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Children's Working Hours and School Enrollment: Evidence from Pakistan and Nicaragua

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Although much of the literature on child labor looks at the decision on whether to send a child to school or to work (or both), little attention has focused on the number of hours worked. This article analyzes the determinants of school attendance and hours worked by children in Pakistan and Nicaragua. A theoretical model of children's labor supply is used to simultaneously estimate the school attendance decision and the hours worked, using a full model maximum likelihood estimator. The model analyzes the marginal effects of explanatory variables, conditioning on latent states, that is, the propensity of the household to send the child to work or not. These marginal effects are in some cases rather different across latent states, with important policy implications.

Child labor is thought to be harmful to children's welfare in many ways. It interferes with human capital accumulation and may affect the present and future health of the child. The recent literature has explored the determinants of child labor supply (see Basu 1999; Rosati and Tzannatos 2003; Cigno and others 2001; Cigno and Rosati 2002), focusing largely on the determinants of the categorical decision of the household on whether to send a child to school or to work or both.[1] Almost no attention has been paid to the amount of time that children devote to work (whether this is their sole activity or whether it is combined with school attendance). An exception is Ray (2000), which treats labor supply separately from the household decision to send a child to school.

The number of hours spent working not only is important in itself as a measure of child welfare (as a measure of forgone leisure, for example) but is also essential for evaluating the cost of work in terms of health and human capital accumulation. This article adds to the literature by focusing on the

1. The cited literature also looks at the quantitatively nonnegligible cases in which children appear to neither work nor go to school.

simultaneous decision on school attendance and amount of work supplied. A simple theoretical model is constructed to simultaneously estimate two equations. In addition to giving full consideration to the joint decisions about work and schooling, the model also calculates marginal effects, conditioning on the "latent" propensity of the child to attend school or to work. These marginal effects are in some cases rather different across latent states; this has interesting analytical and policy implications.

I. The Theoretical Outline and the Model

Consider an altruistic arrangement in which parents care about the present and future consumption and current leisure of their children.[2] The number of children is taken as given and for simplicity of exposition is normalized to one.[3] Human capital accumulation is the only way to transfer resources for children's future consumption.[4] Human capital is accumulated by sending children to school.[5] The time a child has to spend at school is fixed at h_S. Normally, school hours are not flexible, and school attendance requires a minimum fixed amount of time devoted to school. Some of the children who both work and attend school might miss some classes, thus making their school hours more flexible. However, the flexibility that can be achieved in this way is limited, because skipping school often leads to dropping out and is normally not tolerated by school authorities.[6] Hence, school hours are treated as fixed.

School attendance does not rule out child labor, but working hours are assumed to have a negative influence on human capital accumulation. Hours spent at work reduce time available for study, tire the child, and reduce learning productivity. Because most children perform mainly unskilled labor and mostly on a family farm or business, the hours spent at work, h_L, can be considered flexible and so can be treated as a continuous choice variable.

2. As discussed in Rosati and Tzannatos (2003), similar results are obtained if a nonaltruistic model is used.

3. Endogenous fertility does make a difference to child labor analysis (Rosati and Tzannatos 2003), but for the current analysis, nothing of substance is changed by treating fertility as exogenous.

4. If capital markets were present, the efficient level of human capital investment would equalize returns to human capital investment and the market interest rate. Allowing for the presence of capital markets complicates the exposition without bringing additional insights. For a discussion of the role of capital markets in determining child labor supply, see Rosati and Tzannatos (2003).

5. Child labor could also contribute to human capital accumulation through, for example, on the job training. This case is not included in the discussion for two reasons. First, there is no evidence to substantiate the claim that child labor is a means to accumulate human capital. Second, formal education plays an empowerment role that goes beyond that of increasing the productivity of working time. This effect is captured in the model by introducing human capital as such as an argument of the utility function.

6. There are programs that try to make school hours more flexible to accommodate child labor activities, but their coverage is marginal, and in any case, such programs are not present in Pakistan.

The human capital production function takes the form

(1) $$H = h(h_L;h_S); h(,0) = 0,$$

where $\partial H/\partial h_L < 0$. Parents maximize a utility function defined over the current consumption of household members and the current leisure and future consumption of the children.

