Consequences of the Green Revolution for Rural Landless Households:

The Complex Relationship between Income Growth and Human Development

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Abstract

In this paper we examine the effects of the Indian green revolution on the income growth and schooling in landless households in rural Indian villages. To do so, we construct a general-equilibrium model incorporating both landless and landed households and use the model to inform an empirical analysis based on unique panel data describing rural households over the first 15 years of the green revolution. The model suggests that technological change will increase income in both types of households but, given school availability, may have opposite effects on schooling in landed and landless households due to interactions in the market for child labor. Empirical estimates of schooling decision rules by landholding status indicate that these effects are present and of substantial size. We then model the school-building decision from the perspective of a central planner and show how the relationship between technological change and the outcomes of interest depends on the structure of the social welfare function. Interestingly, given the estimated parameters of schooling decision rules, there is no tradeoff in the provision of schools between the objective of higher income growth and of minimizing heterogeneity in achieved schooling: both involve allocating more schools to higher growth areas. Estimates of school allocation decision rules are then used to identify the relative weights given to income level, income heterogeneity, and schooling heterogeneity in the school-building decision.

One of the central issues in development economics is to what extent promoting economic growth leads to increased human development - as indicated, for example, by higher levels of schooling and health - particularly among groups with low levels of resources. Some have argued that raising income levels is not sufficient to augment human development among the poor so that targeted public interventions to promote human development are required. Others have asserted that by increasing the resources available to households financial barriers to increased investments, key impediments to human development, are eliminated or reduced. Growth-promoting polices thus enable additional human development and therefore growth policies should be the key focus of policy-makers. Much of this debate, however, has ignored how and to what extent economic growth affects not only total resources but the incentives for households, classified by different initial levels of resources, to invest in human development.

In this paper we examine the effects of the Indian green revolution, which substantially increased agricultural productivity in many areas of India, on income growth and schooling investment in landless rural households, in which a large proportion of the poor reside. To do so, we construct a general-equilibrium model incorporating both landless and landed households and use the model to inform an empirical analysis based on unique panel data describing rural households over the first 15 years of the green revolution. The model incorporates the findings from Foster and Rosenzweig (1996) showing that rates of return to schooling among farmers in green-revolution India were highest in those regions experiencing substantial agricultural productivity growth and findings (Foster and Rosenzweig 1994) that for workers engaged exclusively in menial tasks, increased schooling attainment has little effect on productivity.[1] These results imply that incentives to invest in schooling differ by land ownership. A key

[1]These results are consistent with the hypotheses of T.W. Schultz (1976) and Nelson and Phelps (1966), which emphasize that the returns to education arise primarily from increased skill in decoding information and in decision-making under changing circumstances.

point of our approach, however, is that to fully understand the mechanisms by which advances in agricultural productivity impact on the rural landless it is necessary to understand the behavior of both landed and landless households. This is because the two types of households interact. This interaction occurs in two spheres - in labor markets and in the political sphere, in which the allocation of such public goods as schools or health centers is determined. In particular, children in landed and landless households may compete in the labor market, so that changes in the time landed children allocate to school can have important effects of the demand for the labor supplied by children from landless households. Second, given the public-good nature of schools, increased returns to schooling among only a subset of households, such as farm households, may result in greater school construction, which may affect schooling investments in landless households. Despite increased interest in child labor in developing countries and its interaction with school attendance (e.g., Basu 1999), however, little evidence is available on the likely magnitudes of these effects.

The panel data set we use describes a representative sample of rural Indian households during the peak period of agricultural innovation associated with the green revolution, 1968-1982. Our analysis based on these data shows that agricultural productivity growth has significantly increased agricultural wage rates, thus benefitting landless households, but has also, in concert with changing expectations about future productivity advancements in agriculture, raised the price of land, benefitting landed households. Consistent with previous work we also find that higher expected future technology and increases in the number of schools raise schooling in landed households. However, while increased school availability also increases schooling in landless households we find that, consistent with the operation of a child labor market, high rates of expected technology, given school availability, substantially decreases schooling investment in landless households. Thus, we have a case in which income growth is associated with both decreased human development among the lowest-resource a households and increased inequality in human development. We also find, however, that schools are allocated to areas in which agricultural technical change is expected by the local farmers to advance most rapidly, the more so the greater the proportion of households in an area that are farming households. This school building effect attenuates, but does not eliminate, the negative direct effect of advancing agricultural productivity on landless schooling operating through the child labor market. These results thus suggest that schooling-related spillovers between landed and landless households, via labor markets and via the allocation of public goods, can substantially affect the distributional impacts of economic change and social policy.

1. Model

a. Schooling decisions in landless and landed households

We construct a two-period general-equilibrium model with two household types, landless and landed, in which the level of agricultural technology in the second period is stochastic. The two household types are distributed among villages, with distinct labor markets and technologies, with a varying fraction λ_j of households in each village j owning land. In this environment each household in the first period is endowed with T units of adult labor, which earns a village-specific return w_{jt} and T units of child labor. Children participate, when not in school, in a child-intensive activity (e.g., herding) carried out in landed households for which a competitively-determined wage w_{cjt} is paid to hired children[2]. Schooling is valued by parents in both landed and landless households for its own sake.[3] It is

[2]We separate the adult and child labor forces to simplify the analysis Allowing substitution would introduce additional income effects arising from the fact that changes in child enrollment would affect adult wages. We show below that this effect is empirically minimal. The reason for introducing a labor market for children is to allow for the possibility that children's time is productive in both landed and landless households and that decreases in participation by landed children impact the return to child labor of landless households and vice versa. Even in the absence of a market for child labor these conditions would be met if children specialized in the production of a locally marketed good such as firewood.

[3]Alternatively we could allow child schooling to earn a return outside of agriculture that is the same for both landless and landed households. Doing so would not change the main points of the analysis.

assumed that the landless are hired by landed households as workers, and that the schooling of hired adult workers does not augment their productivity. The schooling of landowners, who make input decisions, contributes to productivity in direct relation to the level of agricultural productivity.

All households in the first period earn income, choose how much time to allocate their children to school, and consume. Income in landed households is obtained from the wage labor of both children and adults, the profits from agricultural production using adult labor, and the child-intensive activity. Income in landless households arises solely from the wage labor of both adults and children. In the first period a social planner also allocates funds to villages to build schools. Schools are public goods that must accommodate all village children, and all school costs are due to travel time and opportunity costs. In the second period the first-period children are adults, the new technology is realized and the households again earn income and consume, with landed households hiring labor and producing and landless households selling labor.

We assume that the preferences of landless (k=N) and landed (k=A) households are identical and are concave and separable in first and second period consumption and child's human capital:

(1) $$v_{kj}^{*} = v(c_{kj1}, c_{kj2}, h_{kj}) = u(c_{kj1}) + \beta u(c_{kj2}) + z(h_{kj}),$$

where the single-period utility function u is increasing and concave and has a zero third derivative;[4] c_{kj1} and c_{kj2} denote first and second period consumption respectively of households of type k in village j; and h_{kj} denotes child human capital, in units of time, for households of type k in village j. The production function is assumed to have two inputs - land and adult manual labor - and to be multiplicative in the technology level and family human capital so that higher technology increases the returns to family human capital. Hired and family adult farm manual labor are assumed to be perfect substitutes. Agricultural profits in period t in village j are thus

[4]Adopting quadratic utility substantially simplifies the treatment of uncertainty about future technology as discussed below.

(2) $$\pi_{jt} = \theta_{jt} h_{fAjt} A_j f(l_{jt}) - l_{jt} w_{jt},$$

where θ_{j1} denotes state-t technology in village j, h_{fAjt} summarizes family human capital in landed households in period t,[5] f() is the per-unit of assets agricultural production function for given technology and family human capital, A_j denotes productive household assets, and l_{jt} is the amount of adult manual labor used in the period.

The first-period budget constraint for a representative landed households in village j is thus

(3) $$c_{Aj1} = \pi_{j1} + A_j g(l_{jc}) - l_{jc} w_{jc} + Tw_{j1} + Tw_{jc} - (w_{jc} + d(S_{j1}))h_{Aj},$$

where $g(l_{jc})$, with $g''(l_{jc})<0$, is the production function for the child-intensive good; l_{jc} is total child labor used; S_{j1} is the number of schools in village j at time 1; and $d(S_{j1})$ with $d'(S_{j1})<0$ denotes the per unit cost of human capital h_{Aj}, which is assumed to depend on the number of schools.[6] The first-period budget constraint for landless households, which do not undertake own production, is

(4) $$c_{Nj1} = Tw_{j1} + w_{jc}T - (w_{jc}+d(S_{j1}))h_{Nj}.$$

At the start of the second period, second-period technology θ_{j2} is realized. It is assumed that second-period technology is drawn from a distribution that is characterized by a village-specific mean $E\theta_{j2}$ and an additional parameter vector $\boldsymbol{\sigma}_{\boldsymbol{\theta}}$ that is fixed across villages. Children become adults in the second period and join their parents in the labor force. The human capital of landed children is assumed to augment productivity in landed households. The second-period budget constraint for landed households is thus

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[5]Evidence suggests that, for the purpose of determining household productivity, family schooling is best summarized by maximal schooling within the household (e.g., Berhman et al 1999). We also assume for simplicity that children have lower schooling than parents in period one (while the children are being educated) and have higher schooling than parents in period two. That is h_{fAjt} is parental schooling h_{pAj} in period one and child schooling h_{Aj} in period two.

[6]To simplify the analysis we assume that child labor supply is not influenced by school construction except through its effect on human capital. A more sophisticated model would assume that school construction can increase child labor supply given human capital by reducing travel time.

(5) $c_{Aj2} = \pi_{j2} + 2Tw_{j2}.$

By contrast, because the human capital of the children of the landless, who are hired as wage workers, does not augment productivity the budget constraint for landless households in the second period is just

(6) $c_{Nj2}=2Tw_{j2}.$

The partial-equilibrium decision rules for landless households in this model are quite simple - school enrollment decisions depend only on the child wage, the adult wage in the first period and on the stock (proximity) of local schools. There are no effects of variation in expected second-period wages or technology on the human capital investment made by landless because there is no capital market and no second period labor-market return to human capital investment for the landless. Thus there is no opportunity for these households to transfer resources across time through human capital investment. In particular, maximizing expected utility over consumption and human capital investment for landless households subject to (4) and (6) yields a landless-household human capital demand function given by

(7) $h_{Nj}=h_N^*(w_{j1},w_{jc},S_{j1}).$

The partial-equilibrium effect of increasing the stock of schools on child human capital investment in landless households is given by,

(8) $$\frac{\partial h_N^*}{\partial S} = d'(S)\left(\frac{\partial h_k^{*c}}{\partial p_h} - \frac{\partial h_k^*}{\partial r_1}h_N\right),$$

where $\frac{\partial h_A^{*c}}{\partial p_h}<0$ is the compensated own-price effect on human capital demand (i.e., the effect of a compensated increase in the monetary cost of schooling given wages and technology) and $\frac{\partial h_A^*}{\partial r_1}>0$ is the first-period income effect. Assuming income effects are non-negative, both the income and price effects operate in the same direction so that (unsurprisingly) building schools would increase landless schooling investment if wage rates were unaffected by school building. The effect of an increase in the child wage on the amount of schooling among the landless households is also straightforward, and is given by

(9) $$\frac{\partial h_N^*}{\partial w_c} = \frac{\partial h_N^{*c}}{\partial p_h} + \frac{\partial h_N^*}{\partial r_1}(T-h_N).$$

