



Child labour as a response to shocks: evidence from Cambodian villages

L. Guarcello
I. Kovrova
F. C. Rosati

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I. Kovrova*

F. C. Rosati*

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Understanding Children's Work (UCW) Project

University of Rome "Tor Vergata"

Faculty of Economics

V. Columbia 2

00133 Rome Tor Vergata

Tel: +39 06.7259.5618

Fax: +39 06.2020.687

Email: info@ucw-project.org

As part of broader efforts toward durable solutions to child labor, the International Labour Organization (ILO), the United Nations Children's Fund (UNICEF), and the World Bank initiated the interagency Understanding Children's Work (UCW) project in December 2000. The project is guided by the Oslo Agenda for Action, which laid out the priorities for the international community in the fight against child labor. Through a variety of data collection, research, and assessment activities, the UCW project is broadly directed toward improving understanding of child labor, its causes and effects, how it can be measured, and effective policies for addressing it. For further information, see the project website at www.ucw-project.org.

This paper is part of the research carried out within UCW (Understanding Children's Work), a joint ILO, World Bank and UNICEF project. The views expressed here are those of the authors' and should not be attributed to the ILO, the World Bank, UNICEF or any of these agencies' member countries.

* UCW-Project and University of Rome "Tor Vergata"

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ABSTRACT

The paper analyzes the effect of different shocks on household decisions concerning children's involvement in work and school in rural Cambodia. We assess the differential impact of three different types of shocks using propensity score matching and double difference estimates extended to the case of multiple treatments. The findings indicate that household responses to shocks depend considerably on the specific type of shock encountered. Of the three shocks considered, crop failure is the most damaging in terms of school attendance and child labour in the Cambodian context. Droughts appear far less relevant, while flooding does not seem to have any significant impact on children's work and school attendance. The findings argue for the targeting of risk management policies to the specific types of shocks most damaging to children.

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1. INTRODUCTION

The effects of shocks on the supply of children's work is subject of a recent but growing literature. Idiosyncratic shocks (e.g., unemployment or death of a family member) and natural disasters (e.g., floods or droughts involving the loss of income or infrastructure) apparently lead households to use children as risk-coping instruments. Children may enter in the labour force directly, without transiting from school, drop out from school permanently, or leave school temporarily and return once the effect of the shock has been absorbed.

As will be discussed in more detail below, there is now robust evidence indicating that shocks do in fact matter for household decisions concerning children's work and education. This evidence indicates that policies aimed at reducing exposure to risk and at helping to cope with the negative consequences of shocks are helpful in reducing children's work and promoting education.

But shocks experienced by household can take a variety of forms and their consequences may depend on their specific nature. As a result, the policies required to manage and help cope with risk might also vary depending on the kind of shock encountered. The literature to date has accorded little attention to how household responses to shocks may vary according to the specific type of shock. Our study looks at household responses to different types of shocks in the context of rural Cambodia in order to begin to fill this research gap.

We use information on shocks at village level in Cambodia contained in the Cambodia Socio Economic Survey (CSES) for 1999 and 2003-04. In order to evaluate the impact of different kinds of shocks, we follow two complementary strategies. First, we use the CSES data for 2003-04 to carry out estimates based on propensity score matching for multiple treatments. Our approach follows the methodology outlined in Ibens (2000) and, in particular, in Lechner (2001). Treatment effects based on propensity score matching, however, are valid as long as the underlying assumption of unconfoundedness is not violated. To check the robustness of our results, we then use information from the CSES 1999 to build a panel at commune level. A double difference estimator extended to a multiple treatments case is utilized to assess the impact of different kinds of shocks.

The paper is organized as follows. Next section gives a brief overview of the existing literature on the effects of shocks on children's work and education. Section 3 gives a snapshot of the extent of working children in Cambodia, and section 4 describes the dataset used and defines the variables. Section 5 introduces the two econometric approaches that are described in more detail in Sections 6 and 8. The results of the estimates are presented in Section 7 and 9.

2. SHOCKS AND CHILDREN'S WORK

A growing body of research shows that households in developing countries adjust the school attendance and labour force participation of their children to absorb the impact of negative shocks. The effects of idiosyncratic shocks are analyzed in several works. Jacoby and Skoufias (1997), for example, find that in rural India parents facing an unexpected decline in crop income withdraw their children from school. Beegle et al. (2006) find that a crop shock leads to a significant increase in child labour and to a decrease in school enrolment. Such effects, moreover, are negatively related to the level of assets held by the household. Guarcello et al. (2003) not only observe that households in Guatemala adjust the activity status of children in response to idiosyncratic shocks and natural disasters but also that the effects of shocks on children's activities are often enduring, as children who are sent to work are subsequently less likely to return to school. The main study results

indicate that parents' access to credit and to risk reduction schemes (the latter proxied by availability of medical insurance) provide risk-coping instruments that drive households' decisions to invest in the human capital of children, preventing them from entering into the labour market. Duryea et al. (2003) show how in Brazil the loss of employment of the household head increases the probability that a child enters the labour force, drops out from school and fails to advance in school. Parker and Skoufias (2006), using data from urban Mexico find that idiosyncratic shocks such as parents' unemployment and divorce have no impact on boys' schooling, but reduce school attendance and school attainment among girls.

Macroeconomic shocks and political instability also appear to play a role in determining children's labour supply and school attendance. Behrman, Duryea, and Szekely (1999) find for 18 Latin American and Caribbean countries that macroeconomic instability has played a crucial role in slowing down school attainment since the early 1980s. Skoufias and Parker (2001) study the impact of the economic crisis of 1995 and the recovery period of 1998-1999 on the time use of 12-17 year-old Mexicans. Shocks appear to have had a significant effect on whether children continue in school in the next school year. The effect is especially significant for girls, suggesting that they replace their mothers in household production. Lim (2000) finds that the East Asian crisis produced a drop in enrolment rates and a rise in the labour force participation rates for children aged 10 to 14 years in the Philippines.

