees)				
Total income (1)	2202	29457	20584	34635
Net crop income	2202	7355	2138	21420
Net livestock income	2202	4566	3643	6176
Wages from agricultural work	2202	287	0	1210
Non-farm earned income	2202	8823	6036	10067
Rental income	2202	3876	0	14879
Remittances and transfers (2)	2202	4573	0	17427
Assets:				
Total land owned in acres (3)	2526	8.4	2.0	18.4
Irrigated land owned in acres	2526	3.8	0.0	9.7
Rainfed land owned in acres	2526	2.9	0.0	10.2
Total land owned by father in acres	2299	11.7	0.5	29.8
Inherited land in acres	2299	5.1	0.0	15.5
Value of farm tools and equipment in rupees	2374	9054	1011	27359
Number of cattle	2526	2.0	1	2.7
Number of buffaloes	2526	1.8	0	2.6
Number of bullocks	2526	0.3	0	0.8
Number of donkeys	2526	0.2	0	0.7
Number of sheep and goats	2526	2.9	2	4.9
Labor in days:				
Kharif family labor	2526	70	27	106
Rabi family labor	2526	46	20	68
Kharif hired labor	2526	7	0	38
Rabi hired labor	2526	7	0	26
Herding labor	2526	135	36	250
Agricultural wage labor	2526	0	0	7
Non-farm labor	2526	214	141	265

(1) Water tax is deducted from total income. (2) 96% of received transfers are remittances (3) Difference between total land and irrigated and rainfed land is non-cultivable land — mostly pastures.

Table 2. Human Capital Summary Statistics

Husband and wife	Nber obs.	Sample mean	Median	Standard deviation
Age of head	2436	48.2	47.0	13.7
Years of education of head	2436	2.8	0.0	4.1
Raven's test of head	1951	19.3	19.0	6.7
BMI of head	1950	20.4	20.0	3.1
Height of head	2395	167.3	168.0	6.5
Average days ill of head	2441	15.0	1.0	33.3
Age of wife (1)	2242	41.5	40.0	12.1
Years of education of wife (1)	2242	0.3	0.0	1.5
Raven's test of wife (1)	1884	14.5	14.0	5.1
BMI of wife (1)	1876	21.2	20.5	4.0
Height of wife (1)	2014	152.4	152.0	6.5
Average days ill of wife	2253	6.2	0.0	15.1
Household averages				
Average age of adult males	2497	38.0	37.0	8.6
Average years of education of adult males	2497	3.7	2.5	3.9
Average Raven's test of adult males	2075	20.1	19.5	6.2
Average BMI of adult males	1987	20.4	20.0	2.9
Average height of adult males	2426	167.4	167.5	6.1
Average days ill of adult males	2457	11.1	1.0	27.3
Average age of adult females	2493	37.1	36.0	8.2
Average years of education of adult females	2493	0.6	0.0	1.6
Average Raven's test of adult females	2165	14.7	14.0	4.9
Average BMI of adult females	2198	21.0	20.7	3.5
Average height of adult females	2322	152.4	152.0	6.2
Average days ill of adult females	2394	5.8	0.0	13.7

(1) In polygamous households, average over all wives.

Table 3. Crop Production Function Estimation

Dependent variable is the log of the deflated value of crop output. Estimator is ordinary least squares with village fixed effects. Zero land and zero labor observations have been eliminat(e)
Robust standard errors with household clusters are reported.

