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GSICS Working Paper Series

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No. 19
March 2008

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Cooperation Studies
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—A Case Study in Rural Cambodia—

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Ⅰ. Introduction

Child labor has long been recognized as being detrimental to human capital formation of child. However, although numerous literature supports the view that child labor impedes the acquisition of education and human capital, some empirical studies support the argument that child labor has the potential to affect human capital formation of child in a positive manner (for reviews, see Edmonds, 2007; Udry, 2006).

The research question of this paper is as follows: Does child labor affect the acquisition of child human capital?

In recent decades, a large amount of literature has demonstrated the existence of a trade-off between child labor and human capital formation.

Many empirical literatures focusing on whether children go to school or participate in labor force (see Basu and Tzannatos, 2003; Shafiq, 2006) provide evidence on the abovementioned trade-off relationship.

In contrast to the studies, Akabayashi and Psacharopoulos (1999); Rossati and Rossi (2003); Heady (2003); and Gunnarsson, Orzem, and Sanchez (2006) studied Tanzania and Belize; Pakistan; Nicaragua; Ghana; and nine Latin American countries, respectively in order to investigate the relationship between child labor and education outcome by using certain measures of education attainment. All these studies found that the number of hours of work are negatively correlated with the attainment of education.

However, a small increase in child labor does not necessarily result in a trade-off with human capital investment (Fan, 2004), since the positive impact of increased financial resources on education may outweigh the negative impact of reduced time for study. There is some evidence in support of this view (Edmonds and Turk, 2004 for Vietnam).

The estimation results of Ray and Lancaster (2005) indicate a U-shaped relationship between child labor hours and children's attainment of education, where the threshold labor hours are 30 per week. This implies that the children's attainment of education increase until the child labor hours rise up to the threshold hours; after this, it starts to decline once the labor hours exceed the threshold.

Han (2007), Ch. IV, also found a similar relationship between child labor and child education attainment by using the same data, though the econometric methodology used was different.

Compared to the number of studies on child labor and education, there are relatively only a few existing studies on child labor and child health.

1.Negative effects of child labor on health

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a) Direct effects due to illness and injury: International Labour Organization (ILO) (1998) indicates that worldwide, children are being exposed to hazards in their work environments, such as coming into contact with toxic pesticides, lifting heavy loads, operating machinery without appropriate training, being exposed to strong sunlight, dealing with lack of water and sanitation facilities, etc.

Guarcello et al. (2004) studied the cases of Bangladesh, Cambodia, and Brazil, where the causal link between hours of work and ill health indicates that the number of working hours exerts a significant effect on the probability of negative health outcomes.

b) Long-run negative effects: Satyanarrayanan et al. (1986); Kassaouf et al. (2001); Guiffrida et al. (2001); and Rosati and Straub (2007) conducted studies in India, Brazil, and Guatemala, respectively; they found that child labor has negative effects on child laborers when they grow through adulthood, due to injury or illness.

c) Indirect effects through sacrifice of education: According to Guarcello et al. (2004), it is possible that child labor is at the expense of education and the lower level of educational attainment could negatively impact on health through the lower life time earnings and the lower knowledge about health production. However, as mentioned above, in conditions of poverty, child labor may have a positive or neutral impact on education attainment. Therefore it may also have a positive impact on health due to the improved standards of living for the children themselves and their families.

2. Counter examples of negative health effects: The findings of Cigno and Rosati (2001) do not support those of Satyanarrayanan et al. (1986) for the case in India. Fentiman et al. (2001) reported no growth differences between children enrolled in schools and children working, in the case of Ghana.

O'Donnell et al. (2005) have found little evidence of the contemporaneous impact of child labor on health in the case of Vietnam's agricultural child labor, although the work undertaken during childhood raises the risk of illness up to five years later and the risk increases with the duration of work.

Han (2007) suggested a contemporaneous inverse U-shaped relationship between child labor and child health in rural Cambodia.

As mentioned above, these investigations are not sufficient to confirm the relevance of the trade-off between child labor and child human capital formation. On reviewing the existing literature on this subject, we can conclude that the effects of child labor on child human capital largely depend on the type of child labor. Undoubtedly, any hazardous forms of child labor should be prohibited at all costs. However, child labor that is openly indulged in and which is commonly observed in rural Asia might not be considered particularly harmful to children's health (O'Donnell et al., 2005). Further, in the impoverished societies, child labor might contribute to increasing household income and child education attainment (Edmonds, 2005).

The main objective of this paper is to investigate whether or not child labor has contemporaneous negative impacts on child education attainment and health and nutrition status, by focusing on the rural setting of Cambodia.