The set of results summarised above has important policy implications. If the role of child labour as a buffer against uninsured shocks is substantial, policies aimed at reducing household risk exposure might have a substantial bearing on children's labour supply. The existing literature, however, has not assessed the differential impact of the various shocks that can hit households. Instead, shocks have been treated as a general category of negative events affecting the household, while in reality they are of course different in nature and in their likely consequences. Better policy formulation and targeting would require the identification of the shocks that are most damaging to children's welfare in terms of education and participation to child labour.

In what follows, we will employ data from two rounds of the Cambodia Socio Economic Survey (CSES) to assess the relative impact of different shocks. But before moving to the main part of the analysis, we briefly describe the children's work situation in Cambodia

3. CHILDREN'S WORK AND SCHOOL ATTENDANCE IN CAMBODIA

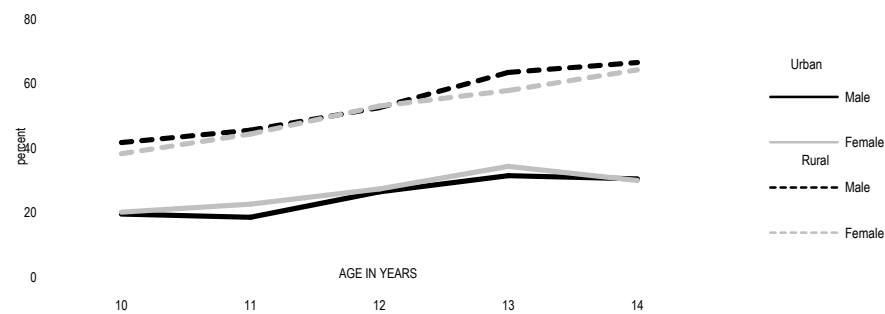
According to CSES 2003-2004, 47 percent of children aged 10-14 are attending school full time, while about 42 percent combine work and school (see Appendix 1)².

The involvement in economic activity of Cambodian children remains one of the highest in the East and South-East Asia region. A total of 49 percent, 885,000 in absolute term, declared to be involved in work activities, with only a negligible difference by sex. The place of residence plays an important role in determining the probability of only attending school or combining work and school. Twenty four percent of children combining work and school reside in urban areas, while the percentage rises to about 45 percent when considering rural areas. It is not surprising to note that children's total involvement in schooling is about 90 percent. In fact, the 96 percent of the villages declare to have a primary school.

² For more detail see "Children's work in Cambodia: a challenge for growth and poverty reduction", 2006, Understanding Children's Work project, www.ucw-project.org

Children living in cities and towns are considerably less likely than their rural counterparts to engage in economic activity. The percentage of work involvement increases with the age of the child. As pointed out before, this reflects both the higher opportunity costs of school in terms of earnings forgone as a child gets older and of the more limited schooling opportunities at the higher grades.

Figure 1. Children's work prevalence, by age and sex



Source: UCW calculations based on *Cambodia CSES, 2003-04*

The percentage of male and female working children in rural area is already high, at around 40 percent, by the age of ten and rise sharply to 65 percent at the age of 14 (**Figure 1**). In urban areas, the percentage of working children is lower at every age, even if the involvement in work activities can be still considered high, starting from 20 percent at the age of 10 and rising to 30 percent at the age of 14 (**Figure 1**).

4. DATA AND VARIABLES DEFINITION

The information on working children, school attendance, and other variables shown above and utilised in the estimates below was collected through the Cambodia Socio Economic Survey (CSES) 2003-2004, carried out from November 2003 to January 2004 by the National Institute of Statistics. (A similar survey conducted in 1999 will be utilised later on to carry out double difference estimates.) CSES 2003-2004 is a nationally representative survey conducted on a sample of 15,000 households in 867 villages, and is designed to collect information about the living standards of the population and the extent of poverty. It collects a range of additional basic indicators to identify determinants and design policy for reducing poverty. The CSES survey focuses on six main areas: household consumption; household production and cash income; education and access to schooling; health and access to medical care; housing and amenities; family and social relation. The survey collects information on children involvement in economic activities starting from the age of 10 years.

The survey also collected information on occurrence of shocks during the last five years at the village level. The main shocks considered are drought, flood and crop failure. Table 1 summarises the occurrence of the three types of shocks in the sampled villages during the 1999 to 2003 reference period.

Table 1. Sampled villages affected by shocks, by year of occurrence and type of shock

	2003		2002		2001		2000		1999	
	N°	%	N°	%	N°	%	N°	%	N°	%
drought	310	34.4	216	4.0	192	1.3	11	3.1	123	3.7
flood	88	9.8	231	5.7	284	1.6	30	4.1	172	9.1
crop	273	30.3	250	7.8	239	6.6	20	2.6	174	9.3

Source: UCW calculations based on *Cambodia CSES, 2003-04*

About 80 percent of the sample villages were hit by one or more shocks. The number of villages experiencing drought during the five-year reference period, from 14 percent in 1999 to 34 percent in 2003. The incidence of floods reached the pick in 2000, when the rising water in the Mekong river produced the worst flooding in 80 years. Flood damage affected irrigation projects, schools, and large areas of rice land. The percentage of villages affected by flooding remained high until 2002 (26 percent) before falling to 10 percent in 2003 (see *Table 1*). The percentage of villages experiencing crop failure increased over the reference period, in large part due to the flooding and drought that occurred at the same time.