If parents send their children to school, current household consumption, C_1, is given by

(2) $$C_{1S} = y + w\,h_L - q$$

where y is the (exogenous) income of the parents, w is the wage rate (marginal product) of child labor, and q is the direct cost of education. Children's future consumption, C_{2S}, is given by $K + H$, where K is the exogenous endowment of human capital and H is defined in equation 1. Parents also attach value to the current leisure enjoyed by children, $L = 1 - h_S - h_L$ (having normalized total available time to one).

If parents do not send their children to school, present household consumption is given by $C_1 = y + w\,h_L$, future consumption by $C_{2L} = K$, and current leisure by $L = 1 - h_L$.

In both cases the choice variable is h_L (the time spent at work), but the money and time budget constraints differ according to whether the child is sent to school or not.

As the amount of time required by school attendance is fixed, the parents' choice of h_L is given by

(3) $$\text{Max}[U_S^*(h_L), U_L^*(h_L)],$$

where

(4) $$U_S^* = \max_{h_L}\ U(y + w\,h_L - q, K + H(h_L;h_S), 1 - h_S - h_L; M)$$

and

(5) $$U_L^* = \max_{h_L}\ U(y + w\,h_L, K, 1 - h_L; M)$$

and M represents a vector of household characteristics, such as education of the parents and location of household. In other words, parents compare the maximized utility under the two regimes and select the one that yields the highest welfare.

The optimal decision regarding school enrollment, s, is given by

(6) $$s > 0, \text{ if } U_S^* > U_L^*$$

and vice versa.

The system of equations 3–6 generates two behavioral equations in s and h_L, which can be expressed in reduced form as functions of the set of exogenous variables already discussed.

The comparative statics properties of the model show that as parents' income rises, the probability that a child attends school increases and the number of hours worked falls. An increase in the cost of schooling reduces human capital accumulation. These results depend on the simplifying assumptions of exogenous fertility and absence of capital markets. Relaxing such assumptions does not change the results of interest here, but it will make a difference to the discussion of child labor policies. (A detailed analysis of these issues can be found in Rosati and Tzannatos 2003). Note that other things being equal, child labor supply is expected to be lower when children are attending school because of the negative effect on human capital accumulation and the higher marginal value of leisure. Also observe that corner solutions are possible in both regimes for h_L.

As illustrated, the decisions on schooling and working are simultaneous. In particular, a child is enrolled in school if $U_S^* - U_L^* > 0 \Rightarrow s^* > 0$, and the hours of work supplied by the child also depends on enrollment status.

Hours worked and enrollment status are modeled using the following reduced form.[7]

(7) $$s^* = Z'g + u$$
(8) $$h^* = X'b + \varepsilon,$$

where h^* is hours worked, s^* is enrollment status, and ε and u are the disturbance terms following a bivariate normal distribution with zero means and variance covariance matrix, Σ, as follows:

$$\Sigma = \begin{bmatrix} 1 & \sigma_{\varepsilon u} \\ \sigma_{\varepsilon u} & \sigma_\varepsilon^2 \end{bmatrix}.$$

The two equations are allowed to be correlated through their error terms. One possible source of correlation is the unobservable (by a researcher) ability of the child. If children with higher abilities are more likely to go to school and work fewer hours, a negative correlation between the two error components would be expected.

Both the enrollment rate and the hours worked are latent variables. Enrollment is observed as a dichotomous variable, according to the following structure:

$$s = 1 \text{ if } s^* > 0$$
$$s = 0 \text{ if } s^* \leq 0$$

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7. The subscript L is dropped because no confusion can arise.

Because it is not possible to buy time, the hours worked are censored at zero. Observed hours worked are assumed to be described by the following Tobit model:

$$h = h^* \text{ if } h^* > 0$$
$$h = 0 \text{ if } h^* \leq 0$$

The joint decision of working and studying is described by a simultaneous equation model that combines a tobit and a probit model with correlated disturbances. More specifically, each observation belongs to one of the four possible regimes:

1. Working hours > 0, enrolled;
2. Working hours $= 0$, enrolled;
3. Working hours > 0, not enrolled;
4. Working hours $= 0$, not enrolled.[8]