In rural Cambodia, many households live under the poverty line.[1)] The local residents belonging to the poor rural communities do not perceive child labor to be harmful to children because they believe that children

understand the difficult lives their parents lead; thus, child labor is regarded as an important source of income for maintaining household consumption.

With regard to child labor in Cambodia and its impact on child human capital formation, as mentioned above, Ray and Lancaster (2005) studied the effects of child labor on child education attainment by using the Cambodia Socio-Economic Survey (CSES) 1999. Guarcello et al., 2004 and other researchers examined the impacts of child labor hours on injury and ill health by using Cambodian Child Labor Survey (CCLS).

However, the CCLS data has the following drawbacks. The work-related ill health rates are extremely high: almost eight times higher than those in Bangladesh and Brazil. In addition, the CSES does not contain the data for child health and nutrition status.

Moreover, the large scale data do not contain information about the characteristics of the community, such as social capital and social structure, which might affect the schooling of children and their health and nutrition.

In order to cope with these problems, we applied the small sample data collected through a village survey. By using this, we can ascertain the reliability of the large scale data and gain access to more detailed required information even though there are certain drawbacks to a small sample size.

We selected rainfed rice-growing area as the survey research site; the main work of children in this area are cattle rearing, fishing, etc., which cannot be considered harmful for child human capital formation if the labor hours are not considerably long. The purpose of the research was to examine the existence of an inverse U-shaped relationship between child labor and child human capital as well as the trade-off relationship.

This paper is organized as follows. In the following section, we describe the characteristics of the region, sample households, child education and health, and child labor in the survey area. Then, we employ the standard hybrid model and three econometric methodologies to examine the determinants of child human capital formation and its relationship with child labor. The estimation results are presented in section 3. The final section comprises the conclusion.

II. Household Characteristics, Child Schooling, Health and Nutrition Status, and Child Labor in the Survey Area

The research sites are located around 100 km southwest from Phnom Penh, Cambodia. We randomly selected four villages (Kan Damra; KK, Prey Changva; PC, Kol Korm; KK, Trapeang Krolong; TK) out of 150 villages that participated in the Rural Development and Resettlement Project (RDRP) which was jointly implemented by the Japan International Cooperation Agency and the Cambodian Ministry of Rural Development.

The village data were collected in September 2006—which was a slack season for farming—with the financial support of the Japan Society for Promotion of Science and Graduate School of International Cooperation Studies, Kobe University.

The sample households were randomly selected on the basis of resident registers. The sample comprised

a total population of 168 households, over 90% of which are farming households. These villages are in typical rainfed low land agro-ecological condition where paddy is the main crop; however, it is an unstable crop with very low productivity—1.5 t/ha–2.5 t/ha. Only village KK is partially irrigated.

The household characteristics are listed in Table 1. Farmers grow paddy in the rainy season and some of them grow vegetables in the early dry season. Moreover, the farm sizes are small—0.5 ha–1.1 ha—and family labor is relatively abundant for farming—2–3 persons. Therefore, farmers do not use capital intensive technology such as tractors and threshing machines; instead, they use labor intensive technology such as cattle for cultivation, hand-operated threshers for threshing, and so forth.

Farmers raise almost two herds of cattle for cultivation and/or for sale.

Agricultural productivity is low and the local job opportunities are limited. Therefore, more than half the households live under the poverty line.

The average per capita household income is $110–$170, and this figure is the highest in village KK where agricultural income is larger due to better availability of water. Village TK has a greater income from non-agricultural sources and it has flourished due to the handicrafts industry.

With regard to village TK, the characteristics of children in age group 5–14 are presented in Table 2.

On an average, each household has 1.2 children belonging to that age group.

The ratios of schooling attainments to age are low, although school enrollment ratios are high. This indicates that quite a few children entered school late as compared to their ages and/or stayed in the same class.

It should be noted that there was a significant delay in schooling in village PC. This could be because the elementary school and this village are situated at a great distance from each other (see Table 1).

The health status measured by self-assessed rank category showed variations, depending on villages. However, 15% of children in the age group of 5–14 assessed that they often suffer from illness or injury. This fact implies that quite a few children are constantly in a state of bad health.

The nutrition status of the children measured by height for age z-score is much lower than the average level, and 50%–80% of these children can be categorized as stunt. The nutrition status measured by Body Mass Index (BMI) for age z-score categorized as underweight is also lower than the average.