The different shocks were not mutually exclusive, but occurred in various combinations. The following table shows the combined distribution of shocks at the village level over the five year reference period. Along the principal diagonal, the table reports the percentage of villages that experienced only one type of shock, all three shocks and no shock at all. Only 20 percent of the villages did not experience any shock during the previous five years. Almost nine percent of villages were affected by drought only, while only three percent experienced crop failure in the same period. The percentage of villages affected by at least two shocks is 16 percent in the case of crop failure in combination with drought, declining to 10 percent for drought in combination with flood, and to nine percent if we consider crop failure in combination with flood. The percentage of villages that experienced all three type of shocks during the five years (flood, crop failure and drought) is about 30 percent.

Table 2. Percentage of Villages affected by one or a combination of shocks

	No shocks	flood	crop	drought	Any shock
No shocks	19.4				
Flood		5.4			
Crop		8.6	3.1		
drought		9.5	15.5	8.9	
					30

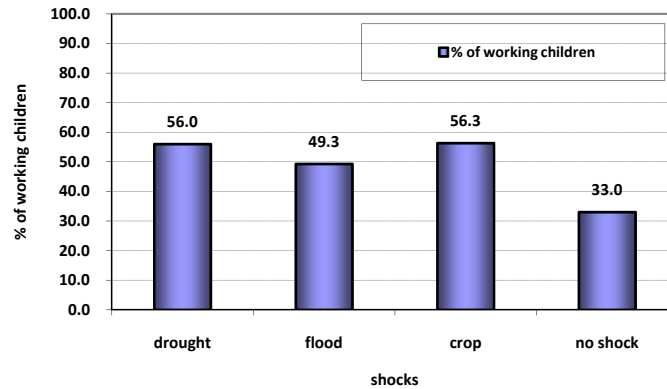
Source: UCW calculations based on *Cambodia CSES, 2003-04*

The data show that even if about 80 percent of the villages were hit by some type of shocks in the five years, there is enough variation in the way the villages were hit (only one shock, different combinations of two shocks, no shocks at all, etc.) to allow us to identify the possible different effects of the various shocks.

The following graph illustrates the differences in the incidence of children's work according to whether a village has been hit by a shock and by the type of shock. Given the

possibility of multiple incidence, the data do not lend themselves, however, to a simple interpretation

Figure 2. Working children by type of shocks



Source: UCW calculations based on *Cambodia CSES, 2003-04*

Children's work appears to be substantially higher in villages hit by a shock: at least 16 percentage points higher than in villages not experiencing any shock. The variation across the different types of shocks is less well defined. We find the highest percentage of working children, about 56 percent, in the villages that experienced a drought or a crop failure during the five years reference period. The impact on children's work appears to be lower in villages hit by flood.

5. ECONOMETRIC ANALYSIS

We use two approaches to assess the impact of the various shocks on household behaviour. Firstly, we use propensity score matching, and secondly, we rely on double difference estimates by merging the information of the CSES 2003-04 with that of CSES 1998-99.

We use the CSES data for 2003-04 to carry out estimates based on propensity score matching for multiple treatments. Our approach follows the methodology outlined in Ibens (2000) and, in particular, in Lechner (2001) for multiple non overlapping treatments. We therefore use data at village level for non overlapping shocks to build the propensity score matching and, then, to compute the average treatment effects.

The approaches developed to date to deal with the effects of multiple treatments do not allow the extension of the analysis to overlapping treatments. Moreover, treatment effects based on propensity score matching are valid only as long as the underlying assumption of unconfoundedness is not violated. To check the robustness of our results, we have used information from the CSES 1999 to build a panel at commune level. We have then utilised a double difference estimator extended to a multiple treatments case.

6. PROPENSITY SCORES MATCHING IN A MULTIPLE TREATMENTS FRAMEWORK

Although the problem of multiple treatments is subject of increasing attention in the literature, the techniques developed so far refer exclusively to non overlapping (or mutually exclusive) treatments. In particular, we have followed the approach suggested by

Ibens (2000) and Lechner (2001) to extend the Propensity Score Matching approach to a multiple treatment framework. The methodology is briefly presented below.

Consider $k+1$ different mutually exclusive treatments with the relative outcome denoted by $\{Y^0, Y^1, \dots, Y^K\}$. In our case, these consist of K categories of mutually exclusive shocks. The assumption is that each individual receives exactly one of the treatments, with 1 denoting the category “no treatment”. Therefore, for any village, only one component of $\{Y^0, Y^1, \dots, Y^K\}$ can be observed in the data with the remaining K outcomes representing the unobserved counterfactuals. This implies that in our analysis we restrict our sample to the villages that have experienced only one shock or no shocks at all.

Let $T \in \{0, 1, \dots, K\}$ denote the actual assignment to a specific treatment K .

Following Lechner (2001), a number of parameters can be identified focusing on a pair-wise comparison of the effect of treatments K and K' . We will focus on the effect of treatment K relative to treatment K' on the treated randomly drawn from the population N . More precisely, for $(K+1)*K$ pair-wise comparisons of the average effect of a shock K relative to a shock K' conditional on receiving the shock K , the effect of treatment on the treated is:

$$E(Y^k - Y^{k'} | T = K) = E(Y^k | T = K) - E(Y^{k'} | T = K)$$

$$\text{for } K, K' \in \{0, 1, \dots, K\}, K \neq K' \quad (1)$$

While the first term is observed in the data (the average outcome of treatment K for villages that have received the treatment K), none of the other pair wise comparisons of the type $E(Y^{k'} | T = K)$ are observed.³ In the evaluation literature, one common estimator of the counterfactuals is:

$$E(Y^{k'} | T = K) = E_X [E(Y^{k'} | T = K', X) | T = K] \quad (2)$$

where X indicates a set of observable.