Whether an increase in the child wage increases or decreases child human capital in landless households thus depends on whether the higher opportunity cost of child time is offset by the higher earnings per child. If income effects are weak, increases in the demand for child labor reduces child schooling for landless households.

b. General-equilibrium effects

Because changes in agricultural technology have no direct effect on the returns to hired-worker schooling investments, whether and how a change in expected technology affects landless schooling decisions depends on how such changes affect child wages and the stock of schools, which will in turn depend on the decisions of the landed households that employ labor and decisions by the school authority. To assess the spillover effects of agricultural technical change on landless-household schooling investment thus requires assessing general-equilibrium effects, in particular the operation of child and adult labor markets. In order to determine the general-equilibrium effects of increasing the number of schools and the level of agricultural technology on schooling investment, by land status, it is necessary to solve for equilibrium wages. In particular, the demand for labor, which is obtained by equating the marginal product of labor on landed households to the wage, must equal the supply. As there is one adult per household in the first period, the total supply of labor per landed household in period 1 is T/λ_j and first-period adult wages must thus solve

(10) $$w_{j1} = \theta_{j1} h_{pAj} A_j \frac{\partial f}{\partial l}(T/\lambda_j)$$

The first-period children's wage, however, reflects the total supply of child labor, which is endogenously determined by the schooling decisions (time allocation) in landless and landed households, so that

(11) $$w_{cj1} = A_j g'((T - (1-\lambda_j)h_{Nj} - \lambda_j h_{A_j})/\lambda_j)$$

In the second period, total (adult) labor supply - the sum of parents in the first period and their grown children - is totally inelastic. The second-period equilibrium wage is thus:

(12) $$w_{j2} = \theta_{j2} h_{Aj} A_j \frac{\partial f}{\partial l}(2T/\lambda_j).$$

We first solve the general-equilibrium model taking as given the supply of schools. Because adult labor supply (demand) in the second period is also fixed and thus deterministic, even though the second-period technology level and wage is stochastic, it turns out that the wage-constant partial-equilibrium demand equations for the landed households that also condition on the fixed second-period labor supply are useful for understanding the general-equilibrium effects of changes in technology on landless households. The relevant equation describing the schooling investment decision rules for landed households, conditional on first-period wages, the expected second-period wage and technology, the stock of schools and second-period labor usage (2T/λ) is given by

$$(13) \qquad h_{Aj} \ = \ h_A^*(w_{j1}, Ew_{j2}, w_{jc}, \theta_{j1}, E\theta_{j2}, S_{j1}, A_j, h_{pAj}, 2T/\lambda, \sigma_\theta),$$

where Ew_{j2} denotes the expected second-period wage.

The comparative statics from the partial-equilibrium problem for landed households are straightforward. In particular, it can be shown that the effect of an increase in child wages on landed household human capital investment, given expected second-period technology, wages, schools, and second-period labor usage, is given by

$$(14) \qquad \frac{\partial h_A^*}{\partial w_c} \ = \ \frac{\partial h_A^{*c}}{\partial p_h} \ - \ \frac{\partial h_A^*}{\partial r_1}(l_c \ - \ (T - h_A)),$$

Expression (14) is unambiguously negative, reflecting the negative effect of a higher opportunity cost of child time and the fact that increases in child wages reduce the income of landed households, who are net hirers of child labor. In contrast, increases in expected second period adult wages given technology, schooling, and second-period labor usage unambiguously increase human capital investment in landed households

$$(15) \qquad \frac{\partial h_A^*}{\partial Ew_2} \ = \ - \ \frac{\partial h_A^*}{\partial r_2}(T/\lambda)(2 - \lambda).$$

This is because landed households, who are also net hirers of adult labor, expect to suffer a loss in the second period if second-period wages rise. This induces them to shift resources from the first to the second period. Given the absence of credit markets such a transfer of resources can only be accomplished by increasing human capital investment. Finally, the wage-constant effect of an increase in expected second-period technology on human capital investments in landed households is given by

(16) $$\frac{\partial h_A^*}{\partial E\theta_2} = f(2T/\lambda)(-\frac{\partial h_A^{*c}}{\partial p_h}E\mu + h_A\frac{\partial h_A^*}{\partial r_2}),$$

where Eμ is the ratio of the expected second to first period marginal utilities of income. An increase in Eθ_2 raises the return to schooling investment, which induces more schooling, but also increases second-period income, which induces households to want to increase their consumption in the first-period by cutting back on schooling.

Expressions (14) through (16), which characterize wage and technology effects on landed-household schooling decisions, are relevant to the schooling decisions of the landless. This is because changes in the allocation of children's time in school h_A in landed households affect the demand for hired landless children as substitute child workers and thus the opportunity cost of schooling for the landless. To assess how changes in expected agricultural technology affect schooling decisions in both landed and landless households gross of wage effects, we combine the human capital demand functions for the two types of households (7) and (13), the three wage equations (10), (11) and (12), and expressions for labor supply to derive human capital demand functions that condition only on aggregate village-level conditions, inclusive of the number of local schools:

(17) $$h_{kj} = h_k^{**}(\lambda_j, T_j, S_{j1}, \theta_{j1}, E\theta_{j2}, A_j, h_{pAj}, \sigma_\theta), \quad \text{k=A,N.}$$

Substituting (17) and the corresponding equations for consumption into the utility function (1) also yields expressions for equilibrium expected utility conditional on the level of schools

(18) $$v_{kj} = v_k^{**}(\lambda_j, S_{j1}, \theta_{j1}, E\theta_{j2}, A_j, h_{pAj}, \sigma_\theta).$$

Implicit differentiation of the human capital equations (17), the wage equations, and labor supply yields the general-equilibrium effect of a change in expected agricultural technology on the schooling decisions of the landed:

(19) $$\frac{\partial h_A^{**}}{\partial E\theta_2} = \frac{1}{D}(A(1-\lambda)g''\frac{\partial h_N^*}{\partial w_c} + \lambda)(\frac{\partial h_A^*}{\partial Ew_2}h_A f'(2T/\lambda) + \frac{\partial h_A^*}{\partial E\theta_2}),$$

where

(20) $$D = \lambda(1 - \frac{\partial h_A^*}{\partial Ew_2} Ew_2/h_A) + (\lambda \frac{\partial h_A^*}{\partial w_c} + \frac{\partial h_N^*}{\partial w_c}(1-\lambda)(1 - \frac{\partial h_A^*}{\partial Ew_2} Ew_2/h_A))Ag'',$$

with D>0, as required for a stable equilibrium. Expression (19) is positive as long as the partial-equilibrium effect of expected technology change on landed schooling investment is non-negative. Moreover, comparison of the general-equilibrium effect (19) with the partial-equilibrium effect (16) suggests that the general-equilibrium effect of an increase in expected technology on the schooling investments in landed households is more positive than the partial-equilibrium effect because the general-equilibrium effect contains both the direct partial-equilibrium technology effect (16) and the second-period wage effect, which is positive. The intuition is that if technology is expected to improve, second-period wages will also be expected to increase (given the fixity of labor supply), which will further induce landed households to transfer resources to the second period. Expression (19) also indicates that the more responsive is schooling investment in landless households to the child wage, the greater is the responsiveness of landed schooling investment to anticipated technical change. This is because the higher the responsiveness of child labor in landless households to wage changes, the smaller is the increase in the child wage induced by the reduction in the supply of landed children to the child-intensive employment activity.

The general-equilibrium effect of a change in expected agricultural technology on the schooling decisions of the landless is given by:

(21) $$\frac{\partial h_N^{**}}{\partial E\theta_2} = -\frac{1}{D}\lambda Ag''\frac{\partial h_N^*}{\partial w_c}(\frac{\partial h_A^*}{\partial Ew_2}h_A f'(2T/\lambda) + \frac{\partial h_A^*}{\partial E\theta_2}).$$

Comparison of (19) and (21) indicates that the effects of a change in expected future agricultural technology on schooling investment in landless households is not only not zero, as suggested by the partial-equilibrium analysis, but rather is opposite in sign to the general-equilibrium effect in landed households. The reason is that if higher future technology induces greater human capital investment on the part of landed households this raises the equilibrium child wage which increases the opportunity cost of schooling in landless households and thus lowers their human capital investments.

In general, because of the operation of the child and adult labor markets all of the characteristics of landed households, inclusive of the level of agricultural technology, affect the schooling decisions in landless households. Indeed, in the partial-equilibrium model of the landless households, the schooling of parents has no effect on either income or preferences and therefore increases in parental schooling in landless households have no effect on landless schooling investment. However, taking into account the operation of the labor market, the schooling of parents in landed households affects the schooling of landless children because the schooling of landed-household parents in the first period affects the demand for both adult and child laborers.

The general-equilibrium effect of the schooling level of parents in landed households on the schooling of children in landed and landless households, respectively, is given by

(22) $$\frac{\partial h_A^{**}}{\partial h_{pA}} = \frac{\lambda}{h_{pA}D}\left[(\pi_1 + w_1 T)\frac{\partial h_A^*}{\partial r_1} + \frac{1-\lambda}{\lambda}\left(\pi_1 \frac{\partial h_A^*}{\partial r_1}\frac{\partial h_N^*}{\partial w_c} + w_1 T(\frac{\partial h_A^*}{\partial r_1}\frac{\partial h_N^*}{\partial w_c} - \frac{\partial h_N^*}{\partial r_1}\frac{\partial h_A^*}{\partial w_c})\right)Ag''\right]$$ and

(23) $$\frac{\partial h_N^{**}}{\partial h_{pA}} = \frac{\lambda}{h_{pA}D}\left[(1 - \frac{\partial h_A^*}{\partial Ew_2}\frac{Ew_2}{h_A})w_1 T\frac{\partial h_N^*}{\partial r_1} - \left(\pi_1 \frac{\partial h_A^*}{\partial r_1}\frac{\partial h_N^*}{\partial w_c} + w_1 T(\frac{\partial h_A^*}{\partial r_1}\frac{\partial h_N^*}{\partial w_c} - \frac{\partial h_N^*}{\partial r_1}\frac{\partial h_A^*}{\partial w_c})\right)Ag''\right].$$

Expressions (22) and (23) indicate (i) if schooling investment does not respond to changes in income, then variation in parental schooling in landed households has no effect on schooling investment in children for either landless or landed households,[7] and (ii) if income effects are positive for both types of households and neither the income nor child-wage effects on child schooling are very different across landed and landless households then increases in parental schooling in landed households will be unambiguously associated with increased schooling investment in landed households but the increase will be less in landless households and landless-household schooling investment may decrease. The intuition is that an increase in the schooling of adults in landed households increases landed-household income which leads to more time being allocated to schooling among landed children. The latter effect raises the demand for substitute child labor and thus increases the child wage, which increases the

[7]This is because we have assumed that the adult and child labor are separable.

opportunity cost of schooling for landless children. Offsetting this is the fact that if landed farmers are more schooled, manual labor is also more productive so that the demand for adult hired labor also increases, leading to higher incomes in landless households. It is thus an empirical question whether on net the effect of the schooling of landed-household adults affects landless schooling investment negatively or positively.