	Kharif output		Rabi output		Total crop output	
Factors of Production	Coef.	t	Coef.	t	Coef.	t
Cultivated acreage	0.323	**4.712**	0.402	**6.545**	0.419	**4.014**
Share of irrigated acreage	0.478	**1.853**	-0.125	-0.570	0.104	0.289
Value of farm tools	0.116	**3.387**	0.038	1.384	-0.013	-0.280
Number of bullocks	0.397	**3.561**	0.211	**2.680**	0.371	**3.072**
Cultivation labor	0.190	**3.623**	-0.049	-1.265	0.155	**2.282**
Share of family labor	0.099	0.445	0.104	0.535	0.311	0.991
Input expenditures (log+1)	0.209	**4.080**	0.221	**3.715**	0.621	**6.106**
Human capital						
Males:						
Age	-0.015	-0.388	0.015	0.590	-0.041	-0.963
Age squared	0.000	0.219	-0.000	-0.703	0.001	1.149
Years of education	0.011	0.630	-0.022	**-1.930**	0.037	**1.771**
Raven's test score	0.011	1.358	-0.003	-0.473	-0.007	-0.701
Height	0.017	**2.105**	0.006	0.979	0.008	0.790
BMI	0.016	1.046	0.022	**1.978**	-0.017	-0.801
Females:						
Age	0.033	0.878	-0.008	-0.301	-0.009	-0.242
Age squared	-0.000	-0.927	0.000	0.263	-0.000	-0.127
Years of education	0.050	1.360	-0.034	-1.181	-0.082	-1.564
Raven's test score	-0.012	-1.288	0.003	0.402	-0.006	-0.486
Height	0.003	0.341	0.004	0.716	-0.005	-0.440
BMI	-0.003	-0.256	-0.000	-0.020	-0.017	-0.826
Family background						
Land owned by father (log+1)	-0.056	-1.364	0.031	0.798	-0.072	-1.028
Inherited acres (log+1)	0.020	0.344	0.028	0.660	0.140	1.579
Father's schooling	0.006	0.131	0.067	**1.847**	-0.045	-0.620
Mother's schooling	-0.274	-1.162	0.062	0.411	0.008	0.019
Shifters						
Dummy for 1986	-0.434	**-3.078**	-0.276	**-3.185**	-0.756	**-4.623**
Dummy for 1987	-0.247	**-1.892**	-0.476	**-5.697**	-1.078	**-5.916**
Intercept	0.459	0.185	4.536	**3.100**	4.088	1.481
Number of observations	677		752		1013	
Number of households	404		413		480	
R-squared	0.7231		0.5919		0.5226	

All values are in 1986 rupees. (log+1) means that the regressor is computed as Log(x+1) to avoid losing zero observations. t and F statistics in bold are significant at the 10% level or better.

Table 4. Livestock, Non-Farm, and Total Income Regressions