If we compare the four villages on the basis of level of income and child education and health in the same table, it will be found that the higher the average household income, the better are the education attainment, and the health and nutrition status measured by self-health assessment and height for age. However, the nutrition status measured by BMI is the worst in village TK where the average income is not lower. This might be related to the fact that ratios of usage of boiled drinking water and using toilet facility are the lowest in this village (see Table 1).

Moreover, the child health and nutrition status measured by height for age in village PC is the worst from among the four villages. This might be related to the longer distance from the health care center to this village and the absence of health care staff who have a good knowledge of medical treatment (see Table 1).

Table 1. Characteristics of Villages and Households

	Villages			
	KD	PC	KK	TK
Yield of Paddy (ton/ha)	1.97	2.69	2.34	2.14
Distance from Elementary School (km)	1	3	1	1
Distance from Secondary School (km)	2	3	4	1.5
Distance from Health Care Center (km)	1	3	2	1.5
Number of Medical Clinics and/or Nurses (person)	2	0	2	0
Ratio of using boiled drinking water (%)	85.71	71.43	78.13	57.69
Ratio of using toilet facility (%)	57.14	42.86	46.88	26.92
Number of Sample Households	46	41	45	36
Number of Farm Households	44	39	43	32
Number of Household Members (person/hh)	4.5	4.85	4.62	5.28
Number of Family Laborers (person/hh)	2.37	2.59	2.18	2.56
Age of Household Head (year)	46.94	41.85	47.31	43.72
The Highest Educational Years of Family Members (year)	8.65	6.07	8.49	6.97
Owned Land Area (m^2)	11049	6111	7160	5508
Household Income [1] ($/year)	661.7	544.35	779	826
Ratio of Agricultural Income (%)	36.55	34.91	52.5	23
Ratio of Non-agricultural Income (%)	35.91	40.19	31.42	60.42
Ratio of Remittance (%)	27.54	24.91	16.08	16.58
Per capita Income ($/person/year)	147.04	112.24	168.62	156.44
Ratio of Household under Poverty Line [2] (%)	63.04	80.49	57.78	61.11

Source: Household survey 2006

[1] 1$ = 4000 Riel

[2] We use the total poverty line in rural area (=0.44$ per capita per day, estimated on the basis of Cambodia Socio-Economic Survey, 2004)

The children are involved in various works in economic activities such as rice farming, cattle rearing, fishing for frog, fish, and crabs, as well as in domestic chores. Table 2 also presents the characteristics of child labor in the sample households.

The figures reveal that 64% of female children of ages 5–14 had experience in working in economic activities or domestic chores, while for their male counterparts, this amount stood at 51%. This is because female children are more frequently engaged in helping parents in the domestic work and taking care of younger children. The average working hours for male children are around 8 hours per week and those for female children are 9.3 hours per week. The working hours for female children are longer than those of male children.

Table 2 also presents the working hours over the past one week and the working hours during the agricultural peak season, categorized according to age groups. The figures indicate that the working hours of

Table 2. Characteristics of Children in the 5-14 Years Age Group

	Village			
	KD	PC	KK	TK
Number of Children	35	56	56	53
Ratio of Female Child (in %)	52.94	53.7	55.56	40.38
Child School & Education Attainment				
School Enrollment Ratio (%)	88.24	79.63	94.44	94.23
Delayed Primary School Enrollment (%)	94.12	94.44	81.48	82.69
Years Delayed (year)	2.15	3.07	1.44	1.79
Child Health & Nutrition Status				
Height-for-age z-score	–2.77	–3.31	–2.11	–2.79
BMI-for-age z-score	–1.75	–1.63	–1.67	–2.02
Ratio of Malnutrition (%) [1)]				
Stunting	76.47	83.33	50.00	73.08
Underweight	28.57	37.56	25.00	47.17

Child Labor	Type of Child Labor	
	Working Hours in the last one week (weekly hours/child)	Working Hours in Agric. Peak Season (yearly hours/child)
Gender		
Male	6.5	
Female	8.9	
Age		
5– 6 years old	0	0
7– 9 years old	3.3	9.7
10 – 12 years old	10.9	96.8
13 – 14 years old	15.6	103.7
14 years old	18.5	132.4
Land Size [2)]		
Less than 7000 m^2	13.9	144.7
7000 m^2 or more	11.9	119.8
Cattle [3)]		
Less than 2 heads	9.16	
2 heads or more	12.6	

Source: Household Survey 2006

[1)] Malnutrition is defined as the nutrition status with height-for-age z-score below –2 for stunting and BMI-for-age z-

[2)] The size of operated farm land per household

[3)] The number of cattle holding is calculated in terms of matured cattle

the children increase as the children get older. Particularly, the child labor hours in the 10 and above age groups, exhibit a remarkable increase. The working hours of children across all age groups in the research site are much

shorter than those put forth in the CCLS (Guarcello et al., 2004).