Finally, the variation in the production assets of the landed household affects the schooling decisions in both landed and landless households. The effect of a change in the level of the landed household asset on landed schooling investment is given by

$$(24) \qquad \frac{\partial h_A^{**}}{\partial A} = \frac{\lambda}{AD}\left[w_c \frac{\partial h_A^*}{\partial w_c} + H_A + \frac{1-\lambda}{\lambda}(H_A \frac{\partial h_N^*}{\partial w_c} - w_1 T \frac{\partial h_N^*}{\partial r_1}\frac{\partial h_A^*}{\partial w_c}) g'' A \right],$$

where $H_A = -\frac{\partial h_A^{c*}}{\partial p_h} E\mu E\theta_2 A f(l_2) + (\pi_1 + w_1 T)\frac{\partial h_A^*}{\partial r_1} + (\pi_2 + 2Ew_2 T)\frac{\partial h_A^*}{\partial r_2}.$

There are three effects, corresponding to the three terms in (24). First, an increase in productive assets raises the return to first-period child labor, given child wage rates, and thus reduces child time allocated to schooling. Second, as given by the second term $H_{A,}$ an increase in the size of the asset stock increases the return to schooling in the second period, which raises schooling if the difference between the first- and second-period income effects is small. Finally there is a general-equilibrium effect which partly offsets any change in schooling via its feedback on child wages.

Variation in the productive assets of the landed affects the schooling in landless households according to:

$$(25) \qquad \frac{\partial h_N^{**}}{\partial A} = \frac{\lambda}{AD}\left[(1 - \frac{\partial h_A^*}{\partial Ew_2}\frac{Ew_2}{h_A})(w_c \frac{\partial h_N^*}{\partial w_c} + w_1 T \frac{\partial h_N^*}{\partial r_1}) - \frac{1-\lambda}{\lambda}(H_A \frac{\partial h_N^*}{\partial w_c} - w_1 T \frac{\partial h_N^*}{\partial r_1}\frac{\partial h_A^*}{\partial w_c}) g'' A \right].$$

Here, there are only two effects because changes in landed-household assets do not change the second-period return to schooling for the landless. Thus, increasing the assets in landed households unambiguously reduces landless schooling, because it raises the demand for child labor in the first period and because landed children may reduce their time spent in the non-school activity, with this only partly offset by the general-equilibrium effect of the rise in child wages.

c. Endogenous school allocations and schooling investment

With endogenous school allocations, the effects of expected improvements in agricultural technology or landed assets on the schooling of landless-household children will also depend on how changes in expectations about future technology or changes in asset holdings also affect the allocation of schools. Increased schooling availability can offset the reduction in landless-household schooling investment that is induced by an increase in the demand for child labor when future agricultural technology is expected to advance. The general-equilibrium effect of an exogenous increase in the stock of schools on school investment in landless households incorporates a direct effect operating through the reduced cost of schooling and an indirect effect that operates through the child labor market::

(26) $$\frac{\partial h_N^{**}}{\partial S} = \frac{1}{D}\lambda((1 - \frac{\partial h_A^*}{\partial Ew_2}Ew_2/h_A)\frac{\partial h_N^*}{\partial S} - (\frac{\partial h_N^*}{\partial w_c}\frac{\partial h_A^*}{\partial S} - \frac{\partial h_A^*}{\partial w_c}\frac{\partial h_N^*}{\partial S})Ag'')$$

Assuming that the second component, which reflects the differential responsiveness of children in landed and landless households to school availability, is not too large, more schools will result in higher schooling of the landless. This effect might be offset, however, if withdrawals of landed households from the labor market to attend school lead to a sufficiently large increase in the child wage to draw landless households out of the labor market. The general-equilibrium effect of school building is less than the partial-equilibrium effect (8).

Whether an increase in anticipated future agricultural technology in a locality does in fact increase school allocations to that locality is not obvious. This will depend in part on the objective function of the planner. A general approach is for the planner to maximize an expected weighted sum of functions of consumption and human capital by landholding status

(27) $$E_1\sum_j n_j \sum_{k=A,N} \phi_{kj}(\lambda_j)\psi(c_{kj1}^{**},c_{kj2}^{**},h_{jk}^{**})$$

where n_j is village size and $\phi_k(\lambda_j)$ denotes the weight allocated to farmers of landholding status k in village j, which is assumed to depend on the share of landed households, and ψ () is a function of S_j-

conditional equilibrium consumption by period and human capital by landholding status. In the special case that the social planner cares about average expected utility across all households, $\phi_A(\lambda_j) = \lambda_j$, $\phi_N(\lambda_j) = (1-\lambda_j)$ and

(28) $$\psi(c_1,c_2,h) = u(c_1) + \beta u(c_2) + z(h) \ .$$

It is assumed that the social planner can only influence welfare through the distribution of resources for the purpose of building schools and is given a fixed set of schools to allocate that is financed outside of the set of villages.[8] In particular, the social budget constraint is:

(29) $$\sum_j s_{j1} \ = \ S_1^* \ ,$$

where $s_{j1}=S_{j1}-S_{j0}$ denotes the number of new schools built in village j at time 1 and S_1^* denotes the maximum number of schools across all villages that may be built at time 1.[9]

Maximizing the planner objective function (27) taking into account the behavior of the landless and landed and the constraint (29) yields the first-order condition

(30) $$n_j \sum_k \phi_k(\lambda_j)\left[\frac{\partial\psi}{\partial c_{kj1}}\frac{\partial c_{kj1}^{**}}{\partial S_j} + \frac{\partial\psi}{\partial c_{kj2}}\frac{\partial c_{kj2}^{**}}{\partial S_j} + \frac{\partial\psi}{\partial h_{kj1}}\frac{\partial h_{kj}^{**}}{\partial S_j}\right] \ - \ \zeta \ = \ 0,$$

where ζ is the Lagrange multiplier on the school construction constraint (29). Equation (30) may then be solved implicitly obtain schooling investment decision rules

(31) $$S_j \ = \ S^{(3)}(\lambda_j,\theta_{j1},E\theta_{j2},A_j,h_{pAj},S_{0j},n_j,\sigma_\theta,\zeta) .$$

It is not possible to predict how school building will respond to anticipated region-specific changes in technology without further specifying the welfare function. To illustrate this point as well to provide a framework that may be used for estimation we consider a simplified parametric social welfare function in which the social planner uses population weights and cares about the level and heterogeneity

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[8]In India the farm sector is exempt from income taxes, and most revenue is generated from Federal tariffs on imports and exports.

[9]Note that, as is common in the theoretical literature examining the interaction between social planners and household fertility and human capital choices (Nerlove *et al.*1987), we assume that the social planner only cares about welfare from the standpoint of the current generation.

of schooling and second period consumption. Thus,

(32) $\psi(c_1,c_2,h)=\kappa_1 c_2-\kappa_2 c_2^2+\kappa_3 h-\kappa_3 h^2,\ \phi_A(\lambda_j)=\lambda_j$, and $\phi_N(\lambda_j)=(1-\lambda_j)$

with $\kappa_i \geq 0$ for all i. The parameter κ_1 captures the extent to which the social planner values higher consumption and therefore income while κ_2 captures the extent to which income-heterogeneity is undesirable. Similarly κ_3 and κ_4 capture the value placed on higher schooling and reductions in schooling heterogeneity.

Positing further that the human capital equations by landholding status are well captured by a linear approximation:

$$h_{kj}=\alpha_{k\theta_2}E\theta_{j2}+\alpha_{kS}S_{j2}+\epsilon_{kj}$$

and introducing, for illustrative purposes, the further simplifications that production function is Cobb-Douglas with land share ρ , one may solve analytically for the effect of technology and school allocation. For ease of interpretation we present a first-order taylor expansion of this effect around the points $r_2=0$, $\alpha_{AS}=\alpha_{NS}$, $S_1=0$, and $\epsilon_{Aj}=0$ and normalize $\kappa_4=1$:

(33)
$$\frac{\partial S^{(3)}}{\partial E\theta_{j2}}=-\frac{1}{\alpha_{NS}}((1-\lambda_1)\alpha_{N\theta_2}+\lambda_j\alpha_{A\theta_2})+\frac{1}{2\alpha_{NS}}\kappa_1+\frac{E\theta_{j2}^2\kappa_2}{\alpha_{NS}\lambda_j}(\lambda_j+(1-\lambda_j)\rho^2)((1-\lambda_j)\alpha_{N\theta_2}+(\lambda_j-3)\alpha_{A\theta_2})$$
$$-\frac{\lambda_j}{\alpha_{NS}^2}(2(1-\lambda_j)\alpha_{N\theta_2}+(1-2\lambda_j)\alpha_{A\theta 2})(\alpha_{NS}-\alpha_{AS})$$

The first term in (33) reflects the desire to reduce schooling inequality. Assuming schools increase school attendance and that technology has opposite effects on the landed and landess as posited above, the sign of this term will depend on the landed share in the population. If most households are landless, and thus schooling is on average lower in high technology areas then this term is negative: putting schools in higher growth areas decreases inter-regional schooling inequality. Conversely if most households are landed inequality is decreased by allocating schools to low growth areas.

By examining the first and second terms it is evident that if there is a higher share of landless and the effects of technological growth on landless schooling sufficiently negative, than there is no tradeoff between income maximization and inequality minimization. The second term reflects the desire to maximize second-period income. It is expected to be positive–if all one cares about is maximizing growth than schools should be allocated to high growth areas. Thus, schools might be allocated to high growth areas either because of a desire to maximize income or a desire to decrease schooling inequality. Note further, however, that an important distinction in these two terms is in the role played by the landed share: the landed share importantly impacts the inequality effect but not the income maximization effect.[10] Thus by examining how technology impacts school building in areas with high and low concentrations of landed households one may be able to distinguish the underlying motivations.

There is a clear tradeoff between income maximization and income inequality, however, as is evident in the third term. This term is expected to be negative because the "weight" on the landed technology effect is negative. Given that both technology and landed schooling raise incomes, inter-regional income inequality will be increased if schools are placed in high technical change areas even if schooling inequality is reduced. It may also be established that the third term is increasing in the landed share when the social planner cares about income inequality. This reflects the fact that within village income inequality is decreasing in the landed share so that land rents are distributed to a larger fraction of the village..