Estimator is non-linear least squares. Village fixed effects included but not shown.

	Livestock net income		**Non-farm net earned income**		**Total earned income**	
Factors of production	Coeff.	t	Coeff.	t	Coeff.	t
Total labor	0.026	**2.363**	0.590	**22.225**	0.101	**2.965**
Share of crop labor					-0.098	-0.877
Share of livestock labor					-0.050	-0.541
Number of livestock	0.903	**16.645**			0.344	**7.109**
Share of bullocks	0.806	**5.782**			-0.316	-1.105
Share of buffaloes	-0.061	-0.190			-0.534	**-5.237**
Share of donkeys	-0.516	-1.255			0.263	0.796
Share of sheept and goats	-0.417	**-2.808**			-0.876	**-6.815**
Total land (1)	-0.174	**-4.827**			0.182	**5.312**
Share of irrigated land (1)	0.106	1.124			-0.164	-1.766
Value of farm tools					0.093	**5.610**
Trading inventories			0.011	**3.020**	-0.033	**-4.428**
Human capital						
Adult males						
Age	-0.031	-1.510	-0.002	-0.175	0.021	0.976
Age squared	0.000	1.706	-0.000	-0.393	-0.001	-1.948
Years of education	0.009	0.896	0.028	**4.442**	0.089	**10.116**
Raven's test score	-0.008	-1.566	0.006	1.665	0.009	1.860
Height	0.022	**4.039**	-0.005	-1.700	0.025	**4.941**
BMI	0.045	**4.298**	0.005	0.913	0.034	**3.292**
Adult females						
Age	-0.009	-0.456	-0.026	**-2.107**	-0.033	-1.523
Age squared	0.000	0.416	0.000	1.561	0.000	0.837
Years of education	-0.077	**-2.495**	-0.016	-1.442	-0.006	-0.382
Raven's test score	-0.000	-0.058	0.002	0.644	0.044	**6.833**
Height	0.019	**3.433**	-0.001	-0.259	-0.042	**-8.617**
BMI	0.016	1.990	0.018	**3.994**	0.061	**8.827**
Family background						
Father's holding (log+1)	-0.005	**-2.186**	0.000	0.477	-0.001	-0.803
Inherited land (log+1)	0.004	1.158	0.002	1.618	0.002	0.902
Father's education	-0.110	**-3.467**	-0.013	-0.739	-0.045	**-2.038**
Mother's education	1.266	**9.043**	0.195	**3.506**	0.185	1.805
Shifters						
Dummy for 1986	-0.021	-0.268	0.111	**2.896**	-0.424	**-6.356**
Dummy for 1987	0.172	**2.212**	0.096	**2.514**	-0.344	**-5.540**
Intercept	0.000	0.705	0.862	1.198	1.403	0.742
Number of observations	1303		1451		1392	
R-squared	0.396		0.638		0.685	