Table 2 indicates that there does not exists a significant difference in child labor hours during the peak season, between the households with larger than the mean size of farms and those with farms of a smaller size. On the contrary, we can find a significant difference in weekly child labor hours during the slack season between the households with two and more cattle, and those with single cattle. These facts suggest that child labor tends to be applied for light work such as cattle rearing rather than crop farming.

Table 3 presents some evidence with respect to the hazard related with the work done by children. This demonstrates the type of activities that children are involved in, such as operating machinery and applying pesticides. In this survey, 88.79% are children who neither applied pesticides nor operated machinery. Only 11.21% of the total number of children can be categorized under the risk group, as their work involves operating machines or applying pesticides or both. This evidence suggests that the frequency of work-related injury or ill health is much lower than 40%–50% in the range from 11 to 30 weekly working hours, as presented in the CCLS (Guarcello et al., 2004).

Table 3: Frequency, Row and Column Percentage of Children Aged 5–14, by Categories of Children Operating Machinery and Applying Pesticide

	Do not operate machinery	Operate machinery	Total
Do not apply pesticide	190	0	190
	100.00	0.00	100.00
	90.48	0.00	88.79
Apply pesticide	20	4	24
	83.33	16.67	100.00
	9.52	100.00	11.21
Total	210	4	214
	98.13	1.87	100.00
	100.00	100.00	100.00

Source: Author's calculation from Household Survey 2006

Ⅲ. Empirical Analysis

1. Theoretical Framework

We assume the optimal child human capital investment, such as child schooling; health is derived by the following household utility maximization behavior:

$$\underset{T, TH, M, X, CL}{Max} \quad U(Z, H) \tag{1}$$

subject to,

$$Z = Z(X, T; SC, PS, \theta F, \theta C) \tag{2}$$

$$H = H_0 + HI \tag{3}$$

$$HI = HI(M, TH, 1-CL; SC, PS, \theta F, \theta C) \tag{4}$$

$$P_m M + P_x X = W \cdot (\Omega - T - TH) + cW \cdot CL + A \qquad (5),$$

where

Z refers to non-child human capital commodities.

H refers to child human capital including child education and/or health.

H is composed of inherited child human capital H_0 and child human capital investment *HI*.

T is time input for production of *Z*.

TH is time input for production of *HI*.

M is expenses for production of *HI*.

X is expense for production of *Z*.

CL is child labor time and 1–*CL* is leisure or schooling time for child. 1–*CL* is assumed to contribute to human capital formation.

SC is the amount of social capital already accumulated.

PS is the amount of public service supplied by public sector.

θF is a vector of family characteristics, and θC is a vector of child characteristics.

P_m, P_x, and *W* are the prices of *M*, *X*, and adult labor wage, respectively.

Ω is total amount of time available for adult family members.

A is non-labor income and initial asset which is included in θF.

Equation (5) is household income constraint, where child labor income, $cW \cdot CL$ is added to revenue. Here, we assume that 1/c children can do the same work as 1 adult ($0 < c < 1$).

The utility functions—*Z* and *H*—are assumed to be strictly increasing and strictly concave function with $U_Z > 0$, $U_{ZZ} < 0$, $U_H > 0$, $U_{HH} < 0$, $Z_X > 0$, $Z_T > 0$, $Z_{CL} > 0$, $Z_{XX} < 0$, $Z_{TT} < 0$, $Z_{CLCL} < 0$, $HI_M > 0$, $HI_{TH} > 0$, $HI_{1-CL} > 0$, $HI_{MM} < 0$, $HI_{THTH} < 0$, $HI_{1-CL1-CL} < 0$.

If we assume interior solutions, the optimal solutions of *T*, *TH*, *M*, *X*, and *CL* can be derived as functions of the exogenous variables, *SC*, *PS*, θF, θC, *W*, Ω, P_m, P_x and H_0.

If we substitute all these optimal endogenous variables into *H* function, we can derive the following child human capital function.

Reduced form:

$$H^* = H^*(SC, PS, \theta F, \theta C, W, \Omega, P_m, P_x, H_0) \qquad (6)$$

While estimates of the reduced form, such as equation (6), are useful, this is not suitable for our research objectives that are concerned with the relationship between child human capital formation and child labor. Therefore, following Rosenzweig and Schultz (1987), we use a hybrid human capital production model for econometric application.

$$H^* = H^*(CL^*, SC, PS, \theta F, \theta C, W, \Omega, P_m, P_x, H_0) \qquad (7)$$

2. Empirical Models

On the basis of the abovementioned theoretical framework, we formulate the following econometric models to test the contemporaneous relationship between child human capital and child labor.