Finally, the fourth term indicates that schooling inequality will be reduced when schools are allocated to high technical change areas if there is a differential impact of schools on the schooling of landed and landless households that is opposite in sign from the differential technology effect. This is primarily an intra-village effect. As technology has opposite effects on the schooling of the landed and

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[10]This incorporates the assumption that an increase in the landed share does not increase total land area. If area per landed household is taken as given and thus total land were increasing in the landed share then a higher landed share would result in a higher school allocation given technical change if the social planner cared about average income. There would still be a contrast with the schooling inequality effect, however, as higher landed shares in that case would decrease the incentive to allocate schools to high technology areas.

landless, intra-village schooling inequality will be reduced by school construction if the landless are more responsive to school construction than are the landless.

d. Agricultural technology expectations and land prices

An important feature of the model is that it incorporates expectations about future technology as a key determinant of schooling investment. Given that data on expectations are not in general available, it is important to reformulate the model in terms of observables that reflect these expectations. Because land prices capitalize the expected discounted stream of future returns on land and land rents are increasing in technology, land prices reflect both current and expected future technology. We posit in particular that land prices are determined by the price that an individual with a high level of schooling h* would be willing to pay for land.[11] In particular, if p_{At} denotes the price of land at time t, then using the notation of the model

$$p_{Ajt} \;=\; E_t \sum_{s=0} \delta^s \theta_{jt+s} h^* f_A(A,T/\lambda_j), \tag{34}$$

where δ is the discount factor. To simplify, we assume further that technological innovation takes place only once such that at $t=\tau$ and for all $s>1$,

$$E_\tau \theta_{j\tau+1} h_{j\tau+1} f(A,T/\lambda_j) \;=\; E_\tau \theta_{j\tau+s} h_{j\tau+s} f(A,T/\lambda_j) \tag{35}$$

Thus for period $t=\tau$,

$$p_{Aj\tau} \;=\; \theta_{j\tau} h^* f_A(A,T/\lambda_j) \;+\; \frac{\delta}{1-\delta} E_\tau \theta_{j\tau+1} h^* f_A(A,T/\lambda_j) \tag{36}$$

With estimates of the production technology and information on land inputs, so that the marginal product of land can be computed, (36) can be solved for $E\theta_{jt+1}$ in terms of current land prices. However, if it assumed that production is Cobb-Douglas it is possible to identify future technology effects using information only on current land prices and yields. In particular in that case, land yields y_{jt} in j at time t

[11] Suppose, for example, that a primary educated individual can achieve the maximal yields given technology. Then land prices would reflect the expected yields that could be achieved by primary educated individuals rather than the yields obtained given the actual and expected actual schooling levels in that village. The underlying assumption is that educated individuals have sufficient access to capital that they could in principle enter the market and bid up the price of land.

are

(37) $y_{jt} = \theta_{jt} h_{jt} f(A_j, T/\lambda_j)/A_j = \theta_{jt} h_{jt} f_A(A_j, T/\lambda_j)/\alpha$,

where α is the Cobb-Douglas land-share parameter. Substituting and solving implicitly yields a function of the form

(38) $E_\tau \theta_{j\tau+1} = E\theta(p_{Aj\tau}, y_{j\tau}, h_j, A_j, T/\lambda_j, h^*)$

where

(39) $\dfrac{\partial \ln E\theta}{\partial \ln p_{Aj\tau}} = p_{Aj\tau} h_{j\tau} / (p_{Aj\tau} h_{j\tau} - \alpha y h^*) > 0$

(40) $\dfrac{\partial \ln E\theta}{\partial \ln y_{j\tau}} = -\alpha y_{j\tau} h^* / (p_{Aj\tau} h_{j\tau} - \alpha y_{j\tau} h^*) < 0$

Substitution of (38) into (31) and (17) then yields the general-equilibrium relationships for school allocations and child schooling expressed in terms of contemporaneous village-specific yields and land prices, as:

(41) $S_j = S^{(4)}(\lambda_j, y_{j1}, p_{Aj1}, A_j, h_{pAj}, S_{0j}, \sigma_\theta, \zeta)$

and

(42) $h_{kj} = h_k^{(3)}(\lambda_j, S_{j1}, y_{j1}, p_{Aj1}, A_j, h_{pAj}, \sigma_\theta)$,

respectively, where

(43) $\dfrac{\partial S^{(4)}}{\partial p_{Aj1}} = \dfrac{\partial S^{(3)}/\partial E\theta_2}{\partial p_A/\partial E\theta_2}$

and so forth.

3. Data

Our main objective in the empirical analysis is to identify how agricultural technical change affects incomes and the schooling decisions of rural households by land ownership status. We do this by estimating agricultural wage functions and approximations to the general-equilibrium relationships (38) and (39) relating (i) school enrollment in landed and landless households, conditional on local school availability, and (ii) school building to expected local agricultural technology, as reflected in local land prices conditional on yields. We use information constructed from data files produced by the National Council of Applied Economic Research (NCAER) from six rural surveys carried out in the crop years 1968-69, 1969-70,1970-71, 1981-82, and 1999-2000. The first set of three survey rounds from the Additional Rural Incomes Survey (ARIS) provides information on over 4500 households located in 261 villages in 100 districts. These sample households are meant to be representative of all households residing in rural areas of India in the initial year of the survey excluding households residing in Andaman and Nicobar and Lakshadwip Islands. The most detailed information from the initial set of three surveys is available for the 1970-71 crop year and covers 4,27 households in 259 villages. The 1981-82 survey, the Rural Economic and Demographic Survey (REDS), was of a subset of the households in the 1970-71 ARIS survey plus a randomly-chosen set of households in the same set of villages, excluding the state of Assam, providing information on 4,596 households in 250 villages. 248 of these are the same villages as in the ARIS. Finally, in1999 a village-level survey (REDS99) was carried out in the same set of original ARIS villages, this time excluding villages in the states of Jammu and Kashmir. Among other data, the survey obtained information on the schools in each of the villages, including information on when they were constructed.

The existence of comparable household surveys at two points in time separated by 11 years enables the construction of a panel data set at the lowest administrative level, the village, for 245 villages that can be used to assess the effects of the changing economic circumstances on incomes and household and school allocations. There are three other key features of the data: First, the first survey took place in the initial years of the Indian green revolution, when rates of agricultural productivity growth began to increase substantially in many areas of India. Second, two-thirds of the households surveyed in 1981-82 were the same as those in 1970-71. This merged household panel, the original 1968-71 panel and information on profits, inputs and capital stocks were used by Behrman *et al*. (1999) based on methodology developed in Foster and Rosenzweig (1996) to estimate rates of technical change for each of the villages between the two survey dates and between 1968 and 1971. Third, in each survey there is information provided at the individual household or village level on daily agricultural wage rates, the prices of irrigated and unirrigated land, as well as information on crop prices, crop- and seed-specific output and planted area by land type that permit the construction of yield rates for high-yielding variety crops on the two types of land.

We aggregated the household survey data to the village level by landownership status to form two panel data sets in order to estimate the determinants of changes in school enrollment rates in landed and landless households. In particular, we chose households with children aged 10 through 14 years of age and constructed the proportions of children in that age group who were attending school in each village separately for households owning land and for landless households in the two survey years using sample weights. We also constructed weighted, village-level aggregates of the schooling and wealth of the parents of the children in this age group for each of the two land groups at each survey date. Slightly over 30% of children 10-14 resided in landless households in 1971. 37% of the children in this age group in the landless households were attending school, compared with 41% in landless households in that year.

The data indicate that in both 1971 and 1982 a significant proportion of the primary school-age children who were not attending school participated in the labor market. In landless households 34.9% of the non-attendee children aged 10-14 worked for wages. Although only 8.3% of the non-attending 10-14 year-olds in landed households worked for wages off the farm, an additional 28% of these landed children worked as “family” workers. In 1982, 30.3% of landless children aged 10-14 who were not attending school worked as wage workers, compared with 22.4% in landed households. In the latter, however, 38.6% of the children not in school worked as family laborers.

Crop yields and land prices play a prominent role in our model. We computed village-specific yield rates for the high-yielding seed varieties of the four major green revolution crops - wheat, rice, corn and sorghum - on irrigated land for 1971 and 1982. We aggregated the total output in each of the years for these crop/seeds using 1971 prices and sample weights and divided by the weighted sum of the irrigated area devoted to these crops for each village and survey year. The 1982 survey data provides information at the village level on the prices of irrigated and unirrigated land. The 1971 survey provides information on the value and quantity of owned land, by irrigation status, for each household. We constructed the village median price of irrigated land for 1971 from the weighted household-level data, and deflated the 1982 village-level irrigated land prices to 1971 equivalents using the rural consumer price index. The measures of the village-specific rates of technical change over the period 1971-82 and the land price and yield data were appended to the two village-specific data sets describing schooling investments in landless and landed households.

The 1999 REDS school building histories provide the dates of establishment for all schools located within10 kilometers of the villages classified by whether they were public, private, aided, or parochial and by schooling level - primary, middle, secondary, and upper secondary. It is thus possible to examine the determinants of school building over the 1971-82 survey span as well as for the decade subsequent to the 1981-82 survey round, relating comparable intervals of school investment to initial village conditions. In Foster and Rosenzweig (2000a) we carried out investigations of the accuracy of recall data pertaining to village infrastructure based on comparisons of the overlapping years for the histories of electrification that were obtained in the 1970-71 and 1981-82 surveys. The results, to the extent that they carry over to the similarly-obtained school histories, suggest that the school building histories accurately reflect the true changes in school availability over the survey period.[12]

For the analyses here, we look at the determinants of changes in the spatial allocation of secondary, inclusive of upper secondary, schools. We do this because even in the 1960's primary schools

[12]There is one caveat - if there are schools that have been destroyed over the period these would not be reflected in a school-building history based on schools in existence in the villages in 1999.

were nearly universal - by 1971 primary schools were located within 90% of the sample villages. The relevant margin is at the secondary school level. In 1971, only 41% of villages were proximate to a secondary school. However there was considerable school building - by 1981 secondary school village coverage had reached 57% and coverage increased to 73% by 1991. As documented in detail in Foster and Rosenzweig (2000a), the school establishment histories also indicate that there were large inter-state disparities in the presence of rural secondary schools 1971, but show as well that there have been substantial variations in state-wide school investments since then.

Table 1 provides the means and standard deviations for daily agricultural male wages, irrigated land prices, and the constructed village-level variables for the 1970-71 and 1981-82 survey rounds, where all money values are in 1971 rupees. The data indicate that over the 11-year period output per acre of HYV crops approximately doubled. During this time agricultural wage rates rose by slightly over 20% in real terms. Landless households engaged in the agricultural sector thus clearly benefitted from the green revolution. The growth in wages is more impressive considering that over the same period the number of adults in the villages more than doubled. Higher wage rates benefit the landless relative to the larger landed households who are net importers of labor. However, owners of land also benefitted - the price of land more than doubled over the period, presumably reflecting population pressures, productivity growth and expectations of future productivity growth. Indeed, the greater increase in the real price of irrigated land compared to productivity growth, given the rise in labor costs, suggests that expectations of future growth rose more than did real output. To properly assess the net gains to farm households, comparable information on farm profits is required for both survey rounds. Unfortunately, because in the 1970-71 survey round information on family labor allocated to farm production was not coded, it is not possible to construct the relevant measure of profits in that crop year, which requires netting out the value of family labor. Nor can wealth per household be used to assess the gains for landed households, as household wealth is affected by the size of household landholdings, which decrease over time as households divide

(Foster and Rosenzweig, forthcoming).

The data show that Inequality in schooling investment by land class did evidently increase in the initial stages of the green revolution. As noted, in 1971 the average primary school enrollment rate among children in landed households was about 11% higher than that in landless households. In the subsequent 11 years, enrollment rates for both sets of households increased, but at a faster rate in landed households, so that by 1982 the disparity in enrollment rates between landed and landless households had increased to over 25%. Over the same period the number of secondary schools built between 1971 and 1982 represented a 38% increase in the stock of secondary schools, with school building continuing in the next 11 years at similar rate.