The model is estimated by maximum likelihood. The log likelihood function, L, for estimation of the parameters b, ρ, and σ is given by

$$L = \sum_{i \in 1} \ln \ p(s = 1, h^* > 0) + \sum_{i \in 2} \ln \ p(s = 1, h^* \leq 0) + \sum_{i \in 3} \ln \ p(s = 0, h^* > 0)$$
$$+ \sum_{i \in 4} \ln \ p(s = 0, h^* \leq 0)$$

II. THE DATA SETS

Two data sets were used in the estimates, drawn from surveys in Pakistan and Nicaragua. This permitted testing the determinants of hours of work and school enrollment with data from largely different economies with different social structures and different patterns of children's employment. A relatively larger number of children work for wages in Pakistan than in Nicaragua. This allows for greater confidence in the generality of the results obtained.

8. The probability associated with each of the regimes can be written as follows:

$$\Pr(1) = P(h^* > 0)^* P(s == 1 | h^* > 0) = \phi(h^* - X'b, \sigma) \Theta\left(\frac{(Z'g + \rho\sigma^{-1}(h^* - X'b))}{\sqrt{1 - \rho^2}}\right)$$

$$\Pr(2) = P(s = 1, h^* = 0) = \Theta 2(-X'b/\sigma, Z'g, -\rho)$$

$$\Pr(3) = P(h^* > 0)^* P(s == 0 | h^* > 0) = \phi(h^* - X'b, \sigma)\left(1 - \Theta\left(\frac{(Z'g + \rho\sigma^{-1}(h^* - X'b))}{\sqrt{1 - \rho^2}}\right)\right)$$

$$\Pr(4) = P(s = 0, h^* = 0) = \Theta 2(-X'b/\sigma, -Z'g, \rho)$$

where $\phi, \Theta, \Theta 2$ are respectively the univariate density function, univariate cumulative function, and the bivariate cumulative function

Pakistan

The survey in Pakistan, carried out in 1996, contains information on working children (age, gender, location, occupation, and industry); working conditions (hours worked, wages received, terms of employment, and safety and health aspects of the workplace); and socioeconomic characteristics of the children and their families. The Pakistan survey is part of the Statistical Information and Monitoring Programme on Child Labor led by the International Labour Organization (ILO) as part of its International Program for the Elimination of Child Labor (IPEC). The survey covers 10,453 households with an average of eight members, for a total of 77,684 household members. The goal of the survey is to investigate the conditions of working children, so only households that reported child labor within the age group 5–14 years were interviewed. The sample, therefore, is representative of the subset of the population of households that have at least one child working.

On the basis of the survey data on households with at least one working child, ILO-IPEC estimated that during the reference week 3.3 million children of the total of 40 million children ages 5–14, or 8.3 percent, were economically active and that during most of the previous 12 months almost 8.1 percent had as their principal activity either working or being available for economic activity.[9]

In the model estimates, however, references are to the sample of households with at least one working child and not to the whole Pakistani population. After eliminating observations with missing values, there are 27,512 children aged 5–14 in the sample. Table 1 shows the proportion of children who work and are enrolled in school programs and the proportion of full-time students and part-time workers among total children in the sample. The overall enrollment rate is about 40 percent, and there are very large gender differentials in enrollment rate at all age groups. A large proportion of the children cannot be classified in any of the three activities: "working only," "studying only," and "working and studying." They are classified as children with "no activities." Girls are more

TABLE 1. Children's Activities by Gender in Pakistan, 1996 (percentage of all children in sample aged 5–14)

Activity	Male	Female	Total
Work only	36.35	27.49	32.83
Study only	29.85	20.36	26.08
Work and study	19.56	2.32	12.71
No activities	14.24	49.82	28.38
Total	100	100	100

Source: ILO-IPEC 1996 Statistical Information and Monitoring Programme on Child Labor survey.

9. For details, refer to the technical documentation on the ILO Web site (www.ilo.org).

TABLE 2. Children's Activities by Gender in Nicaragua, 1998
(percentage of all children in sample aged 6–14)

Activity	Male	Female	Total
Work only	8.61	1.07	4.88
Study only	66.69	76.29	71.44
Work and study	6.81	2.77	4.81
No activities	17.90	19.87	18.87
Total	100	100	100

Source: Living Standards Measurement Study survey 1998.

likely than boys to belong to this group, probably because the questionnaire does not classify household chores as working activities.