Child human capital production function:

$$H = \alpha + \beta \cdot CL + \gamma \cdot X + \varepsilon \qquad (8),$$

where X represents a vector of exogenous explanatory variables of child human capital, $X1$ represents a vector of explanatory variables included in X and $X2$ is that not included in X.

To estimate equation (8), we use learning measures such as school attainment relative to age ($= Age - E - years\ of\ schooling$) for education attainment as a dependent variable. Here, E represents the formal school entry age. This indicator is similar to the most widely used indicator of education attainment— $SAGE$ ($= years\ of\ schooling / age - E$).

With regard to health status, the self-health assessment with three categories (often, occasionally, or seldom suffered from ill health), the height for the age z-score, and BMI for the age z-score are used as dependent variables. This is because each measurement has its limitation; the subjective self-health assessment has reliability problem, the height for age may be of limited use in estimating the health effects of child work, and BMI is more appropriate measure for adult health. Therefore, with this recognition of measurement problems, we estimate the regression equations with these three health measures, following the suggestions of Guarcello et al. (2004) and O'Donnell et al. (2005).

The former is an indicator of general health and the latter two measures are a nutrition based measure expressed in terms of anthropometrics.

The explanatory variables in equation (8) are weekly child labor hours, square of weekly child labor hours, child characteristics (child age, child age square, gender dummy), household characteristics (gender of household head, age of household head, number of household members, parents' education, household assets, excluding land), an indicator of social capital, public service (village dummy).

Here, we also use child age square and child labor square as explanatory variables, following Ray and Lancaster (2005) and Han (2007) who attempted to examine the existence of an inverse U-shaped relationship between child labor and child human capital.

From among these explanatory variables, "child labor hours" is expected to be an endogenous variable because this variable is simultaneously determined as contemporary child health and nutrition status as well as child school attainment. In order to cope with the "endogeneity problem," we applied the IV methodology. For this purpose, we need to determine some appropriate instrumental variables and estimate the following child labor function:

$$CL = \delta_0 + \delta_1 \cdot X1 + \delta_2 \cdot Y2 + \xi \qquad (9)$$

Here, $X1$ is a vector of exogenous variables included in equation (9). $Y2$ is a vector of the instrumental variables.

The dependent variable in equation (9) is child labor hours in the last one week. The explanatory variables include all the exogenous explanatory variables in equation (8) and the number of cattle, square of the number of cattle, and dependency ratio are included as the instrumental variables.

The detail descriptions of all these variables are shown in Table 4.

Depending on the characteristics of the dependent variables we estimated these equations by using the following econometric methodologies.

1. The Tobit model (censored model) was used for the child education attainment because the data includes zero values of dependent variable (learning measures such as school attainment relative to age), and the observed zero values are not due to the decision of individual households, but due to censoring.

Ray and Lancaster (2005) also estimated the equation similar to equation (9) by applying the Tobit model; however we have done this by using the IV Tobit model with the censored endogenous variable.

For child education attainment and the endogenous variable of child labor hours, it might be necessary to estimate both by using the Tobit model because child labor and school attainment might be decided simultaneously.

In such a case, we have to examine the possibility of the endogeneity problem of child labor hours to arrive at a consistent estimation. For this purpose, following Datt and Ravallion (1994, Appendix 1), we estimate equation (9) by the Tobit model to obtain the residual; then, we insert the residuals into equation (8) as an additional regressor and obtain consistent estimators of each parameter by the Tobit model.

2. For the self-health assessment, we employed the ordered probit model because the categories of self-health assessments are inherently ordered. The dependent variables take the following three values.

= 0 if the subject suffered from ill health often,

= 1 if the subject suffered from ill health occasionally,

= 2 if the subject suffered from ill health seldom.

Here, we also have to consider the endogeneity issue of child labor hours. For this purpose, we apply the methods proposed by Ravallion and Wodon (2000).

According to Ravallion and Wodon (2000), we will be able to apply the abovementioned estimation method of simultaneous Tobit model, for the model where the equation in the second step is estimated by a probit model. The consistency proof for the case of the ordered probit model can be made in the same way as that of the probit model with censored endogenous variable. So as a second step, we apply the method shown in Datt and Ravallion (1994) to the model where the equation in the second step is estimated by a ordered probit model; we

insert the residuals from the Tobit model estimates of equation (9) into equation (8) as an additional variable and obtain consistent estimates of each parameter by the ordered probit model.