4. Output Growth, Population Growth and Wage Changes

We first investigate how changes in output brought about by agricultural technical change, the increase in the number of potential adult workers and changes in work participation by children affect agricultural wages. In particular, we estimate the following wage equation:

(44) $$\ln wage_{jt} = \gamma_F F_{jt} + \gamma_T T_{jt} + \gamma_l l_{jt} + v_j + e_{jt},$$

where F_{jt} = total output at time t in village j, T_{jt}=total adults at time t in village j, l_{jt}=total child laborers aged 10-14 in village j at time t, v_j=village-specific time-invariant unobservable, and e_{jt} is a village-specific time-varying wage shock.[13] Estimation of (44) by OLS would produce biased estimates of the parameters. First, there may be semi-permanent characteristics of areas, captured by v_j, that make wages higher or lower, such as trade unions or monopsony. Because higher wages would lower output, there would be a negative correlation between the error term and output, which would impart a negative bias to γ_F. To correct for this we estimate (44) in difference form:

(45) $$\Delta \ln wage_{jt} = \gamma_F \Delta F_{jt} + \gamma_T \Delta T_{jt} + \gamma_l \Delta l_{jt} + \Delta e_{jt},$$

[13]Note that the γ coefficients in (40) for F and T would be equal to one if the technology were strictly Cobb-Douglas.

where the Δ is a difference operator denoting that the variable is the change between 1971 and 1982. The differenced transitory wage shocks that remain in (45) would still induce bias in γ_F. Another source of bias is that children's labor supply may respond to variation in adult wages, as in the model via income effects. To eliminate these sources of bias, we use instrumental variables. We instrument the change in log output and the change in the labor-force participation of children using the estimated village-level technical change measure for the interval 1971-82. In addition to this variable, we make use of the fact that the Indian government introduced at the initial stages of the green revolution two programs - the Intensive Agricultural District Program (IADP) and the Intensive Agricultural Advancement District Program (IAADP) - in selected districts, roughly one in each state. The programs were designed to provide more assured supplies of credit and fertilizer. As part of the ARIS sampling design, moreover, households residing in these program districts were oversampled (as reflected in the sample weights), so that roughly a third of the households (villages) are represented in each program area. We also use as instruments the initial, 1971, total gross cropped area in the village, average wealth and the proportion of households with a primary schooled male. These variables should also have influenced output growth over the period. We add to the list of instruments the 1971 number of secondary schools in the village and the change in the ratio of boys to girls in the households between 1971 and 1982. These variable should have influenced the change in schools and labor-force participation rates by children.

Table 2 reports in the first and second columns the first-stage estimates of the change in the log of total village-level agricultural output and the total number of child workers, respectively. These estimates suggest that, as expected, areas experiencing higher rates of technical change and with the IADP experienced greater output growth, for given initial conditions. Child labor-force participation, however, evidently declined in such areas, perhaps reflecting increased child schooling, as we investigate below. In the third column we report the two-stage least squares (TSLS) estimates of the difference log wage equation (45). The predicted change in the log of farm output has a statistically significant positive effect on wages. The point estimate of γ_F suggests that an exogenous doubling of farm output would raise adult male wage rates by 18%. Augmenting agricultural productivity thus does benefit landless workers. The estimates also suggest, however, that a doubling of the adult population would lower wages by 14%. Finally, in the fourth column we add the number of child workers. The estimates suggest that there is some substitutability between child and adult workers, but the effect is small - a 10% in crease in child participation rates would only depress adult wages by just over a half a percent, although the estimated effect is not measured precisely.

5. Land Prices and Expected Future Yields

The results in Table 2 indicate that productivity increases in agricultural production brought about by improvements in seeds and perhaps increased inputs were in part captured by landless households in the form of wage increases. To assess how the green revolution affected human capital investments in landless households requires, as noted, that we assess how changing expectations about future growth in landed households influenced their schooling investment decisions. In this section we assess whether land price variation captures, in accordance with economic theory, variation in expectations about future productivity that are assumed to condition the current decisions of the forward-looking farm households. In particular, we estimate a log-log approximation to (38) using data on land prices and HYV yields from the 1971 round of the data and "future" yields from the 1982 data using OLS and instrumental variables, the latter to deal with possible measurement error in the land price and yield measure. We instrument the log price of land in 1971 using the estimated village-level technical change measure for the interval 1968-71. In addition to this variable, we make use of the fact that the Indian government made a forecast "announcement" at the initial stages of the green revolution by placing IADP and IAADP in areas the government had identified as having substantial potential for agricultural productivity growth due to the newly-available high-yielding seed varieties. We assume therefore that the existence of these well-publicized programs affected positively farmer's expectations about future growth in addition to augmenting yields.

The first and second columns of Table 3 report OLS and two-stage least squares (2SLS) estimates, respectively, of the relationship between the log of HYV crop yields in 1982 and the log of HYV crop-yields and land prices in 1971. In both columns 1971 yields are negatively related to 1982 yields, controlling for 1971 land prices, while 1971 land prices and 1982 yields are positively and significantly related, in accordance with expressions (39) and (40). The two variables, plus the initial stock of schools and the schooling of farmers, together explain 14% of the variation in the actual variation in crop yields 11 years in the future. As expected, moreover, relative to the 2SLS estimates the OLS estimates of the yield and price effects are biased towards zero, due presumably to measurement error.[14]

6. The Determinants of School Enrollment

We now are ready to estimate a linear approximation to equation (39) determining the school enrollment rates of 10-14 year-olds in landless and landed households. In particular, the equations we estimate (for k= A,N) are

(46) $$h_{kjt} = \alpha_{k1} y_{jt} + \alpha_{k2} p_{Ajt} + \alpha_{k3} A_{jt} + \alpha_{k4} h_{hjt} + \alpha_{k5} S_{jt} + \alpha_{k6} \lambda_{jt} + \mu_j + \epsilon_{kjt},$$

where the subscript t denotes time; μ_i captures unobserved time-invariant characteristics of villages, including second moments of the technology distribution (σ_θ) and preferences for schooling; and ϵ_{jt} denotes an i.i.d. mean-zero taste shock.

Because parental human capital reflects investments made in the village in previous periods, OLS estimation of (46) given the unobservability of the fixed preference factors embedded in μ will in general yield biased estimates of the coefficients. Moreover, cross-sectional variation in land prices may reflect variations in such permanent qualities as location, inclusive of proximity to cities or even

[14]Inspection of equations (36) and (37) suggests that the sum of the log land price and yield coefficients should be unity if the technology is Cobb-Douglas and technology improves in a discrete jump. Our estimates clearly reject this combination of assumptions.

attractiveness, rather than just expectations of future changes in agricultural technology and current yields. These problems may be addressed in part by estimating (46) in cross-time differences:

(47) $$\Delta h_{kjt} = \alpha_{k1}\Delta y_{jt} + \alpha_{k2}\Delta p_{Ajt} + \alpha_{k3}\Delta A_{jt} + \alpha_{k4}\Delta h_{hjt} + \alpha_{k5}\Delta S_{jt} + \Delta\epsilon_{kjt}$$

so that the fixed unobservables are swept out.

There are two additional problems, however. First, because an exogenous (say, taste- or income-driven) shock to the demand for schooling in period t will, given the model, result in, among other things a higher level of parental schooling and possibly a higher level of wealth A in period t+1, there will be a correlation between the differenced regressors in (47) and the differenced residual. To eliminate this correlation, we employ instrumental variables, using the initial values of the variables in (42), including the survey information on pre-1971inherited assets and the period-t adult schooling, which will be uncorrelated with the differenced residuals given the assumption of i.i.d. taste shocks, as instruments.[15]

A second problem is that land prices, as noted, may measure expectations of future profitability with error and the yield variables may be error-ridden, as we have seen in the estimation of the yield forecast equations. We also use instrumental-variables estimation to deal with these problems, adding to the list of instruments the technical change and pre-1971 program variables used to estimate the yield forecast equation.

The first column of Table 4 reports the fixed-effects instrumental-variables (FE-IV) estimates of the determinants of school enrollment in the landed households. The estimates indicate that, for given current yields, in villages in which land prices are higher, school enrollment rates in landed households are also higher, consistent with the hypothesis that expectations of future higher levels of technology raise the returns to landed schooling investments. In addition, adding a secondary school increases school

[15]We use the information on inherited assets rather than the 1971 wealth level as an instrument because it is likely that wealth, as in most surveys, is measured with error. We assume that the correlation between the measurement error in the inherited wealth variable and the measurement error in the 1971-82 wealth change variable is substantially less than that between the error in the initial wealth level and the change in wealth.

enrollment for 10-14 year-olds in the landed households, for given expectations and yield levels. The point estimates indicate that increasing expectations of future productivity such that land prices doubled would raise the school enrollment rates in landed households by 14%. This would imply, given expression (39) and a discount rate of 3%, a rate of growth in agricultural technology over the next 11 years of 7.4% per year. Adding a school raises enrollment by 68%, although that estimate is not very precise. Finally, increases in the total wealth of the landed households appears on net to depress landed child school enrollment, consistent with most wealth being land wealth and with the opportunity cost effect outweighing the second-period schooling gains as seen in expression (24).

The estimates of the determinants of schooling enrollment for landless households, based on the same specification, are given in the second column. As expected given the operation of a child labor market and the effects of anticipated technical change on landed schooling seen in column one, increases in expected future productivity reduce schooling enrollment in the landless households, and the effect is strong - the same doubling of land prices induced by an expected rise in agricultural productivity reduces landless schooling enrollment by over 90%.. For given expectations about future productivity, increases in current yields also lower landless schooling. These effects, however, are more than offset by building a school, which evidently would more than double landless enrollment in the same technology regime.

Finally, given yields and land prices, an increase in the schooling of farmers appears to also reduce the schooling investment made by landless households. This effect also operates through the child labor market, but requires care in interpretation given the inclusion of the yield and land price variables in the specification - among farm households with the same yields, assets and land prices, those with more productive (schooled) farmers must have poorer land quality and thus must expect higher future levels of technology growth. If so, we should expect to observe more schooling investment in the farm households and less in the landless households, which is what the columns one and two estimates indicate, although the effects are imprecise. In contrast, the schooling of the landless household adults should have no effect, given our assumption of the absence of schooling returns for the landless, on landless schooling investment. This is confirmed in the column-three specification, in which the schooling of the landless adults is included in the landless enrollment equation - the coefficient for landless adult schooling is less than half of that of the schooling of the landed-household adults, is small in magnitude and not statistically significantly different from zero by any conventional standard.

7. The Determinants of School Building

The estimates in Table 4 suggest that the gap between landless and landed schooling widens with increased agricultural technical change and that there is an absolute decline in landless schooling investment where the landed are increasing their schooling in response to technological advances, in the absence of offsetting forces. One offsetting factor is school building. The net effect of technical change on schooling investment in landless households depends therefore on how changes in expected technology impact on school construction. The first column of Table 5 reports estimates of the school building equation (41), using the same estimation procedure as was used to estimate the enrollment equations. The estimates indicate that schools are built where agricultural productivity is expected to increase in the future. On average, a doubling of land prices, for given current productivity, results in .16 schools being built in the subsequent 11 years, which represents more than a doubling in the average rate at which schools were built between 1971 and 1982.

The responsiveness of school building in a village to changes in expectations about future farm productivity appears to be significantly related to the proportion of landless in the village, as seen in the estimates reported in the second column of Table 4 in which the log of the land price is interacted with the proportion of landless households. In particular, consistent with school allocation rules that condition on total incomes and income heterogeneity, more schools are evidently built in response to an increase in anticipated productivity in villages with few landless households compared with villages with many households who have no land. The point estimates suggest that if almost all of the households in a village are landless, school building is almost totally unresponsive to agricultural change. In contrast, if almost all households are farm households, an increase in expected local increases in future agricultural productivity that results in a doubling of land prices would increase the number of schools built over the next 11 years by almost one-half of a school on average, which is 2.5 times the average rate.

These coefficients, in combination with those from the schooling investment and income discussed above, provide a way of characterizing the distributional effects of technical change in Green-revolution India given the particular set of preferences for income and education outcomes that governed school-allocation decisions in India over the relevant period. They do not, however, permit an assessment of the relative value attached to different outcomes over this period. Nor do they allow one to examine the extent to which the level and distributional effects of the green revolution might have differed if the government had valued outcomes in a different way.