Nicaragua

The Nicaragua survey, conducted in 1998, was part of the Living Standards Measurement Study survey.[10] There are 6,084 children aged 6–14 in the sample, representing 28.8 percent of the sample.

About 71 percent of children attend school (table 2). Attendance is higher for girls than for boys at all ages. Most of the children study only (76 percent of girls and 67 percent of boys). Girls are less likely than boys to work. About 20 percent of the children are apparently involved in no activities. Most of these are girls, again perhaps reflecting their greater participation in household chores than boys.

III. ESTIMATES OF CHILDREN'S LABOR SUPPLY AND SCHOOL ATTENDANCE

Table 3 present descriptive statistics, and tables 4 and 5 present the results of the maximum likelihood estimates for Pakistan and Nicaragua. The coefficient of correlation, ρ, is negative in both estimates, indicating that it would be inappropriate to estimate the two equations separately. This is confirmed by the estimated coefficients for independent probit and tobit regressions, which differ from those obtained in the maximum likelihood estimation by more than 10 percent in some cases. It is beyond the scope of this article to try to establish the direction of the bias and the characteristics of the correlation structure among the variables that are likely to influence the size and the direction of the bias itself.[11]

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10. The Living Standards Measurement Study was developed by the World Bank in 1980 to explore ways of improving the type and quality of household data collected by government statistical offices in developing economies.

11. For reasons of space, the results are not shown here. Interested readers are referred to a longer version of the article available online at www.ucw-project.org.

TABLE 3. Descriptive Statistics

Variable	Pakistan		Nicaragua	
	Mean (1)	SD (2)	Mean (1)	SD (2)
Weekly hours worked	15.72	20.74		
Daily hours worked			0.68	2.11
Weekly hours worked if working	35.29	16.59		
Daily hours worked if working			5.94	2.77
Age (years)	10.14	2.780	9.82	2.58
Household size (number of members)	8.46	3.54	7.74	2.99
Number of babies	1.38	1.30	3.13	1.45
Number of children	3.55	1.48	1.04	1.07
Household (net) income (rupees)	2,968.34	2,588.09		
Household income (cordobas)			4,779.45	5,894.62
Proportion of female	0.389	0.487	0.49	0.50
Proportion of rural	0.435	0.496	0.55	0.50
Father's education: proportion with primary	0.267	0.442	0.42	0.49
Father's education: proportion with secondary or more			0.19	0.40
Mother's education: proportion with primary	0.053	0.225	0.44	0.50
Mother's education: proportion with secondary or more			0.16	0.37
Number of observations	27,512		4,278	

Note: The samples consist of children aged 5–14 in Pakistan and 6–14 in Nicaragua.

Source: Authors' computations based on ILO-IPEC 1996 Statistical Information and Monitoring Programme on Child Labor survey (Pakistan) and the Living Standards Measurement Study survey of 1998 (Nicaragua).

The regressors used in the enrollment equation include the following variables for the Pakistani data: age, age squared, household income net of child earnings,[12] household size, number of children aged 5–14, number of children aged 0–5, number of children aged 0–5 interacted with the female dummy variable, a dummy variable for girls, a dummy variable for rural areas, and dummy variables for fathers or mothers who have at least a primary education. A similar set of regressors was used for Nicaragua, with a change in the dummy variables for parents' education to reflect the different characteristics of the sample: one dummy variable for parents' completion of primary school and

12. To obtain total adult income, children's wages were first estimated using a two-step Heckman procedure to predict the earnings of children who do not work for a wage or for whom wage data are not available and then netting out the predicted child earnings from the household income.

a second for completion of secondary school. Moreover, because the data for Nicaragua did not allow separating adults' and children's income, total expenditures were used as a proxy for total available household resources.

The structure of the model enables estimation of the marginal effects, conditioning on the latent status of children: enrolled or not, working or not. This provides information on the effects of exogenous variables differentiated by latent status of children. The differences that emerge among the various groups are not negligible, indicating that the policy effects of the interventions might be differentiated according to the target selected.