3. For the height for age z-score, we apply OLS with IV. In this case, we obtain the residuals from equation (9) by using the Tobit model in the first step. Then, regress equation (8) by OLS with those residuals as an additional regressor and obtain consistent estimates of each parameters, following Vella (1993) and Maddala (1996).

Table 4. Descriptive Statistics

Variable	Definition	Mean	Std. Dev.
Education Attainment	School Attainment Relative to age (year)	1.23	1.448
Self-health assessment	=0 if often, =1 if occasionally, =2 if seldom suffered from ill health	0.86	0.642
Height for age z-score	Height-for-age z-score	–2.748	1.534
BMI for age z-score	BMI-for- age a-score	–1.623	1.462
Characteristics of Child			
Child labor hours	Hours worked in the past 7 days	8.663	12.218
A ge of Child	Age of child (month)	122.88	32.995
Female child	=1, if female child, =0 ,otherwise	0.51	0.501
Household characteristics			
Mother's education	Mother's education (year)	3.145	2.632
Father's education	Father's education (year)	5.235	3.284
Female HH head	=1, if female household head, =0, otherwise	0.065	0.247
HH head age	Age of the household head (year)	41.085	9.297
Family size	Number of household members (person)	5.79	1.823
Ln (assets)	Log of assets of household (excluding land)	15.789	0.907
Social Capital	See Appendix 1	3.779	0.432
Village dummy [1)]			
KD village	=1, if KD village, =0, otherwise	0.175	0.381
KK village	=1, if KK village, =0, otherwise	0.28	0.450
TK village	=1, if TK village, =0, otherwise	0.265	0.442
Instrumental Variables			
No. of cattle	Number of cattle (head)	2.228	1.394
Dependency ratio	Dependency ratio of household	53.756	24.942

Total sample size is 200.

Source: Household Survey 2006

[1)] We define PC village as the base village, because this village has the worst level of average education attainment and among the four study villages.

3. Results of Estimation

The results of the estimation are presented in Table 5 (for the results of IV coefficient estimates, see

Appendix; Table 2).

With regard to child education attainment, female headed household and the number of household members affect education attainment negatively while mother's education, village dummies for KK and TK have positive impacts on child education attainment.

Further, we should remark that we cannot find any significant effect of child labor on child education attainment. We obtained the same results even when not considering the IV methodology as child labor hours.

These findings are consistent with those of our field observation. In our study area, one day at primary school entails four hours of class time in the morning or afternoon, and on an average, children work for two or three hours before or after class (Table 2). Therefore, we cannot assume that the time the children spend working should be at the expense of their formal time at school, although there may be displacement of informal (after-school) tutorials or homework.

With regard to self-health assessment, the age of the household head and village dummies of KK and KD have positive effects on child health, while the social capital indicator has a positive impact on child health status. In addition, child age has a U-shaped relationship with health status.

The coefficients of the residuals of child labor hours' are significant. This implies that child labor is regarded as an endogenous variable. Child labor has a significant inverse U-shaped relationship with child health status. Therefore, the quadratic has a parabolic shape, and we can calculate the turning point of child labor hours as 22 hours per week. This implies that health status improves if the working hours of children is shorter than the threshold level. As we have already observed, in our study area, even children belonging to the13–14 years age groups who worked the longest hours, worked within the threshold (see Table 2).

With respect to the coefficients of height for age z-score, female household heads and the number of household members negatively affect child nutrition status. On the contrary, age of household heads, social capital indicators and village dummies of KD, KK, and TK have positive effects on child nutrition status. The results also show an inverse U-shaped relationship between child age and child nutrition status. In the case of BMI for age z-score, the estimated coefficients show the same signs as Height for age except for social capital and village dummy TK of which estimated coefficients show the negative sign although insignificant.

These results can be explained by the fact that the ratios of using boiled drinking water and toilet facility are the lowest in village TK.

The impacts of child labor on nutrition status are similar to those on health status. The coefficients of child labor show that there exists an inverse U-shaped relationship between child labor and child nutrition status. The turning point of child labor is a little over 18 or 22.5 hours per week, which is significantly longer than the average working hours of children in 13 and below age group (see Table 2). However, the average working hours of 14 year olds is almost same as this threshold level or longer. This fact suggests that many children of 14 years and above work longer than the threshold working hours, even though exceeding this is detrimental to the child nutrition status.