It may be established, however, that the effects of technology on school allocation and how this relationship changes with the landless share are sufficient to identify key parameters of the social welfare function posited above (equation 32). In particular, examination of the first-order approximation to the first-order condition (33) of the government's school allocation problem it may be established that the effect of productivity growth on schools depends on the coefficients of the schooling decision rules for landed and landless households, inclusive of the constants, the technologically determined land-share in production ρ, the effects of schooling on production, the number of existing schools, the landed share, the expected productivity growth, as well as parameters on the income level κ_1 and income squared κ_2 in the social welfare function.[16]

The average number of existing schools (.41) and the share of households that have land (0.71)

[16]In principal the parameters of the social-welfare function relating to schooling should also appear. Note, however, that given the assumption that schooling is linear in the number of schools, the schooling-level coefficient does not influence the effect of technology on school allocation and that we can normalize the social welfare function so that the schooling-squared coefficient to one without loss of generality.

(Table 1) can be taken directly from the data. Normalizing technology in 1971 to 1, one can compute the average expected productivity growth to be 2.0 based on yield growth between 1971 and 1982 (Table 1). The schooling coefficients on schools and technology for landed and landless households were taken directly from Table 5. Although the constant terms for the schooling decision rules are not estimated directly due to the use of fixed effects, reasonable estimates may be obtained by subtracting predicted schooling at the average expected growth and actual number of schools (existing in 1971 plus new over the 1971-1982 period) for landed and landless households from the average schooling for these two groups as reported in Table 1. This yields a landless constant of .966 and a landless constant of -.123.[17] The land-share in agricultural production, based on the total (family plus hired) imputed value of the labor allocation and output value in the 1982 data set, is 0.74 . [18] Based on estimates of an HYV-conditional profit function (Behrman et al 1998) we computed a return to middle schooling on new technologies of 30%. With this information in combination with data on average school construction (Table 1) and the technology and technology times landless share coefficients from the school-building decision rule (Table 5) one may use the first order condition from the school-building problem to solve for estimates of κ_1, κ_2 and μ, for any given level of κ_3.[19]

Setting κ_3=1.2, we obtained estimates of κ_1=11.9, κ_2=.752, and μ=1.45. Thus there is evidence that school allocations in India were importantly governed by a desire to maximize total income. There is

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[17]Note that constant refers to the level of schooling that would be predicted based on zero schools and an expected technology of zero; as this is substantially outside the range of the data one would want not to make too much of the fact that the landless constant is considerably higher than the landless one.

[18]Note that the ARIS data do not provide information on the labor allocation of family members and thus cannot be used to determine the technological parameters.

[19]One cannot separately identify μ and κ_3 with the available information due to the assumption that the schooling decision rules are linear in schools and the use of fixed effects, which precludes estimation of the effect of landed share on school allocations. To see this note that if κ_1=κ_2=κ_4=0, then the first-order condition is $\kappa_3(\lambda_i\alpha_{AS}+(1-\lambda_i)\alpha_{NS})-\mu=0$. Thus given λ_i and the α_{kS} coefficients a proportionate increase in μ and κ_3 will not change the allocation of schools or their relationship with technology.

also evidence, however, that some consideration was given to both variance in income and in schooling. In order to consider the relative magnitudes of these effects and their implications for school allocations as well as human capital and income levels and differences, a series of simulation exercises were carried out using these parameter estimates and varying the level of expected productivity growth. The results appear in Figures 1-5. For each figures 6 scenarios are considered. The first scenario (A) considers what would have happened if no schools had been built over the relevant period. The second (B) uses the actual values of the estimated parameters of the social welfare function to determine school allocations. The third (C) considers what would have happened if the social planner had only cared about income, with the magnitude of this effect equal to the derivative of the social welfare function with respect to income evaluated at average income. The fourth (D) considers the effects of adding a schooling level effect (set equal to the derivative at mean schooling) to C. The fifth (E) considers the implications of incorporating the income level and income-squared parameters but no schooling effects. The final scenario (F) considers the results of combining the income level effect and the level and quadratic effects of schooling.

The predicted school allocations based on the different scenarios are presented in Figure 1. It is evident that, given the actual parameter estimates, the social planner's school allocations are increasing in productivity growth up through a growth rate of 2.6 (Scenario B). Moreover, no single component of social preferences drives this effect–there are important contributions arising from concern for schooling level and inequality as well as the level and inequality of income.

The effect of income-maximization is evident in scenario C, in which the relevant parameter κ_1 is set equal to the derivative of the actual parameter estimates evaluated at mean income and the other parameters set to zero ($\kappa_1^C = \kappa_1^A - 2\kappa_2^A \bar{y}$ and $\kappa_2^C = \kappa_3^C = \kappa_4^C = 0$, where κ_i^k denotes parameter i for scenario k and the κ_i^B are the parameters used in the baseline scenario B). In this case technological growth would have a substantial positive impact on school building reflecting the fact that the returns to landed schooling and thus school building are increasing in the level of technology. If the government cared, in addition about schooling itself (scenario D, with $\kappa_1^D=\kappa_1^A-2\kappa_2^A\bar{y},\ \kappa_3^D=\kappa_3^A-2\kappa_4^A\bar{h}$ and $\kappa_2^C=\kappa_4^C=0$), then the number of schools built overall all would be higher relative to scenario C, particularly at low rates of productivity growth where the income returns to school building are small.

There are very different implications of adding concern about inequality in income and schooling to the levels-only scenario (D), with concern for inequality in income resulting in a substantial reduction in school building and concern for inequality in schooling resulting in a modest increase in school construction. Scenario E shows the effect of introducing concern for income inequality through a negative quadratic effect for income ($\kappa_1^E=\kappa_1^A,\ \kappa_2^E=\kappa_2^A,\quad \kappa_3^D=\kappa_3^A-2\kappa_4^A\bar{h}$ and $\kappa_4^C=0$). Given the assumption that the only instrument available to the government is the provision of schools, and given that the ratio of landed to landless income is fixed by the technology, the only way to reduce the difference in income between landed and landless households is to reduce overall income in high growth areas through a reduction in the level of landed schooling. Thus fewer schools are built relative to scenario D, particularly at high levels of technological growth. By contrast, the effect of introducing concern for schooling inequality through a negative quadratic schooling effect (scenario F, $\kappa_1^E=\kappa_1^A-2\kappa_2^A\bar{y},\ \kappa_2^E=0,\ \kappa_3^E=\kappa_3^{Ar}$ and $\kappa_4^E=\kappa_4^A$) is to raise the number of schools built relative to scenario D, particularly at low levels of productivity growth where the income incentive for building schools is small. Recall that due to the fact that the impact of schools on schooling for landless households is greater than that for landed households, the construction of schools tends to decrease schooling inequality.

Figures 2-5 indicate that, in terms of the allocation of schools, there is a correspondence between policies that maximize income and schooling level and minimize schooling inequality, but that each of these objectives tends to conflict with the objective of minimizing income inequality. Figure 2 shows the effects of the alternative scenarios on the mean fraction of children (both landed and landless in school) under alternative regimes of productivity growth. Note that

Figure 2 and Figure 1 differ only slightly except with respect to scale. This is because of the child wage effect: the expected future technology has opposite effects on the schooling of landed and landless households with the average effect, weighted by the population shares, being positive but quite close to zero. As a consequence the average schooling is importantly driven by the presence or absence of schools. Over the relevant range, the highest levels of average schooling are obtained under scenario F when the planner cares about schooling level and variance and income level but not income inequality. Relative to the worst case, that which arises when there is concern only for income level and inequality (E), there is a substantial 0.29 increase in mean schooling for productivity growth of 2. As landed schooling is a key determinant of income level, it is not surprising that a similar ranking of scenarios obtains with respect to mean income. As illustrated in Figure 3, the highest levels of mean income are achieved under scenario F and he lowest under scenario C, with the former yielding 7 percent higher income than the former for productivity growth equal to 2.[20]

The tradeoff between minimization of inequality in schools and income is evident in Figures 4 and 5. In Figure 4, it is clear that inequality in schooling is rising in productivity growth, a result of the child wage effect, with essentially no gap at low levels of productivity growth and a gap of .4-.6 at high levels of growth, depending on the scenarios. For any given level of productivity growth, however, the landed-landless gap in schooling is highest when there

[20]It may seem surprising that scenario D yields higher income relative to income maximization. This reflects the fact that the marginal utility of income (i.e., the return to using the funds elsewhere in the economy) is held constant across the scenarios and that the value of the income level coefficient is not altered when tastes for schooling are added to social preferences. By adding tastes for schooling to the objective function the marginal return to schools at any given level of schools increases and thus more schools are built for given marginal utility of income. With more schools there is higher landed schooling and thus higher income than if the social planner cared only about income maximization.

is concern for income inequality (scenario E) and lowest, not surprisingly, when there is concern for schooling inequality (scenario F). The differences are of reasonably large magnitude, with the latter yielding a mean schooling difference of .01 and the former resulting in a difference of .16. Figure 5 presents the income gap divided by the gap that arises when no new schools are built.[21] Again, with the exception of the scale, this graph corresponds closely with Figure 1. The highest levels of income inequality arise under scenario F when there is concern for schooling inequality and the lowest levels of income inequality arises under scenario E. At a productivity growth of 2, the former represents a gap that is 96% of that achieved with no school building (scenario A) and the latter represents a gap that is 103% of that achieved under scenario A. Thus there is a 7 percentage point difference in the income gap in the two scenarios.[22] Thus the policy that maximizes schooling inequality minimizes income inequality and vice versa.

8. Conclusion

While there has ben much debate over to what extent economic growth reduces poverty and augments human development among the poor, few micro-level empirical studies have explored the underlying mechanisms by which economic growth affects the distribution of human resource investment across households differentiated by income or wealth levels. This fact is likely due not only to the limited availability of longitudinal data that permits one to examine these relationships at units of analysis below that of the country or state, but also to the methodological difficulties that arise in attempts to account for general-equilibrium effects that are likely to importantly influence the distributional and human development effects of growth.

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[21]Without this normalization it is difficult to distinguish the different lines on the graph.

[22]Note that the fact that this 7 percent corresponds with that for income is no accident. As the relative income of landed and landless gap is technologically determined and invariant to the number of schools or productivity, the income difference is simply proportional to the level of income.

By focusing on school attendance in a setting for which the nature of technical change, the operation of labor markets, and the extent of schooling returns are well understood, we have in this paper provided one example of how human development among the poorest households and its distribution can be worsened in an environment in which there is significant poverty reduction. The partial equilibrium-responses in this paper are straightforward. Because there is no market return to schooling for landless households, expected agricultural technological change increases schooling in landed but not landless households thus increasing school inequality. From a general-equilibrium perspective, however, two additional factors come into play: the market for child labor and school construction. The operation of the market for child labor worsens the distributional impact of agricultural productivity on school investment across landless and landed households, as landless child labor is used to replace landed child labor lost due to increased child school attendance in landed households.

Our results also suggest, however, that school construction is undertaken a t higher levels in areas in which there are expectations of greater future productivity increases and that the closer proximity of schools differentially benefits landless households. Thus endogenous school building tends to offset the adverse distributional consequences of agricultural technological change. The allocation of schools, however, does not fully offset the incentives for landless households to reduce schooling investments. Fundamentally, the perverse correlation between human development and income growth among the poor is not due to lack of responsiveness of public resources but to the lack of a return to schooling in the non-farm sector. Unless the green revolution is also accompanied by nonfarm productivity change and growth it is unlikely that human development among the rural landless will increase at the same pace as among the landed in the foreseeable future.