(1) In the livestock regression, land is cultivated acreage; in the total earned income equation, land is owned acreage.

Table 5. Estimation of Crop Labor Use With Selection Correction

Estimator is 2-step Heckman procedure. Village fixed effects included but not shown.
Human capital variables are household averages.

	Kharif labor				Rabi labor			
	Selection		Days worked		Selection		Days worked	
Household composition	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Household size (log)	0.242	1.414	0.484	**5.058**	0.030	0.178	0.424	**4.828**
Adult females (share)	-1.227	-1.558	-0.482	-1.087	-0.948	-1.195	-0.874	**-2.128**
Children (share)	-1.106	**-1.897**	-0.825	**-2.515**	-0.484	-0.836	-1.172	**-3.908**
Young (share)	-1.050	**-1.947**	-0.566	**-1.961**	-0.336	-0.625	-0.535	**-2.011**
Old(share)	-3.269	**-3.292**	-1.238	**-2.354**	-1.981	**-2.033**	-2.124	**-4.396**
Human capital								
Adult males								
Age	-0.065	-1.514	-0.006	-0.241	-0.053	-1.241	-0.032	-1.452
Age squared	0.001	1.294	0.000	0.187	0.001	1.204	0.000	1.400
Years of education	-0.021	-1.060	-0.023	**-2.252**	-0.034	**-1.765**	-0.021	**-2.276**
Raven's test score	-0.003	-0.286	0.003	0.642	0.003	0.308	-0.005	-0.948
Height	0.006	0.680	-0.003	-0.519	0.018	**1.950**	0.010	**2.128**
BMI	0.007	0.390	-0.015	-1.364	-0.000	-0.008	0.001	0.126
Adult females								
Age	0.058	1.333	-0.015	-0.603	0.022	0.513	-0.025	-1.129
Age squared	-0.001	-1.451	0.000	0.693	-0.000	-0.790	0.000	1.112
Years of education	-0.061	**-1.689**	-0.047	**-2.098**	-0.088	**-2.417**	-0.010	-0.469
Raven's test score	0.037	**2.835**	-0.005	-0.725	0.027	**2.088**	-0.007	-1.163
Height	-0.000	-0.015	-0.001	-0.123	-0.002	-0.248	0.001	0.160
BMI	0.004	0.258	0.001	0.111	0.020	1.246	-0.014	**-1.698**
Factors and inputs								
Total owned land (log+1)	0.346	**4.167**	0.010	0.294	0.249	**3.042**	0.077	**2.512**
Share of irrigated land	0.182	0.973	0.149	1.517	0.354	**1.883**	0.005	0.057
Value of farm tools (log+1)	0.124	**3.638**	0.087	**3.701**	0.168	**5.008**	0.049	**2.284**
Number of livestock (log+1)	0.572	**6.952**	0.345	**6.856**	0.596	**7.194**	0.340	**7.531**
Share of buffaloes	0.136	0.734	-0.238	**-2.088**	-0.051	-0.282	-0.038	-0.354
Share of bullocks	2.297	**3.288**	0.060	0.211	1.075	**1.783**	0.183	0.699
Share of donkeys	-0.960	**-1.788**	0.012	0.028	-0.069	-0.139	-0.397	-1.169
Share of sheep and goats	-0.575	**-3.108**	-0.612	**-4.910**	-0.568	**-3.107**	-0.221	**-1.933**
Non-farm capital	-0.028	**-1.776**	0.001	0.126	-0.043	**-2.868**	0.015	1.536
Family background								
Father's holding (log+1)	0.180	**2.383**			0.141	**1.917**		
Inherited land (log+1)	-0.129	-1.362			-0.040	-0.422		
Father's education	-0.098	**-1.730**			-0.080	-1.396		
Mother's education	-0.131	-0.648			0.001	0.004		
Non-earned income								
Total unearned (log+1)	-0.064	**-3.973**	-0.029	**-3.319**	-0.033	**-2.053**	-0.006	-0.797
Share of rental income	-0.737	**-4.366**	-0.077	-0.788	-0.845	**-5.034**	-0.218	**-2.467**
Share of pension income	0.605	**1.928**	0.040	0.211	0.029	0.094	0.087	0.496
Shifters								
Dummy for 1986	0.334	**2.444**	0.436	**5.232**	0.106	0.772	0.021	0.282
Dummy for 1987	-0.540	**-4.113**	-0.870	**-10.455**	-0.343	**-2.587**	-0.061	-0.822
Intercept	-1.014	-0.424	3.987	**2.851**	-2.724	-1.116	3.072	**2.393**
Selection terms								
Tan(Rho * Pi/2)	0.347	**3.369**			-0.095	**.**		
Log(Sigma)	-0.169	**-6.205**			-0.240	**-10.412**		
Rho	0.333				-0.095			
Sigma	0.845				0.787			
Number of observations	1385				1385			
Log-likelihood	-1711.6				-1652.1			

Table 6. Estimation of Livestock and Non-farm Labor Use With Selection Correction

Except for total labor, estimator is 2-step Heckman procedure. Tobit is used for total labor. Village fixed effects included but not sh
Human capital variables are household averages.