Table 5. Estimation Results of Education Attainment, Self-health Assessment, Height for age z-score, and BMI for age z-score

Model	Tobit model		Ordered probit model		OLS		OLS	
Dependent Variable	Education Attainment		Self-health Assessment		Height for age z-score		BMI for age z-score	
Explanatory variables	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	1.406	0.22	—		–2.564	–0.47	11.569 **	2.19
Child labor hours	–0.151	–0.68	0.395 **	2.3	0.45 **	2.28	0.361 *	1.89
(Child labor hours)^2	0.004	0.78	–0.009 **	–2.15	–0.012 **	–2.45	-0.008 *	-1.77
Child labor hours_residuals	0.106	0.47	–0.387 **	-2.25	–0.418 **	–2.12	-0.328 *	-1.71
(Child labor hours)^2_residuals	–0.004	–0.68	0.009 **	2.21	0.011 **	2.32	0.008	1.64
Child age	0.051	0.93	–0.099 **	–2.56	0.03	0.67	-0.089 **	-2.06
(Child age)^2	–0.0001	–0.52	0.0004 ***	2.63	–0.0001	–0.53	-0.0002	1.64
Female child	0.002	0.01	–0.140	–0.75	-0.229	–1.04	0.242	1.14
Mother's education	–0.110 *	–1.91	0.041	–1.02	–0.034	–0.73	-0.1 **	-2.19
Father's education	–0.105 **	–2.06	0.006	0.16	0.049	1.16	-0.029	-0.71
Female HH head	1.914 ***	2.73	0.214	0.43	–2.236 ***	–3.78	-1.997 ***	-3.48
HH head age	–0.028	–1.39	0.044 ***	2.85	0.053 ***	2.95	0.047 ***	2.69
Family size	0.379 **	2.24	–0.239 *	–1.87	–0.514 ***	–3.44	-0.208	-1.43
Ln (assets)	–0.254	–1.07	–0.240	–1.32	–0.231	–1.09	-0.538 ***	-2.62
Social Capital	–0.275	–0.46	0.901 **	2	0.875 *	1.68	-0.547	-1.08
KD village	–1.029	–1.16	1.695 **	2.48	2.014 **	2.58	1.39 *	1.83
KK village	–1.722 ***	–3.11	1.22 ***	2.87	1.63 ***	3.36	1.537 ***	3.27
TK village	–1.157 ***	–2.89	0.578 *	1.86	0.76 **	2.13	-0.03	-0.09
Cut 1	—		–8.544 *		—		—	
Cut 2	—		–6.643		—		—	
Sigma	1.388		—		—		—	
Log likelihood	–252.033		–168.319		—		—	
LR	150.4 ***		46.63 ***		—		—	
Pseudo R^2	0.23		0.122		Adjusted R^2	0.196	Adjusted R^2	0.166
Number of observations	200		200		200		200	

Source: Author's calculation from Household Survey 2006

Note: Statistically significant at the * 10%, ** 5%, and *** 1% level

IV. Conclusion: Summary and Policy Implication

We examined the determinants of child human capital in order to test the trade-off relationship between child labor and child human capital formation based on the data collected in rural Cambodia.

The major findings worthy of mention are summarized as follows:

1. We cannot find a trade-off relationship between child labor and child education attainment. This finding is different from those of existing literatures (Ray and Lancaster, 2005).
2. Child labor is not detrimental to children's health and nutrition but improves them if children work within a threshold level. These fact findings are inconsistent with the findings of Guarcello et al. (2004) for the case of Cambodia.
3. However, children in the 14 years and above age group tend to work longer than the threshold working hours. Exceeding this threshold has a negative effect on child human capital formation.
4. In KK village where the distance from school and health care center is shorter and the number of nurses is the larger, child health and nutrition status and child education attainment are better.
5. The effects of individual social capital and village characteristics on child education attainment, and health status and height for age are significantly positive, but the effects of those on BMI for age are different. The fact that the ratios of using boiled drinking water and toilet facility are the lowest in relatively rich village TK, although the usage of boiled drinking water and toilet facility have been recommended for the villagers of four villages through the rural development project, suggests that socio-political factor such as governance of village community or strength of personal ties may affect human capital formation of children. .

We can draw the following policy implications based on the results of these investigations.

First, in poor, rural Cambodia, farmers face difficulties with the expansion of land size and finding off-farm job opportunities. Raising livestock is one of the feasible ways by which they can increase the household income and cope with risk. According to our findings, child labor increases with the number of cattle, and child health increases with child working hours before the turning point, however, child working hours lead to a decline in child health beyond the turning point. Further, child labor does not have a significant impact on child education attainment. These findings indicate that child labor in rural Cambodia can contribute to improvement of child health and nutrition status and that it is not harmful for child human capital formation. Therefore, the protection measures of child labor mentioned in UCW (2006) should target only hazardous forms of child labor.[2)]

Moreover, in order to promote human capital formation of children who are employed in the less hazardous forms of work, the working hours should not be extended over the threshold level. For this purpose, certain policy measures must be implemented for the enhancement of household income such as an increase in adults job opportunities in rural areas and the improvement of credit access for the poor.