Columns (a) and (b) of tables 4 and 5 report the marginal effects conditioned on desired working hours being positive or not. Some of the explanatory variables have quite different effects on the two (high and low propensity to work) groups.[13] School enrollment is a nonlinear function of age. Income has a positive effect on enrollment. However, the effect is much smaller for children with a high propensity to work compared with the other group. The household composition effects are well determined. With income controlled for, these effects should reflect mainly the marginal productivity of children's time in the various activities. Again, the marginal effects are differentiated across latent groups. Household size has a negative and small effect on the probability of attending school for the potentially working children, and it has a strong and significant positive effect on the other group. Substitutability between adult and child work appears to be stronger in households that are not likely to send their children to work than in those that are.

An additional child in the household negatively affects the enrollment rate for the nonworking children in both countries. The presence of preschool-age children reduces the enrollment probability for children who are not likely to work and has the opposite effect for children who are likely to work. This effect is more pronounced for girls, even though in Nicaragua it is significant only at the 10 percent level. Children living in rural areas are also less likely to be enrolled in school. The presence of a significant gender differential in enrollment is confirmed by the estimates in both countries, albeit in opposite directions. In Pakistan girls are less likely than boys to be at school, and the probability decreases further if there are preschool-age children in the household, as shown by the negative coefficient of the product of the number of young children in the household and the dummy for being a girl. In contrast, girls have a higher probability than boys of being enrolled in school in Nicaragua, although the chances of attending school are reduced if there are preschool-age children in the household.

Columns (c) and (d) of tables 4 and 5 show the marginal effects on working hours conditional on the latent enrollment or nonenrollment status of the

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13. The standard errors of the marginal effects are reported in the extended version of the article (www.ucw-project.org).

TABLE 4. Maximum Likelihood Estimates of Child Enrollment and Hours Worked in Pakistan

| | Enrollment | | | | Hours | | | |
| | | | Marginal effect | | | | Marginal effect | |
Regressor	Estimated coefficient	P^a	working (a)	not working (b)	Estimated coefficient	P^a	enrolled (c)	not enrolled (d)
Age	0.592	0.000	0.192	0.459	18.762	0.000	4.712	3.899
Age^2 / 100	−3.339	0.000	−0.205	−2.178	−49.515	0.000	−1.308	2.817
Household size	0.038	0.000	−0.006	0.021	0.033	0.782	−0.221	−0.264
Number of children	0.023	0.011	−0.061	−0.014	−3.686	0.000	−1.798	−1.794
Number of babies	−0.051	0.000	0.035	−0.015	1.685	0.000	1.073	1.116
Number of babies * female child	−0.127	0.000	0.067	−0.047	2.924	0.000	2.104	2.221
Household income/1000	0.032	0.000	0.008	0.016	−0.173	0.036	−0.278	−0.313
Female child	−0.375	0.000	−0.133	−0.173	−28.744	0.000	−8.389	−11.25
Rural	−0.048	0.004	−0.018	−0.021	−1.307	0.001	−0.603	−0.768
Father with primary education or more	0.620	0.000	0.245	0.237	−5.115	0.000	−0.401	−0.927
Mother with primary education or more	0.460	0.000	0.179	0.181	−3.760	0.000	−0.266	−0.714
Constant	−2.966	0.000			−115.923	0.000		
Coefficient of correlation	−0.643							

TABLE 5. Maximum Likelihood Estimates of Child Enrollment and Hours Worked in Nicaragua

	Enrollment				Hours			
			Marginal effect,				Marginal effect,	
Regressor	Estimated coefficient	P^a	working (a)	not working (b)	Estimated coefficient	P^a	enrolled (c)	not enrolled (d)
Age	0.777	0.000	0.464	0.174	3.092	0.001	5.161	-2.792
Age^2 / 100	-0.041	0.000	-0.011	-0.009	-0.059	0.165	-0.113	0.177
Household size	0.0386	0.005	-0.070	0.009	-0.564	0.000	-0.834	-0.357
Number of children	-0.035	0.149	0.076	-0.008	0.603	0.009	0.896	0.350
Number of babies	-0.132	0.000	0.161	-0.029	1.316	0.000	1.922	1.034
Number of babies * female child	-0.067	0.108	-0.041	-0.015	-.278	0.515	-0.463	0.238
Household income/1000	0.0968	0.000	0.010	0.022	0.016	0.749	0.082	-0.460
Female child	0.2295	0.001	0.007	0.046	-6.083	0.000	-0.804	-1.109
Rural	-0.362	0.000	-0.108	-0.105	3.196	0.000	0.470	0.673
Father with primary education or more	0.2562	0.000	0.104	0.072	-0.900	0.072	-0.073	-0.095
Mother with primary education or more	0.4575	0.000	0.180	0.229	-0.914	0.281	-0.020	0.001
Father with secondary education or more	0.3073	0.000	0.124	0.084	-1.524	0.002	-0.161	-0.214
Mother with secondary education or more	0.4901	0.000	0.192	0.123	-3.791	0.000	-0.453	0.612
Constant	-3.298	0.000			-32.186	0.000		
Coefficient of correlation	-0.344							