	Herding labor				Non-farm labor				Total labor	
	Selection		Days worked		Selection		Days worked		Days worked	
Household composition	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Household size (log)	-0.011	-0.085	0.360	**3.146**	0.798	**5.829**	0.522	**6.356**	0.835	**9.323**
Adult females (share)	-1.520	**-2.407**	-1.889	**-3.240**	-0.425	-0.680	-1.368	**-3.535**	-1.441	**-3.447**
Children (share)	-1.285	**-2.734**	-1.490	**-3.162**	-1.040	**-2.215**	-1.348	**-4.764**	-1.746	**-5.651**
Young (share)	-0.457	-1.071	-1.039	**-3.035**	-0.951	**-2.284**	-0.882	**-3.403**	-1.088	**-3.930**
Old(share)	-1.746	**-2.261**	-1.808	**-2.711**	-1.355	**-1.796**	-1.074	**-2.247**	-2.168	**-4.316**
Human capital										
Adult males										
Age	-0.022	-0.630	-0.022	-0.791	-0.021	-0.625	-0.021	-1.020	-0.024	-1.076
Age squared	0.000	0.844	0.000	0.832	0.000	0.378	0.000	1.111	0.000	1.145
Years of education	-0.033	**-2.071**	0.000	0.007	0.029	**1.958**	0.006	0.669	0.009	0.860
Raven's test score	-0.005	-0.677	-0.009	-1.371	0.008	0.985	-0.011	**-2.162**	-0.001	-0.268
Height	0.013	**1.717**	0.002	0.260	0.007	0.916	0.008	**1.690**	0.012	**2.409**
BMI	0.003	0.186	-0.010	-0.799	0.043	**2.746**	0.010	1.065	0.010	0.963
Adult females										
Age	-0.002	-0.055	-0.016	-0.598	-0.063	**-1.874**	-0.002	-0.086	-0.027	-1.206
Age squared	-0.000	-0.236	0.000	0.389	0.001	**1.881**	0.000	0.258	0.000	1.042
Years of education	-0.006	-0.189	-0.013	-0.517	-0.068	**-2.156**	0.029	**1.658**	-0.072	**-3.425**
Raven's test score	-0.007	-0.726	0.005	0.643	0.001	0.147	-0.011	**-1.823**	-0.004	-0.633
Height	-0.002	-0.297	0.007	1.068	-0.003	-0.425	-0.001	-0.183	-0.002	-0.363
BMI	-0.014	-1.136	0.005	0.443	-0.001	-0.083	-0.020	**-2.650**	-0.013	-1.622
Factors and inputs										
Total owned land (log+1)	0.089	1.460	-0.046	-1.160	-0.070	-1.236	0.073	**2.576**	0.016	0.391
Share of irrigated land	-0.053	-0.362	0.192	**1.713**	0.033	0.237	-0.400	**-4.689**	-0.074	-0.784
Value of farm tools (log+1)	-0.035	-1.267	-0.017	-0.663	-0.064	**-2.178**	0.000	0.024	0.009	0.486
Number of livestock (log+1)	0.495	**7.359**	0.396	**3.588**	-0.413	**-6.033**	-0.094	**-2.324**	0.165	**3.730**
Share of buffaloes	0.386	**2.514**	-0.106	-0.678	-0.096	-0.625	-0.058	-0.617	0.033	0.324
Share of bullocks	0.527	1.308	0.947	**2.549**	-0.063	-0.154	0.048	0.188	0.120	0.422
Share of donkeys	0.400	0.848	0.215	0.564	0.509	1.131	0.095	0.339	0.215	0.681
Share of sheep and goats	-0.162	-1.037	-0.363	**-2.637**	0.613	**3.665**	0.128	1.373	-0.056	-0.534
Non-farm capital	-0.025	**-1.827**	-0.004	-0.335	0.028	**1.932**	0.036	**4.655**	0.022	**2.445**
Family background										
Father's holding (log+1)	0.009	0.158			-0.046	-0.969			0.004	0.117
Inherited land (log+1)	-0.024	-0.339			-0.069	-1.235			-0.045	-1.044
Father's education	-0.097	**-1.929**			0.085	**1.940**			-0.039	-1.244
Mother's education	-0.097	-0.418			0.105	0.505			0.364	**2.718**
Non-earned income										
Total unearned (log+1)	-0.000	-0.030	-0.031	**-3.243**	-0.044	**-3.589**	-0.024	**-3.216**	-0.046	**-5.646**
Share of rental income	0.103	0.765	0.179	**1.705**	0.207	1.552	0.148	**1.792**	0.001	0.010
Share of pension income	-0.214	-0.796	0.417	**1.901**	0.237	0.830	0.107	0.713	0.156	0.885
Shifters										
Dummy for 1986	0.681	**5.825**	-0.857	**-6.105**	0.136	1.194	0.056	0.811	0.153	**2.013**
Dummy for 1987	0.412	**3.791**	-0.933	**-8.374**	0.174	1.558	0.227	**3.434**	-0.152	**-2.069**
Intercept	0.177	0.089	5.404	**3.267**	0.427	0.213	5.637	**4.594**	4.713	**3.569**
Selection terms										
Tan(Rho * Pi/2)	0.031	0.066			-1.040	**.**				
Log(Sigma)	-0.190	**-6.876**			-0.291	**-13.616**				
Rho	0.031				-0.778					
Sigma	0.827				0.748				0.936	
Number of observations	1385				1385				1385	
Log-likelihood	-1662.3				-1744.4				0.112	(*)