Identifying assumptions need to be invoked for (2) to hold, since no villages can be in more than one state at the same time and so only one of the $K+1$ outcomes is observed for any given village.

Ibens (2000) describes two forms of conditional independence assumption, labelled respectively “strong and weak unconfoundedness”. The “strong unconfoundedness” assumption requires the existence of a set of observable characteristics X such that the treatment indicator T is independent of the entire set of potential outcomes conditional to the characteristics X .

The “weak unconfoundedness” assumption relaxes two aspects of the strong unconfoundedness assumption, and its concept is closely linked to the missing data interpretation of the problem of causal inference (Rubin, 1976). Weak unconfoundedness

³ The term $E(Y^{k'} | T = K)$ represent the counterfactuals, i.e. all the outcomes that the treated population would have experienced, on average, if they had received any treatment different than K .

requires only pair-wise independence of the treatment with each of the potential outcome. In addition, it requires the independence of the potential outcome $Y(t)$ and the treatment to be "local" at the treatment level of interest, i.e., independent of the binary treatment level indicator $D(t)$, rather than of the treatment level T .

Since we are interested in the pair-wise comparison of the various treatments, we can relax the strong unconfoundedness assumption, by requiring conditional independence to hold only for the sub population receiving either treatment K or treatment K' . The unobserved counterfactual can thus be identified and the ATT estimated by using eq. (2). The inner expectation are identified thanks to the conditional independence assumption. In order to evaluate the outer expectation, however, all participants in K need to have a counterpart in the K' comparison group for each set X of observables. In other words, a "common support" region must be identified.

The propensity score matching estimator specifically addresses the potential problem of common support. When the number of covariates is large, to reduce the problem to a one-dimensional one, we can use the propensity score, i.e., the individual probability of receiving the treatment given the observed covariates $p(X) = P(T = 1 | X)$.

In fact, under unconfoundedness the following results hold (Rosenbaum and Rubin, 1983)

T is independent of X given the propensity score $p(X)$

$Y(0)$ and $Y(1)$ are independent of T given the propensity score

From (1) we can see that the propensity score has the so-called balancing property, i.e., observations with the same value of the propensity score have the same distribution of observable (and possibly unobservable) characteristics independently of the treatment status; from (2), exposure to treatment and control is random for a given value of the propensity score. These two properties allow us to a) use the propensity score as a univariate summary of all the X , to check the overlap of the distributions of X , because it is enough to check the distribution of the propensity score in the two groups, and b) use the propensity score in the ATE (or ATT) estimation procedure as the single covariate that needs to be adjusted for, as adjusting for the propensity score automatically controls for all observed covariates (at least in large samples).

This approach originally suggested by Rosenbaum and Rubin (1983a) can be extended to a multiple treatment framework (Lechner 2001, Ibens 2000). Moreover, Lechner (2001) points out that when comparing two treatment groups, the existence of multiple treatments can be ignored, since individuals (or villages in our case) who do not take part to the considered pair of treatment are not needed for identification.

The estimates are carried out using the publicly available Stata subroutine developed by Leuven and Sianesi (2003) that performs various types of Mahalanobis-metric⁴ and propensity score matching. It also allows to impose common support in the ways described and to test the resulting matching quality in terms of covariate balance in the matched groups. Standard errors are computed by bootstrapping.

⁴ The Mahalanobis metric is a unit free metric which assigns weight to each co-ordinate X in proportion to the inverse of the variance of that co-ordinate. The distance between i and j is thus defined as $d(i, j) = (\bar{x}_i - \bar{x}_j)' \Sigma^{-1} (\bar{x}_i - \bar{x}_j)$, with Σ the covariance matrix of \bar{X} .

7. RESULTS

In tables 3 and 4, we present the ATT estimates of the effect of the selected shocks on the percentage of children at village level involved in economic activities and attending school, respectively. Tables 5-8 report the ATT estimates of the effect of shocks on the proportion of children involved in economic activity only, attending school only, combining economic activity and school, and being neither in economic activity nor in school.

As mentioned above, in order to perform our analysis we have excluded from the sample the villages that have been hit by two or more shocks. Each cell in the tables therefore presents the impact of a particular shock with respect to a different shock or to villages that did not experience any shock. The number in each cell indicates the percentage impact of the shock listed in the row with respect to that listed in the column on the outcome variable considered.⁵

The impact of shocks on the participation of children to economic activities is quite differentiated. In fact, only a crop failure seems to have an impact on children's work when compared to the case of no shocks. The importance of crop failure is also confirmed by the fact that it also produces a significant effect on children's work in villages hit by a drought.

On the other hand, school attendance seems not to be significantly affected by any of the shocks considered.

Table 3. Average treatment effects of different type of shocks

Economic Activity	Flood	Crop	Drought	No-shock
Flood		-0.2018 (0.1358)	0.0358 (0.0791)	0.0694 (0.0676)
Crop	0.1326 (0.1435)		0.1639** (0.0950)	0.3680* (0.1088)
Drought	-0.0336 (0.0507)	-0.0470 (0.1226)		0.0944 (0.0862)

Note: bootstrapped standard error in parenthesis

*significant at 5%; ** significant at 10%

Table 4. Average treatment effects of different type of shocks

School Attendance	Flood	Crop	Drought	No-shock
Flood		0.0058 (0.0567)	-0.0447 (0.0346)	-0.0309 (0.0280)
Crop	-0.0323 (0.0730)		-0.0267 (0.0405)	0.0029 (0.0415)
Drought	-0.0040 (0.0336)		-0.0280 (0.0462)	-0.0389 (0.0279)

Note: bootstrapped standard error in parenthesis

*significant at 5%; ** significant at 10%

⁵ Note that as shown by Gerfin and Lechner (2000) the matrix of ATT is not necessarily symmetric.