[a]Probability that true coefficient is zero.

Source: Authors' computations based on ILO-IPEC 1996 Statistical Information and Monitoring Programme on Child Labor survey (Pakistan) and the Living Standards Measurement Study survey of 1998 (Nicaragua).

working child.[14] Once the covariance in the errors is taken into account, the marginal effects are quite different from the estimated coefficients. An increase in income reduces the number of hours children work, with a stronger effect for children who are likely not to be in school. Household size has a negative effect on hours worked: children in larger households work fewer hours, if they work. The presence of an additional preschool-age child increases the number of hours worked. This effect is more pronounced for girls (though not significant for girls enrolled in school in Nicaragua), as shown by the positive coefficient of the interaction between number of children and being a girl. In Nicaragua the presence of an additional school-age child in the household increases the daily hours worked by more than an hour.

Girls work fewer hours than boys, probably because household chores are not recorded as working activities in the survey. Children working in rural areas are less likely to attend school, but they work fewer hours than do children working in urban areas.

The results are similar for Nicaragua and Pakistan. The main differences are in the effects of the number of school -age children and area of residence. Children in households with larger numbers of school-age children tend to work more hours in Nicaragua but fewer hours in Pakistan. Living in a rural area increases the number of hours worked in Nicaragua but lowers the hours in Pakistan.

IV. Conclusions

The literature on child labor has somewhat neglected the determinants of the number of hours worked by children in favor of the determinants of the household decision to send children to school or work. Knowing the duration of work is important for assessing its impact on children's health and human capital accumulation. A simultaneous equation system was derived from a simple theoretical framework and used to estimate household decisions relative to children's school enrollment and hours worked. The results show the importance of taking into account the simultaneity of the decision about schooling and hours worked in assessing the importance of different explanatory

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14. The marginal effects in column (c) were obtained by differentiating with respect to each regressor the expected value of the hours worked conditional on the enrollment and working status of the child (Maddala 1993):

$$E(h|h^* > 0, s^* > 0) = \beta'X + \frac{\sigma}{\Phi_2(X'\beta, Z'g, \rho)} \left(\phi(-X'\beta/\sigma)\Phi\left((1-\rho^2)^{-1/2}(Z'g - \rho X'\beta/\sigma)\right) \right.$$
$$\left. + \rho(-Z'g)\Phi\left((1-\rho^2)^{-1/2}(X'\beta/\sigma - \rho Z'g)\right) \right).$$

Total marginal effects of the enrollment probability conditional on the working status of the child in column a are derived by partially differentiating the enrolment probability with respect to each regressor: $E(s^* > 0 \| h^* > 0) = \Phi_2(X^{*'}\beta^*, Z'g, \rho)/\Phi(X^{*'}\beta^*)$.

variables. In this simultaneous system the effect of the variables on the hours worked also depends on the changes they induce in the probability that a child is sent to school, through the correlated error terms of the two equations.

Moreover, the structure of the model allows the marginal effects to be computed conditional on the latent variable indicating the propensity of the household to send the child to work or not. These marginal effects may be very different among the two groups and show that policy action can have a different impact depending on whether the child is likely to be sent to work or not.

Consider, for example, the case of income. The results indicate that policies aiming to reduce child labor by introducing incentive schemes (like income transfers) that only marginally modify the opportunity set of the household are likely to produce more significant effects on households that are at the margin between sending their children to work or to school—households that have a low propensity for child labor. Such schemes are likely, if not properly targeted, to be ineffective in households—most likely the poorest and most uneducated—that have a high propensity to send their children to work.

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