Second, villages that are located at a large distance from schools experience low child education

attainment. This fact suggests that elementary school children, particularly those that are less than 10 years of age, find it difficult to commute to school if the village is far from the school, and parents cannot provide them with a vehicle. In addition, children in the age group of 14 years worked longer than the threshold hour. This may be as a result of the lack of secondary school and the long distance between the village and the school. In order to cope up with these problems, government should make investment for construction of elementary and secondary school.[3)]

Third, the health and nutrition status is better in the villages that are close to health care centers or homes of licensed medical staff. This implies that an increase in the number of health care centers and nurses may be effective for improving child health and nutrition status.[4)]

NOTES

1. For the latest estimate of poverty, see Royal Government of Cambodia, 2006, pp.41–52.
2. Understanding Children's Work (UCW), 2006, pp.52–67.
3. The construction of high school is a recommended policy measure by the World Bank for eradication of inequality in child education (World Bank, 2007, pp.122–140).
4. These policy measures for reduction of inequality in child health are also recommended by the World Bank, 2007, pp.90–121

Appendix 1

An indicator of social capital is generated through the principal component analysis based on the following three questions asked during the field survey (Han, 2007).

Q1: What percentage of villagers participated in cooperative works, such as building public houses, pagodas, or roads in the village, in the last one year?
[3 if everyone (almost everyone), 2 if about half, and 1 if no one or few]

Q2: If there is water supply problem or natural calamity in this village, what percentage of the villagers will cooperate to solve the problem?
[3 if everyone (almost everyone), 2 if about half, and 1 if no one or few]

Q3: Do you agree or disagree with the following sentence. If you lose a pig or a cow, someone in the village will help you look for it and will return it to you.
[3 if agree, 2 if neither agree nor disagree, and 1 if disagree]

The result of the principal component analysis is shown in Appendix Table 1, and we generate the indicator of social capital, called "Social Capital," by using the first principal component of questions 1 and 2.

Appendix Table1. Result of Principal Component Analysis for Indicator of Social Capital

Principal components / correlation

Component	Eigenvalue	Difference	Proportion	Cumulative
comp 1	1.20361	0.217113	0.4012	0.4012
comp 2	0.986501	0.176615	0.3288	0.7300
comp 3	0.809886		0.2700	1.0000

Principal components (eigenvectors)

Variable	Comp 1	Comp 2	Comp3
Q1	0.6143	0.4850	–0.6224
Q2	0.6943	0.0427	0.7184
Q3	–0.3750	0.8735	0.3105

Source: Author's calculation from Household Survey 2006

Appendix Table 2. Tobit Coefficient Estimates of Child Labor Hours

Dependent Variable	Child Labor Hours			(Child Labor Hours)^2		
Explanatory Variables	Coefficient		t-value	Coefficient		t-value
Constant	–96.238	**	–2.33	–2779.56		–1.44
Child age	0.996	**	2.35	32.962	*	1.65
(Child age)^2	–0.002		0.136	–0.073		–0.93
Female child	–0.844		–0.35	–54.755		–0.48
Mother's education	1.107	**	2.13	41.189	*	1.68
Father's education	0.129		0.31	0.975		0.05
Female HH head	–18.338	**	–2.53	–766.708	**	–2.23
HH head age	0.188		1.1	9.494		1.18
Family size	–2.247	**	2.13	–113.516	**	–2.47
Ln (assets)	0.085		0.04	–42.601		–0.45
Social Capital	–1.743		–0.57	23.965		0.17
KD village	1.99		0.5	232.261		1.24
KK village	–0.084		–0.02	73.255		0.4
TK village	–2.027		–0.58	–30.853		–0.18
No. of cattle	9.054	***	2.85	397.665	***	2.63
(No. of cattle)^2	–1.944	***	–3.17	–81.609	***	–2.80
Dependency ratio	0.116	*	1.96	4.345		1.56
Sigma	14.173			662.444		
Log likelihood	–474.967			–880.309		
LR	127.58	***		98.56	***	
Pseudo R^2	0.118			0.053		
Number of observations	200			200		

Source: Author's calculation from Household Survey 2006

Note: Statistically significant at the * 10%, ** 5%, and *** 1% level

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