(*) Pseudo R-square

Table 7. Tobit Regression on Crop Expenditures and Cultivated Acreage
Village fixed-effects included but not shown. Household average human capital used.

	Expenditures on variable inputs				**Cultivated acreage**			
	Kharif season		*Rabi season*		*Kharif season*		*Rabi season*	
Household composition	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Household size (log)	-0.012	-0.047	0.299	0.941	0.142	1.585	0.172	**2.044**
Adult females (share)	-1.687	-1.386	-2.828	**-1.899**	-0.631	-1.531	-0.334	-0.853
Children (share)	-1.121	-1.245	-1.563	-1.422	-0.638	**-2.108**	-0.518	**-1.807**
Young (share)	-1.221	-1.515	-1.873	**-1.906**	-0.665	**-2.479**	-0.230	-0.910
Old(share)	-3.292	**-2.224**	-3.968	**-2.197**	-0.086	-0.180	-0.100	-0.220
Human capital								
Adult males								
Age	-0.026	-0.393	0.078	0.963	-0.029	-1.326	-0.026	-1.232
Age squared	0.000	0.183	-0.001	-0.937	0.000	1.415	0.000	1.352
Years of education	-0.041	-1.358	-0.084	**-2.301**	-0.019	**-1.873**	-0.034	**-3.628**
Raven's test score	0.001	0.072	0.004	0.203	0.002	0.406	0.003	0.684
Height	0.024	**1.688**	0.056	**3.208**	0.011	**2.220**	0.017	**3.685**
BMI	0.029	0.964	0.011	0.293	-0.002	-0.200	0.008	0.830
Adult females								
Age	0.054	0.807	0.023	0.282	0.003	0.124	-0.016	-0.751
Age squared	-0.001	-0.935	-0.000	-0.460	-0.000	-0.235	0.000	0.579
Years of education	-0.048	-0.768	-0.031	-0.406	-0.021	-0.930	-0.017	-0.810
Raven's test score	0.081	**4.229**	0.047	**1.991**	0.001	0.143	-0.003	-0.534
Height	-0.000	-0.006	0.002	0.095	-0.001	-0.142	0.001	0.247
BMI	0.045	**1.848**	0.006	0.202	0.000	0.010	0.010	1.246
Factors and inputs								
Total owned land (log+1)	0.319	**2.735**	0.471	**3.308**	0.182	**4.804**	0.148	**4.175**
Share of irrigated land	1.031	**3.769**	1.442	**4.336**	-0.334	**-3.635**	-0.259	**-2.967**
Value of farm tools (log+1)	0.544	**9.373**	0.684	**9.630**	0.110	**4.822**	0.116	**5.424**
Number of livestock (log+1)	1.369	**10.526**	1.379	**8.703**	0.242	**5.163**	0.233	**5.361**
Share of buffaloes	0.498	**1.660**	0.428	1.166	-0.204	**-1.960**	-0.141	-1.414
Share of bullocks	2.298	**2.862**	1.158	1.182	-0.458	**-1.841**	0.002	0.010
Share of donkeys	-1.112	-1.161	-0.003	-0.002	-0.468	-0.963	0.000	0.001
Share of sheep and goats	-1.388	**-4.317**	-1.016	**-2.605**	-0.428	**-3.554**	-0.304	**-2.761**
Non-farm capital	0.008	0.224	0.045	1.049	-0.028	**-2.246**	-0.004	-0.326
Share of shop inventory	-2.097	**-4.984**	-2.346	**-4.561**	0.137	0.832	0.010	0.063
Family background								
Father's holding (log+1)	0.301	**2.882**	0.314	**2.471**	0.015	0.458	0.009	0.293
Inherited land (log+1)	0.117	0.922	0.023	0.149	0.027	0.700	0.041	1.094
Father's education	-0.124	-1.332	-0.078	-0.683	-0.054	**-1.705**	-0.027	-0.863
Mother's education	0.811	**2.095**	0.572	1.205	-0.076	-0.512	0.164	1.128
Non-earned income								
Total unearned (log+1)	-0.059	**-2.502**	-0.052	**-1.800**	-0.006	-0.714	-0.009	-1.240
Share of rental income	-0.950	**-3.598**	-1.565	**-4.852**	-0.001	-0.016	-0.196	**-2.296**
Share of pension income	0.119	0.229	-0.881	-1.395	-0.346	**-1.922**	-0.155	-0.920
Shifters								
Dummy for 1986	-0.452	**-2.026**	-0.297	-1.097	0.003	0.042	-0.116	-1.599
Dummy for 1987	-0.307	-1.432	-0.823	**-3.147**	0.109	1.426	-0.019	-0.274
Intercept	-8.065	**-2.085**	-14.652	**-3.105**	-1.068	-0.826	-3.069	**-2.503**
Selection-term	2.578		3.120		0.700		0.694	
Number of observations	1338		1338		895		983	
Censored	322		369		102		109	
Non-censored	1016		969		793		874	
Pseudo R-square	0.1791		0.1387		0.2473		0.2289	