References

Basu, Kaushik. (1999) “Child Labor: Cause, Consequence, and Cure,” *Journal of Economic Literatur*e, 37:3, pp.1083-1119.

Behrman, Jere, Andrew D. Foster, Mark R. Rosenzweig, and Prem Vashishtha, 1999, "Women's Schooling, Home Teaching, and Economic Growth", *Journal of Political Economy*,

Foster, Andrew D. and Mark R. Rosenzweig, 1996, "Technical Change and Human Capital Returns and Investments: Evidence from the Green Revolution", *American Economic Review* 86(4): 931-953 September.

Foster, Andrew D. and Mark R. Rosenzweig, forthcoming, “Household Division and Rural Economic Growth,” Review of Economic Studies.

Foster, Andrew D. and Mark R. Rosenzweig 2000a “Does Economic Growth Increase the Demand for Schools? Evidence from Rural India, 1960-1999,” manuscript.

Foster, Andrew D. and Mark R. Rosenzweig 2000b, “Child Labor, Adult Wages, and the Welfare Consequences of the Green Revolution in Rural India.,” manuscript.

Foster, Andrew D. and Mark R. Rosenzweig,1994, "Information, Learning, and Wage Rates in Rural Labor Markets", *Journal of Human Resources*, 28(4): 759-790.

Nelson, Richard R. and Edmund S. Phelps. 1966. "Investments in Humans, Technological Diffusion and Economic Growth." *American Economic Review* 56:69-75.

Nerlove, Marc Assaf Razin and Efraim Sadka, 1987, *Household and Economy : Welfare Economics of Endogenous Fertility* Boston : Academic Press, 1987

Schultz, Theodore W., 1975, "The Value of the Ability to Deal with Disequilibria," *Journal of Economic Literature* 13:3, 827-846.

Table 1
Means and Standard Deviations of Key Variables, by Survey Year

Variable	1971	1982
Daily male agricultural wage rates, 1971 rupees	2.63 (1.01)	3.16 (1.46)
Price of irrigated land, 1971 rupees	4405 (3581)	10848 (9713)
Per-acre yield index using 1971 prices, HYV crops	289.3 (257.0)	586.0 (348.5)
Primary school enrollment rate, children 10-14 - landed	.408 (.302)	.503 (.359)
Primary school enrollment rate, children 10-14 - landless	.367 (.373)	.401 (.385)
Number of secondary schools built in subsequent 11 years	.157 (.371)	.170 (.382)
Number of secondary schools	.410 (.630)	.568 (.703)
Wealth per farm household, 1971 rupees	13647 (12947)	12091 (10060)
Proportion of landed households with a primary-schooled male	.449 (.326)	.421 (.365)
Proportion of landless households with a primary-schooled male	.171 (.321)	.269 (.383)
Total number of adults in village	835 (1092)	1831 (1209)
Total number of child workers in village, ages 10-14	18.3 (47.8)	62.7 (119)
Proportion children 10-14 who are boys - landed households	.541 (.231)	.533 (.285)
Proportion children 10-14 who are boys - landless households	.575 (.316)	.506 (.378)

Table 3
Land Prices in 1971 and Future (1982) Yields

	OLS	2SLS
Log irrigated land price, 1971[a]	.223 (3.48)[b]	.762 (2.20)
Log yields, 1971[a]	-.0553 (1.00)	-.581 (1.68)
Number of secondary schools in village, 1971	.167 (2.04)	.299 (2.37)
Proportion of farm households with a primary schooled male, 1971	.191 (1.30)	.227 (0.91)
Adverse weather in 1971	.217 (1.91)	.0311 (0.16)
Constant	3.83 (8.21)	2.80 (1.15
R^2	.140	-
N	229	229

[a]Instrumented variable. Instruments are: estimated technical change, 1968-71; presence of IADP program; presence of IAADP program. See text.
[b]Absolute value of t-ratio in parentheses.

Table 4
FE-IV Estimates: Determinants of School Enrollment Among 10-14 Year-Olds, by Land Ownership

	Landed	Landless	
Log of land price	.143 (2.52)[a]	-.342 (2.40)	-.330 (2.26)
Log of yield	.0441 (1.02)	-.168 (2.66)	-.168 (2.64)
Number of secondary schools	.278 (1.46)	.455 (2.03)	.472 (2.05)
Total wealth	-.104 (1.75)	-.0324 (0.57)	-.0301 (0.52)
Proportion of landed households with a primary-schooled male	.0918 (0.93)	-.184 (1.42)	-.170 (1.27)
Proportion of landless households with a primary-schooled male	-	-	-.0766 (0.43)
Proportion of 10-14 year olds male	.0732 (0.95)	.348 (3.62)	.343 (3.50)
N	382	222	222

[a]Absolute value of asymptotic t-ratio in parentheses.

Table 5
FE-IV Estimates: Determinants of School Building

	(1)	(2)	(3)
Log of land price[a]	.163 (2.37)[b]	.439 (2.53)	.387 (2.56)
Log of land price x proportion of households landless[a]	-	-.388 (1.92)	-.320 (1.70)
Log of yield[a]	.00790 (0.17)	-.227 (1.59)	-.196 (1.45)
Log of yield x proportion of households landless[a]	-	.527 (2.00)	.439 (1.70)
Number of secondary schools[a]	-.779 (3.12)	-.665 (2.03)	-571 (1.75)
Total wealth[a]	-.00357 (0.07)	-.141 (1.10)	-.102 (0.96)
Proportion of landed households with a primary-schooled male[a]	-.439 (4.07)	-.571 (2.99)	-.503 (2.75)
Proportion of landless households with a primary-schooled male[a]	-	-	-.407 (1.59)
N	410	410	410

[a]Instrumented variable. See text.
[b]Absolute value of asymptotic t-ratio in parentheses.

Table 2

Dependent variable	ΔLog Total Farm Output	ΔLog Total Child Workers	ΔLog Daily Male Agricultural Wage	
Est. Procedure	OLS	OLS	TSLS	TSLS
ΔLog total farm output[a]	-	-	.178 (4.83)[b]	.198 (4.82)
ΔLog total child workers[a]	-	-	-	-.0581 (1.53)
ΔLog total adults	-	-	-.142 (2.44)	-.127 (2.03)
Estimated technical change	.0431 (1.95)	-.0481 (1.31)		
IAADP	.569 (2.48)	-.712 (1.80)		
Proportion of farm households with primary school person	.489 (1.49)	1.51 (2.90)		
Log wealth in 1971	-.491 (3.34)	-.324 (1.34)		
Log gca in 1971	-.124 (0.97)	.635 (2.92)		
Number of secondary schools in 1971	-.0243 (0.14)	.269 (0.91)		
ΔRatio boys/girls	.112 (0.41)	.772 (1.65)		

[a]Endogenous variable.
[b]Absolute value of t-statistic in parenthses.

Figure 1: Productivity and School Construction given Alternative Social Welfare Functions

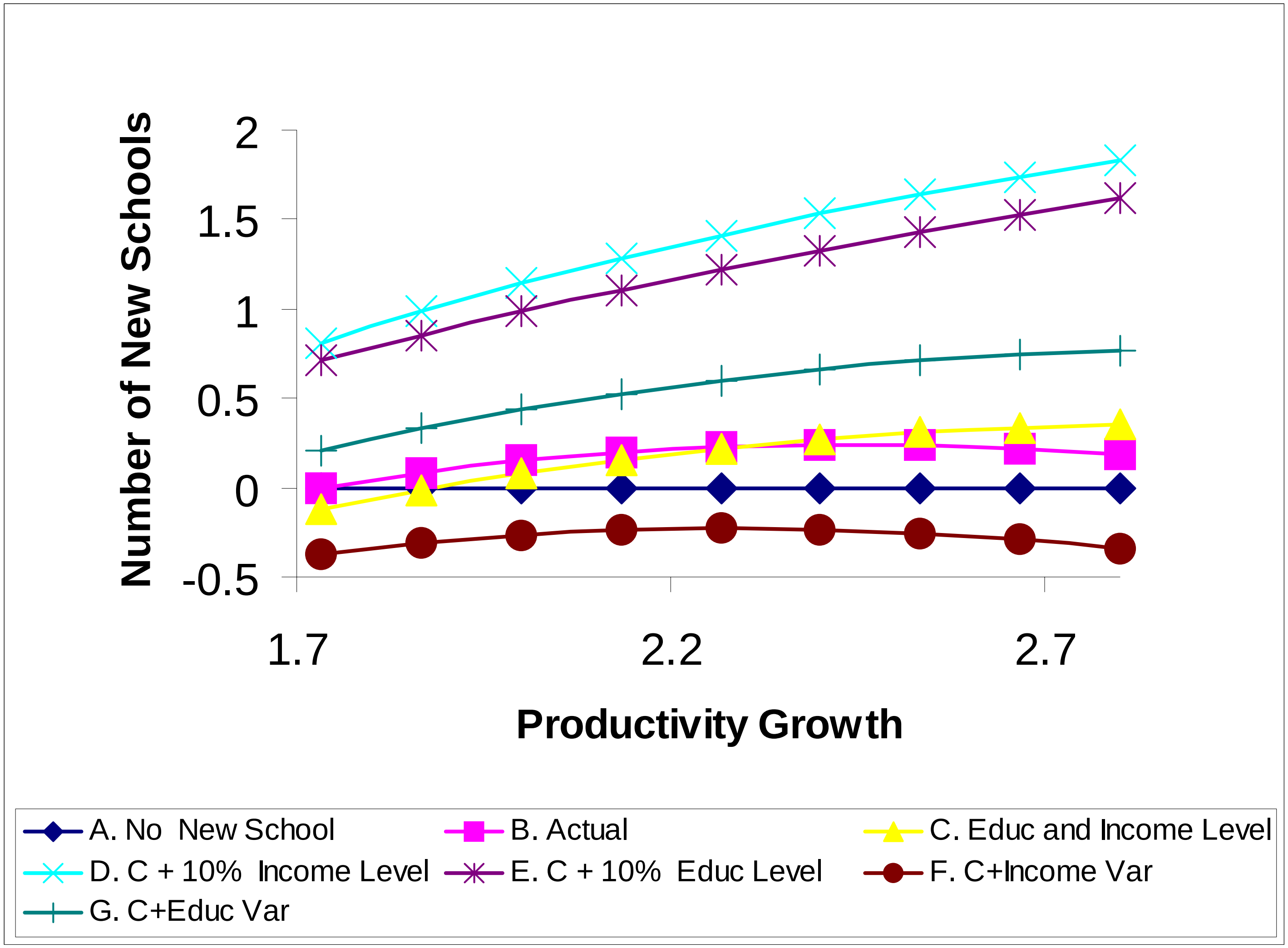

Figure 2: Productivity and Mean Schoolng given Alternative Social Welfare Functions