The results become more precise and articulated when we consider as outcomes four non overlapping combination of children's activity: economic activity only, school attendance only, school attendance and economic activity, and neither in economic activity nor in school.

None of the shocks considered seems to have an impact on the share of children involved in economic activity only (*Table 5. Average treatment effects of different type of shocks*). A crop failure reduces the number of children attending school only with respect to villages not hit by any shock as well as with respect to villages hit by flood. Note that the positive coefficient of flood with respect to crop failure confirms this finding, as it indicates that school attendance is higher in villages hit by flood with respect to villages that experienced a failure of crop (*Table 6*). The share of children working and studying increases in villages hit by crop failure, with respect both to villages that experienced no shocks and to villages hit by a drought (*Table 7*). Finally, no significant impact of shocks on children neither in school nor working could be identified (*Table 8*).

In conclusion, the results indicate that not all the shocks have the same impact. In fact, in the case of Cambodia, only a crop failure appears to have a significant effect on households' decisions relative to children's time use. Such effects, moreover, seem to consist mainly of making some of the children combine work and school, rather than inducing children in school to drop out in order to join the work force.

Table 5. Average treatment effects of different type of shocks

Economic activity only	Flood	Crop	Drought	No-shock
Flood		-0.0021 (0.0448)	0.0414 (0.0257)	0.0100 (0.0284)
Crop	0.0226 (0.0443)		0.0264 (0.0309)	0.0164 (0.0358)
Drought	0.0030 (0.0307)	0.0412 (0.0391)		0.0146 (0.0220)

Note: bootstrapped standard error in parenthesis

*significant at 5%; ** significant at 10%

Table 6. Average treatment effects of different type of shocks

School only	Flood	Crop	Drought	No-shock
Flood		0.1910* (0.0916)	0.0916 (0.0711)	0.0746 (0.0654)
Crop	-0.1526** (0.0887)		-0.1680* (0.0718)	-0.2037* (0.0843)
Drought	0.0440 (0.0793)	0.0930 (0.0827)		-0.0149 (0.0513)

Note: bootstrapped standard error in parenthesis

*significant at 5%; ** significant at 10%

Table 7 Average treatment effects of different type of shocks

Combining Economic activity and school	Flood	Crop	Drought	No-shock
Flood		0.191* (0.100)	0.002 (0.072)	-0.096 (0.062)
Crop	0.115 (0.101)		0.140** (0.079)	0.157** (0.092)
Drought	0.047 (0.081)	-0.085 (0.096)		0.007 (0.051)

Note: bootstrapped standard error in parenthesis
*significant at 5%; ** significant at 10%

Table 8 Average treatment effects of different type of shocks

Neither in economic activity nor in school	Flood	Crop	Drought	No-shock
Flood		0.013 (0.020)	0.008 (0.017)	0.014 (0.012)
Crop	0.007 (0.032)		0.0001 (0.018)	0.023 (0.026)
Drought	-0.001 (0.017)	-0.014 (0.017)		-0.009 (0.012)

Note: bootstrapped standard error in parenthesis
*significant at 5%; ** significant at 10%

8. DIFFERENCE IN DIFFERENCE ESTIMATES

The estimates presented above on the impact of the different shocks on children schooling and work suffer from at least two important limitations. First, the validity of the ATT estimated in the previous sections relies on the unconfoundedness hypothesis, and second, it neglects the effects of combined shocks.

To try to overcome these limitations, we use data from the CSES 2002-03 and CSES 1999 to build panel data by pooling together the two datasets at the commune level. While we lose in terms of number of observations, as each commune includes two or three villages, we are able to use a double difference estimator of the various treatment effects.

Our sample is composed of 275 communes in each of the two periods of observation. The information drawn from CSES 1999 constitutes the pre-shock period and from 2003-2004 the post-shock period.

In order to estimate the impact of the three kind of shocks considered in the paper, we employ a double difference approach extended to allow for multiple and possibly overlapping treatments.

In particular, following a double difference approach, we want to estimate the excess outcome growth, Δ_k , for the communes exposed to a given shock k as:

$$\Delta_k = (\bar{Y}_1^{T_k} - \bar{Y}_0^{T_k}) - (\bar{Y}_1^{C_k} - \bar{Y}_0^{C_k}) \quad (3)$$

for

$T_k = 0, 1$ ($k=1, 2, 3$), where 1 indicates villages affected by shock k , and 0 – those not affected by shock k .

$\bar{Y}_0^{T_k}$ and $\bar{Y}_1^{T_k}$ ($k=1, 2, 3$) are the sample averages of the outcome for the treatment group before and after the shock k ; $\bar{Y}_0^{C_k}$ and $\bar{Y}_1^{C_k}$ ($k=1, 2, 3$) are the corresponding sample averages of the outcome for the control group; $t=0, 1$, where 0 indicates pre-shocks period and 1 indicates post-shocks period.

To estimate (3), we need to take into consideration the fact that some communes have received more than one treatment and in different combinations, other communes only one and finally some no treatment at all. This makes it necessary to define carefully our treatment group (i.e. the communes hit by a given shock) and the control group (i.e. the communes not hit by that particular shock). The excess outcome for a shock k can then be defined with respect to the possible situations in which the shock occurred, The treatment group includes communes hit only by shock k or also by shock(s) $j \neq k$, while the control group is defined by the set of communes hit by any combination of shock $j \neq k$ or by any shock at all.

Let I_k ($k=1, 2, 3$) be the set including the l_k ($k=1, 2, 3$) communes which were hit only by shock k , analogously the set I_{i+j} consists of l_{i+j} ($i, j=1, 2, 3, i \neq j$) communes which were hit by shocks i and j , the set I_{1+2+3} consists of l_{1+2+3} communes which were hit by all three shocks, and, finally, set I_0 consists of l_0 communes which were not hit by any shock. Thus, we can identify eight types of communes that differ according to the combination of shocks (including none) by which they were hit.