Table 8. Predicted Effect of Male Education on Earned Income

In percentages:	**Kharif**	**Rabi**	**Livestk**	**Nonfarm**	**Total (1)**	**Total (2)**
Productivity effect (a)	1.1%	-2.2%	0.9%	2.8%	1.4%	
Share of labor in activity (b)	19.0%	0.0%	2.6%	59.0%		
Labor use (c)	-3.3%	-3.4%	-2.4%	2.0%		
Labor allocation effect (d)	-0.6%	0.0%	-0.1%	1.2%	0.4%	
Combined prod & labor alloc. effect (e)	0.5%	-2.2%	0.8%	4.0%	1.7%	8.9%
Share of labor in total income (f)						10.1%
Labor supply (g)						0.9%
Labor supply effect (h)						0.1%
Total with labor supply effect (i)						9.0%
In absolute terms:						
Average net income (j)	4702	2653	4565	9110	21029	21029
Productivity effect on income (k)	52	-58	41	255	290	
Labor allocation effect on income (l)	-30	0	-3	108	76	
Total prod & labor allocation effect (m)	22	-58	38	363	365	1872
Labor supply effect (n)						19
Total with labor supply effect (o)						1891

Notes: (a) Coefficient of schooling in the production function (Tables 3 and 4). (b) Coefficient of labor in the production function (Tables 3 and 4). (c) Computed by applying the formula reported in footnote 28 to the coefficient of schooling in the labor use regressions (Tables 5 and 6). (d) Product of (b) and (c). (e) Sum of (a) and (d), except for Total (2), where it is the coefficient of schooling in total net income regression (Table 4, last column). (f) Coefficient of labor in total net income regression (Table 4, last column). (g) Computed by applying the formula reported in footnote 28 to the coefficient of schooling in total labor supply (Table 6). (i) Sum of (e) and (h). (j) Computed from the data. (k) Product of (a) and (j). (l) Product of (d) and (j). (m) Sum of (k) and (l), except for Total (2) where it is the product of (e) and (j). (n) Product of (h) and (j). (o) Sum of (m) and (n). Total (1) is computed by aggregating over the four income sources listed in columns 1 to 4 and computing percentages from the 'absolute terms' part of the table. Total (2) is computed directly from the total income and family labor supply regressions. The two need not agree.