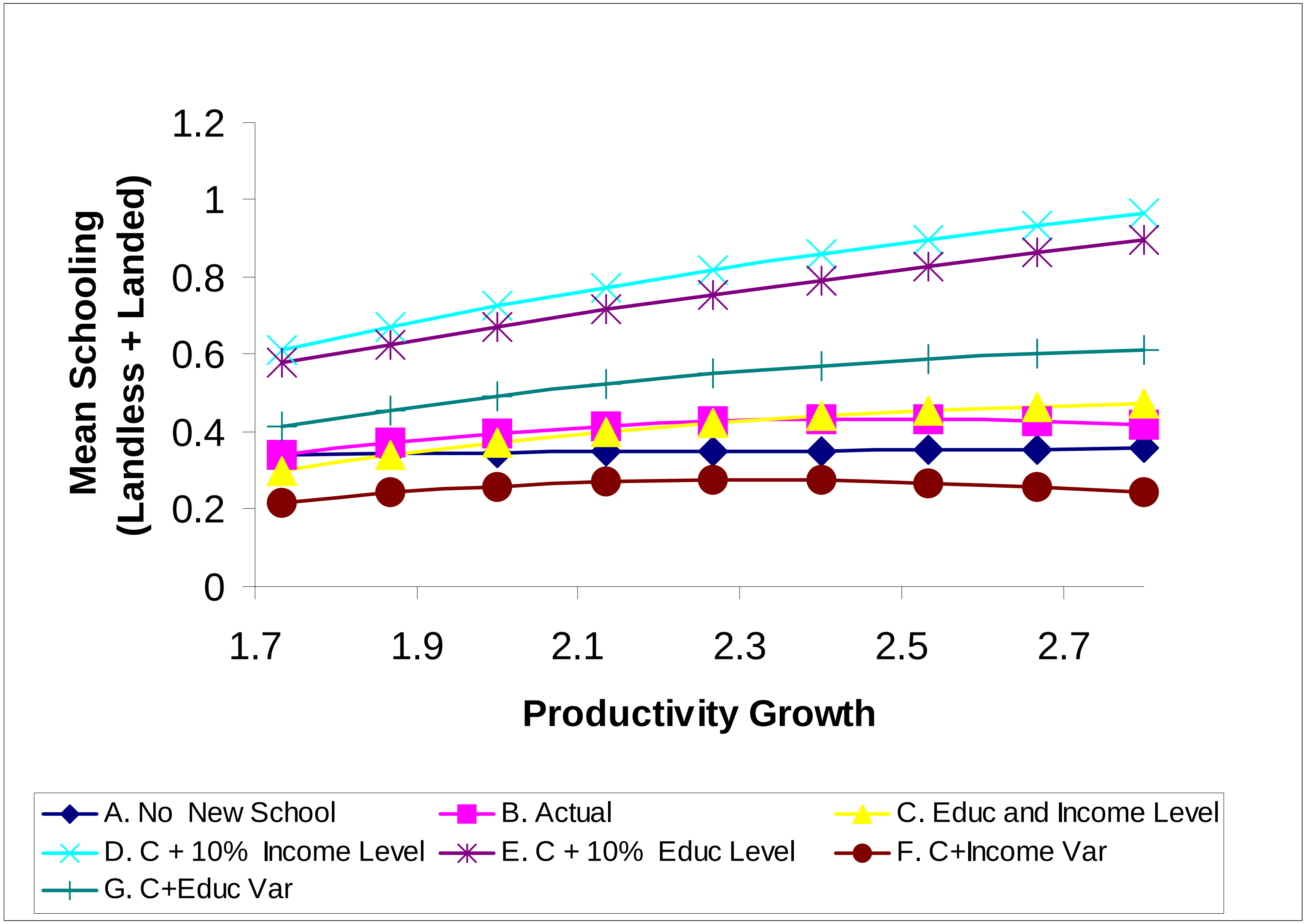

Figure 3: Productivity and Mean Income given Alternative Social Welfare Functions

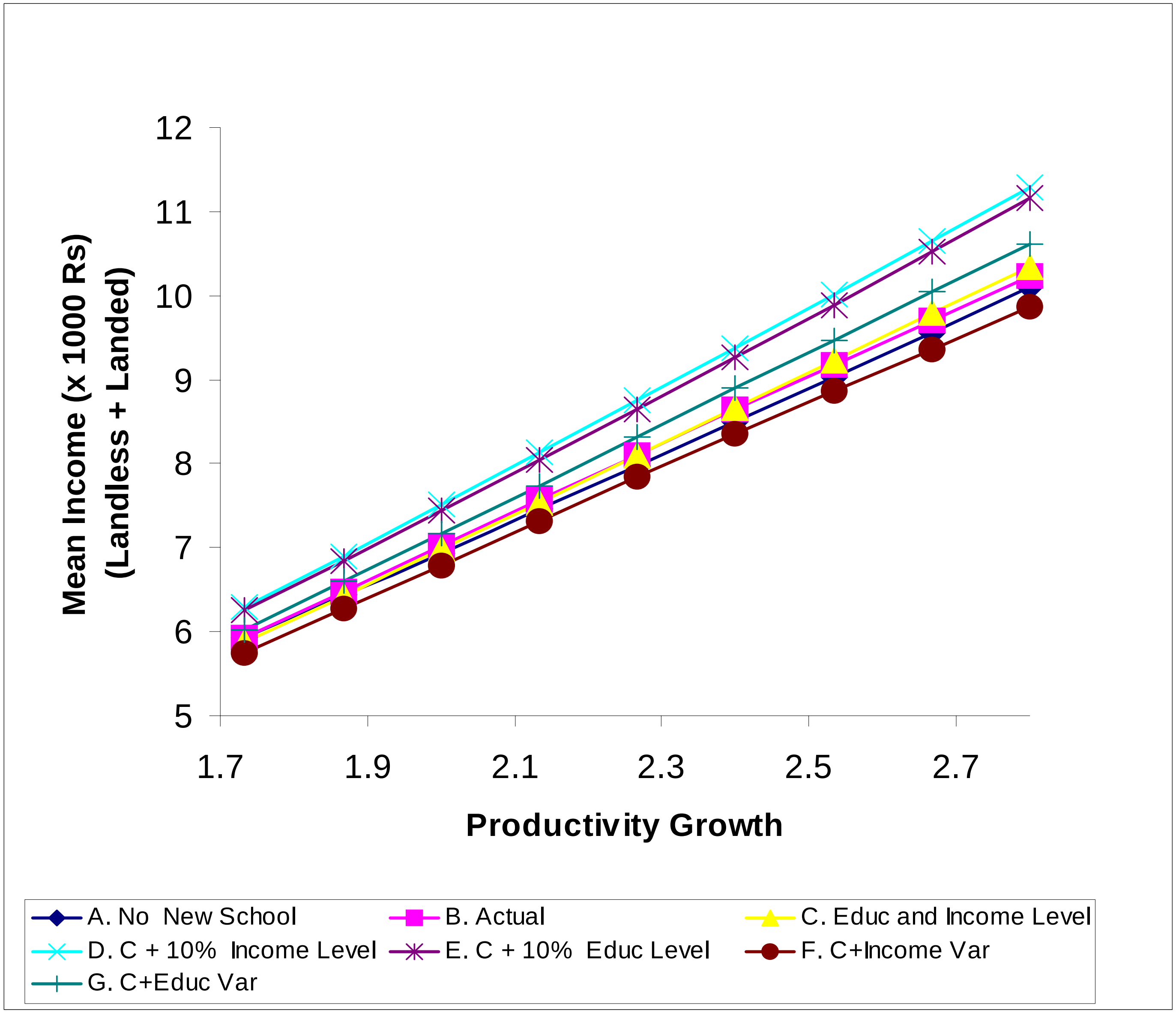

Figure 4: Productivity and Schooling Differential given Alternative Social Welfare Functions

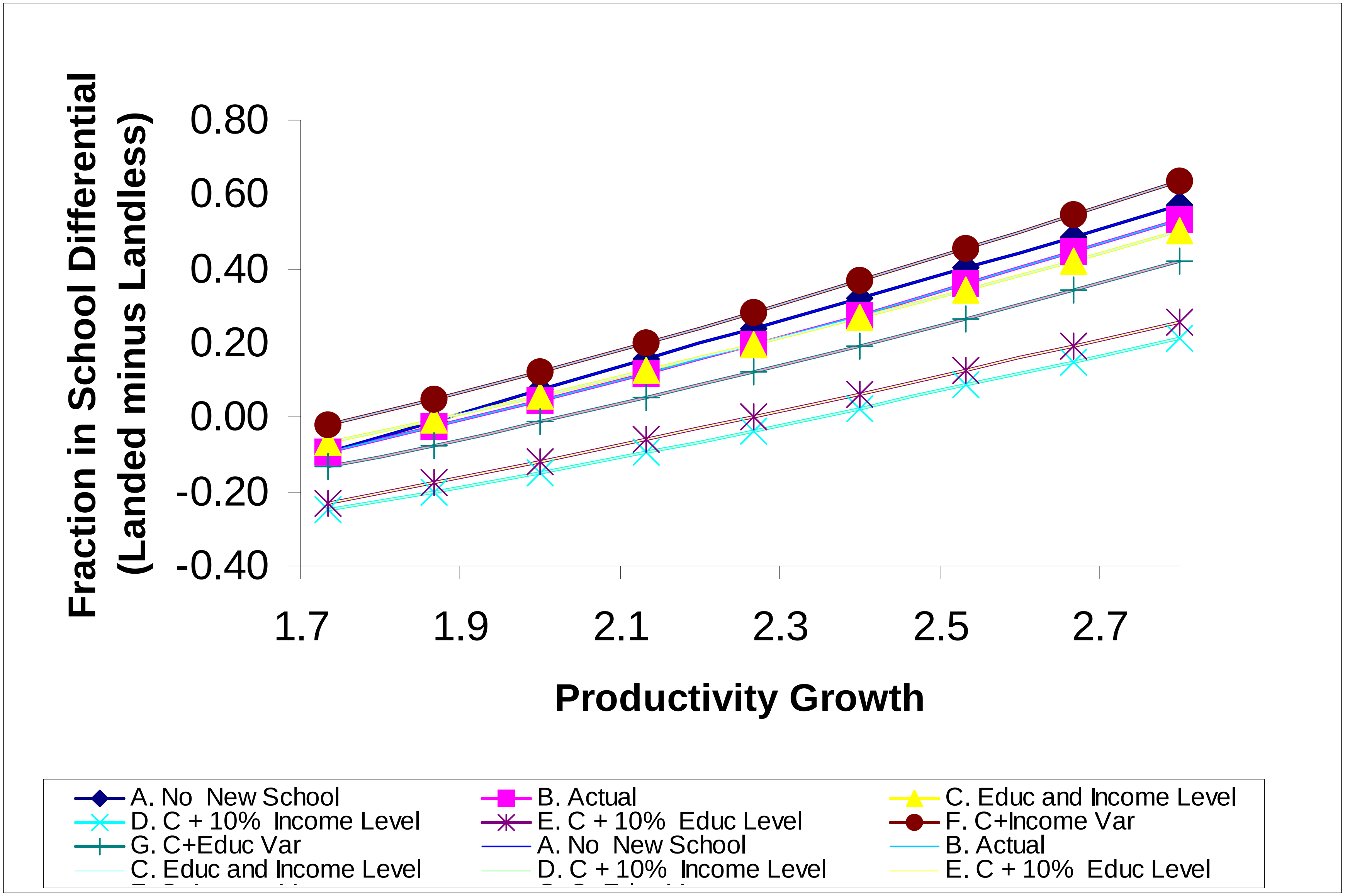

Figure 5: Relative Income Differential given Alternative Social Welfare Functions