We assume that the process determining the outcome Y can be defined in terms of treated, control group and common time trends as follows:

$$Y = \alpha_0 + \sum_{k=1}^3 \alpha_k T_k + \lambda_1 (T_1 T_2) + \lambda_2 (T_1 T_3) + \lambda_3 (T_2 T_3) + \theta (T_1 T_2 T_3) + \gamma + \sum_{k=1}^3 \delta_k (T_k t) + \sigma_1 (T_1 T_2 t) + \sigma_2 (T_1 T_3 t) + \sigma_3 (T_2 T_3 t) + \chi (T_1 T_2 T_3 t) + \beta X' + \varepsilon \quad (4)$$

We make the standard assumptions that the error term is on average zero and uncorrelated with the other variables.

On the basis of parameters estimated from equation (4) and taking expectation of (3), the parameters of interest, Δ_k ($k=1, 2, 3$), can be defined as:

$$\hat{\Delta}_1 = \hat{\alpha}_1 + \hat{\delta}_2 \left(\frac{l_{1+2} + l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} - \frac{l_2 + l_{2+3}}{l_0 + l_2 + l_3 + l_{2+3}} \right) + \hat{\delta}_3 \left(\frac{l_{1+3} + l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} - \frac{l_3 + l_{2+3}}{l_0 + l_2 + l_3 + l_{2+3}} \right) + \hat{\alpha}_1 \frac{l_{1+2} + l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} + \hat{\alpha}_2 \frac{l_{1+3} + l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} + \hat{\alpha}_3 \left(\frac{l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} - \frac{l_{2+3}}{l_0 + l_2 + l_3 + l_{2+3}} \right) + \hat{\chi} \frac{l_{1+2+3}}{l_1 + l_{1+2} + l_{1+3} + l_{1+2+3}} + \bar{X}_A \hat{\beta}$$

$$\hat{\Delta}_2 = \hat{\delta}_2 + \hat{\delta}_1 \left(\frac{l_{1+2} + l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} - \frac{l_2 + l_{1+3}}{l_0 + l_1 + l_3 + l_{1+3}} \right) + \hat{\delta}_3 \left(\frac{l_{2+3} + l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} - \frac{l_3 + l_{1+3}}{l_0 + l_1 + l_3 + l_{1+3}} \right) + \hat{\sigma}_1 \frac{l_{1+2} + l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} + \hat{\sigma}_2 \left(\frac{l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} - \frac{l_{1+3}}{l_0 + l_1 + l_3 + l_{1+3}} \right) + \hat{\sigma}_3 \frac{l_{2+3} + l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} + \hat{\chi} \frac{l_{1+2+3}}{l_2 + l_{1+2} + l_{2+3} + l_{1+2+3}} + \bar{X}_{\Delta_2} \hat{\beta}$$

$$\hat{\Delta}_3 = \hat{\delta}_3 + \hat{\delta}_1 \left(\frac{l_{1+3} + l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} - \frac{l_1 + l_{1+2}}{l_0 + l_1 + l_2 + l_{1+2}} \right) + \hat{\delta}_2 \left(\frac{l_{2+3} + l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} - \frac{l_2 + l_{1+2}}{l_0 + l_1 + l_2 + l_{1+2}} \right) + \hat{\sigma}_1 \left(\frac{l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} - \frac{l_{1+2}}{l_0 + l_1 + l_2 + l_{1+2}} \right) + \hat{\sigma}_2 \frac{l_{1+3} + l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} + \hat{\sigma}_3 \frac{l_{2+3} + l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} + \hat{\chi} \frac{l_{1+2+3}}{l_3 + l_{1+3} + l_{2+3} + l_{1+2+3}} + \bar{X}_{\Delta_3} \hat{\beta}$$

where the superscript $\hat{\cdot}$ indicates parameters obtained by the estimation of eq (4).

Finally, we compute the standard errors of $\hat{\Delta}_k$ ($k=1,2,3$) by using the methodology illustrated in Papke and Wooldridge (2005).

Our results are robust to inclusion in equation (4) of controls for socio-demographic characteristics of the commune. In order to favour simplicity of exposition, we base our presentation on the results obtained without the additional controls.

The following table presents the estimates of the coefficients of eq. 4 relevant for the estimation of Δ_k for children's work and school attendance.

Table 9. Estimates of eq. (2): selected parameters.		
Type of shock	Effect on children's work	Effect on school attendance
δ_K		
Flood (T1)	0.2216 (2.523)**	-0.0276 (0.465)
Crop failure (T2)	0.4341 (3.849)***	-0.0241 (0.316)
Drought (T3)	0.0755 (0.923)	-0.0718 (1.296)
σ		
T1*T3	-0.1904 (1.457)	0.1172 (1.326)
T1*T2	-0.6190 (4.080)***	0.1419 (1.382)
T2*T3	-0.3371 (2.337)**	0.1166 (1.196)
T1*T2*T3	0.5462 (2.851)***	-0.2604 (2.009)**
Notes: Absolute value of z statistics in parentheses		
* significant at 10%; ** significant at 5%; *** significant at 1%		
N.obs. 550		

The estimates of the impact of the three shocks considered here are shown in Tables 10 and 11. The share of child working at commune level is significantly influenced by crop failure and by drought, while the occurrence of a flood does not seem to impact children's work. Observe also that the effects of a crop failure are much larger than those of a drought. School attendance, on the other hand, does not seem to be affected in any significant way by the occurrence of any of the shocks considered.

The results obtained through the double difference estimates are not substantially different from those obtained through the propensity score matching, but they permit more clear identification of the effects of the shocks. This is possibly because with double differences we are able here to exploit information on communities that have been affected by more than one shock.

Table 10. Estimates of Δk for economic activity

Economic activity			
	Δk	sd	Z
Flood	.0550898	.07642	0.72
Crop	.2063584	.08021	2.57
Drought	.071918	.03792	1.90
t			

Table 11. Estimates of Δk for school attendance

School Attendance			
	Δk	sd	z
Flood	.01685	.05168	0.33
Crop	.00191	.05425	0.04
Drought	.02429	.02564	0.95

We know that quite a large number of children in Cambodia, as well as in other countries, combine school and economic activity, while a much smaller number devotes itself to economic activities only. Looking only at the attendance and participation rate might therefore lead us to miss relevant information on household behaviour. For this reason, we have again extended the analysis to four non overlapping categories of children activities: economic activity only, school only, economic activity and school and neither in economic activity nor attending school.

Table 12 reports the estimates of the parameters of eq. (2) for the four outcome variables considered, while the following Tables 13 to 16 reports the estimates of the impact on the set of children's activities considered.

	(1) Economic activity only	(2) Economic activity and school	(3) School only	(4) Neither economic activity nor in school
dif_flood	0.0785 (2.002)**	0.1464 (1.792)*	-0.1638 (1.795)*	-0.0521 (1.302)
dif_crop	0.0588 (1.169)	0.3744 (3.570)***	-0.4085 (3.487)***	-0.0370 (0.720)
Dif_drought	0.0514 (1.407)	0.0250 (0.328)	-0.0901 (1.059)	0.0182 (0.488)
Interaction				
difT1T3	-0.1529 (2.623)***	-0.0406 (0.334)	0.1478 (1.089)	0.0373 (0.627)
difT1T2	-0.1688 (2.494)**	-0.4498 (3.186)***	0.6017 (3.816)***	0.0293 (0.424)
difT2T3	-0.1141 (1.772)*	-0.2210 (1.647)*	0.3500 (2.335)**	0.0004 (0.006)
difT1T2T3	0.2610 (3.053)***	0.2835 (1.591)	-0.5610 (2.818)***	-0.0041 (0.047)
Absolute value of z statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				
N.obs. 550				

The picture that emerges from these estimates is more articulated, but of course consistent with the results just discussed.

The occurrence of a crop failure increases both the number of children in economic activity only and of those combining economic activity and school, with the latter being by far the larger effect. The number of children attending school only decreases, but overall school attendance does not change significantly, as most of the children that begin to work as a consequence of a crop failure continue to attend school. However, the number of children neither working nor attending school is also reduced, likely contributing to the increase in the number of children in economic activity only.

The effects of drought are much smaller and apparently limited to shift children to combining work with attending school.

	Δk	sd	z
Flood	.0279243	.0340974	0.82
Crop	.0602539	.0357912	1.68
Drought	-.0142465	.016914	-0.84

Table 14 Effect of shocks on children combining economic activity and school

	Δk	sd	z
Flood	.0301536	.0711149	0.42
Crop	.1486004	.0746354	1.99
Drought	.0869462	.0353031	2.46

Table 15 Effect of shocks on children in school only

	Δk	sd	z
Flood	.0017136	.0794392	0.02
Crop	-.1379271	.0833717	-1.65
Drought	-.0574758	.0394355	-1.46

Table 16 Effect of shocks on children neither in economic activity nor in school

	Δk	sd	z
Flood	-.0454767	.0347681	-1.31
Crop	-.0633331	.0365058	-1.73
Drought	-.0103437	.0172251	-0.60

9. CONCLUSIONS

The role of shocks as a determinant of child labour and school attendance is becoming well-established in the literature. This offers support to intervention strategies that aim at reducing exposure to shock and at improving coping mechanisms.

However, shocks differ in their nature and intensity and, hence, most likely, in their consequences. Knowledge in this area will help shape intervention policies, by allowing a focus on prevention and protection from the most dangerous shocks in terms of consequences for school attendance and children's work.

Little or no attention has been paid to this issue in the literature. This paper tries to begin to fill this gap by looking at whether shocks of different nature that hit Cambodian communes produce different impacts on school attendance and children's work. In order to analyse this question, we also needed to extend the currently available estimation techniques to the multi treatment case, especially in the case of double difference estimation. The paper, then, also contains some methodological aspects that might be useful to analyzing situations in which multiple treatments are present.

The results obtained clearly confirm the intuition that not all shocks are alike in terms of their consequences. In the case of Cambodia, a crop failure is the most damaging event in terms of school attendance and, especially, children's work. Droughts appear far less relevant, while flooding does not seem to have any significant impact on children's work and school attendance. The shocks considered here are somehow similar in nature, being all related to natural events, but they are likely to produce different effects. In particular, floods are more likely to have a direct impact on public and private infrastructure, and possibly also on the income generating potential of the household. Droughts and, especially, crop failure, on the other hand, have a more direct impact on the earning capacity of the household. The results presented here seem to indicate that, at least in

Cambodia, natural shocks are relevant to household decisions mainly by reducing the income of the household rather than through their effects on infrastructure.

Our results are robust to the two estimation approaches used here: namely propensity score matching and double difference. Unfortunately, the available data allowed only the analysis of limited and not dissimilar set of shocks. More research is hence needed in this area to assess the differential impact of the various shocks that can hit an household, in order to better focus risk management policies.

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APPENDIX I

Table 17 - Child activity status (10-14), by sex and residence

Type of Activity	Residence	Male		Female		Total ⁽²⁾	
		%	No. ⁽¹⁾	%	No. ⁽¹⁾	%	No. ⁽¹⁾
Economically active only	Urban	3.0	4.2	4.2	5.5	3.6	9.7
	Rural	6.6	51.8	8.2	61.7	7.4	113.6
	Total	6.1	56.0	7.6	67.3	6.8	123.3
School only	Urban	72.2	98.6	68.1	90.7	70.2	189.3
	Rural	42.5	333.6	43.9	331.8	43.2	665.4
	Total	46.9	432.2	47.5	422.6	47.2	854.7
Combining school and economic activity	Urban	22.5	30.8	23.0	30.7	22.8	61.5
	Rural	47.2	370.0	43.6	330.0	45.4	700.0
	Total	43.5	400.8	40.5	360.7	42.1	761.5
Neither in school nor in economic activity ⁽³⁾	Urban	2.3	3.1	4.7	6.3	3.5	9.4
	Rural	3.7	29.0	4.3	32.8	4.0	61.9
	Total	3.5	32.1	4.4	39.2	3.9	71.3
Total work ⁽³⁾	Urban	25.6	34.9	27.2	36.2	26.4	71.2
	Rural	53.8	421.9	51.8	391.7	52.8	813.6
	Total	49.6	456.8	48.1	427.9	48.9	884.7
Total study ⁽⁴⁾	Urban	94.7	129.4	91.1	121.4	92.9	250.8
	Rural	89.7	703.6	87.5	661.8	88.6	1365.4
	Total	90.4	833.0	88.0	783.2	89.3	1616.2

Notes: (1) Numbers expressed in thousands; (2) Totals may not add up due to rounding; (3) 'Total work' refers to children that work only and children that work and study; (4) 'Total study' refers to children that study only and children that work and study.

Source: Authors calculations based on Cambodia Socio Economic Survey (CSES), 2003-2004

APPENDIX II

$$\begin{aligned}
\bar{X}_{\Delta_1} &= \left(\left[\frac{\sum_{i=1}^{l_1+l_{1+2}+l_{1+3}+l_{1+2+3}} X_i}{l_1+l_{1+2}+l_{1+3}+l_{1+2+3}} \right]_{t=1, i \in I_1 \cup I_{1+2} \cup I_{1+3} \cup I_{1+2+3}} - \left[\frac{\sum_{i=1}^{l_1+l_{1+2}+l_{1+3}+l_{1+2+3}} X_i}{l_1+l_{1+2}+l_{1+3}+l_{1+2+3}} \right]_{t=0, i \in I_1 \cup I_{1+2} \cup I_{1+3} \cup I_{1+2+3}} \right) - \\
&\quad - \left(\left[\frac{\sum_{i=1}^{l_0+l_2+l_3+l_{2+3}} X_i}{l_0+l_2+l_3+l_{2+3}} \right]_{t=1, i \in I_0 \cup I_2 \cup I_3 \cup I_{2+3}} - \left[\frac{\sum_{i=1}^{l_0+l_2+l_3+l_{2+3}} X_i}{l_0+l_2+l_3+l_{2+3}} \right]_{t=0, i \in I_0 \cup I_2 \cup I_3 \cup I_{2+3}} \right) \\
\bar{X}_{\Delta_2} &= \left(\left[\frac{\sum_{i=1}^{l_2+l_{1+2}+l_{2+3}+l_{1+2+3}} X_i}{l_2+l_{1+2}+l_{2+3}+l_{1+2+3}} \right]_{t=1, i \in I_2 \cup I_{1+2} \cup I_{2+3} \cup I_{1+2+3}} - \left[\frac{\sum_{i=1}^{l_2+l_{1+2}+l_{2+3}+l_{1+2+3}} X_i}{l_2+l_{1+2}+l_{2+3}+l_{1+2+3}} \right]_{t=0, i \in I_2 \cup I_{1+2} \cup I_{2+3} \cup I_{1+2+3}} \right) - \\
&\quad - \left(\left[\frac{\sum_{i=1}^{l_0+l_1+l_3+l_{1+3}} X_i}{l_0+l_1+l_3+l_{1+3}} \right]_{t=1, i \in I_0 \cup I_1 \cup I_3 \cup I_{2+3}} - \left[\frac{\sum_{i=1}^{l_0+l_1+l_3+l_{1+3}} X_i}{l_0+l_1+l_3+l_{1+3}} \right]_{t=0, i \in I_0 \cup I_1 \cup I_3 \cup I_{2+3}} \right) \\
\bar{X}_{\Delta_3} &= \left(\left[\frac{\sum_{i=1}^{l_3+l_{1+3}+l_{2+3}+l_{1+2+3}} X_i}{l_3+l_{1+3}+l_{2+3}+l_{1+2+3}} \right]_{t=1, i \in I_3 \cup I_{1+3} \cup I_{2+3} \cup I_{1+2+3}} - \left[\frac{\sum_{i=1}^{l_3+l_{1+3}+l_{2+3}+l_{1+2+3}} X_i}{l_3+l_{1+3}+l_{2+3}+l_{1+2+3}} \right]_{t=0, i \in I_3 \cup I_{1+3} \cup I_{2+3} \cup I_{1+2+3}} \right) - \\
&\quad - \left(\left[\frac{\sum_{i=1}^{l_0+l_1+l_2+l_{1+2}} X_i}{l_0+l_1+l_2+l_{1+2}} \right]_{t=1, i \in I_0 \cup I_1 \cup I_2 \cup I_{1+2}} - \left[\frac{\sum_{i=1}^{l_0+l_1+l_2+l_{1+2}} X_i}{l_0+l_1+l_2+l_{1+2}} \right]_{t=0, i \in I_0 \cup I_1 \cup I_2 \cup I_{1+2}} \right)
\end{aligned}$$