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Child Labor and Schooling Responses to Production and Health Shocks in Northern Mali

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ABSTRACT

This paper investigates children's time allocation to schooling, home production, and market production using a unique data set collected from northern Mali. Production shocks from harvest period pest infestations induce households to withdraw children from school and increase the probability that they are selected into farm work. Health shocks to women increases the probability that a child participates in the family business and childcare activities. These results are robust to varying assumptions about the structure of unobserved heterogeneity at the household and village levels. Different measures of household assets are also constructed to test whether assets serve as a buffer against increased child labor in response to shocks. Assets such as livestock have mixed effects on child labor and schooling, depending on the shock and asset type. However, household durables are substitutes for increased child labor when households face health shocks.

Keywords: child labor, production shocks, health shocks, labor substitution effects

1. INTRODUCTION

Child labor is an economic imperative for many households, especially poor households in developing countries. The 2004 International Labour Organization estimate of working children aged 5-14 suggests that more than 190 million children work worldwide, of whom more than 49 million (26.4 percent of the region's child population) reside in Sub-Saharan Africa (Hagemann et al. 2006). Children contribute to household labor supply when reserves of labor are essential at critical periods of the production process, supervision of labor is costly, and household production by children frees other household members to pursue remunerative market activities. While some children do contribute income directly to households through formal wage labor,[1] most often children perform a combination of market activities and/or domestic activities, especially in Africa. These market activities include unpaid agricultural production on the family farm and formal or informal family businesses. Domestic activities include household public goods such as food preparation, household cleaning, and provision of childcare for other siblings. Without children's work, poor households lose one of the few mechanisms they have to increase incomes or smooth consumption in the face of economic shocks. This paper investigates children's time allocation to schooling, home production, and market production. It uses a unique data set collected from northern Mali to examine the marginal effects of production and health shocks on child time allocation. In addition, the paper estimates the effect of assets on mitigating children's withdrawal from school and increased participation in work activities.

While the literature on children's schooling is extensive[2] and the fertility literature explicitly models the quantity/quality tradeoffs among additional children,[3] the child labor literature has focused on the causes of children's work (Basu and Van 1998; Basu 1999; Baland and Robinson 2000; Bhalotra and Heady 2003) and the substitution effects caused by household composition and birth order (Edmonds 2006b and Emerson and Souza 2007). Increasing attention has also been paid to the income effect of production shocks and the ex-post changes in the distribution of children's work and schooling caused by these shocks (Jacoby and Skoufias 1997; Jensen 2000; Beegle et al. 2006, de Janvry et al. 2006, Kruger 2007). As Edmonds et al. (2007) note, our understanding of the mechanisms that determine child labor and schooling substitution effects are a critical lacuna in the literature. This paper contributes evidence regarding these substitution effects by using data that disaggregates children's work to better reflect the multiplicity of activities that children carry out in the developing world.

The paper also contributes to the literature by developing a model of children's participation in market production, home production, and schooling. The model, developed in the paper's second section, builds on Beckerian models of human capital investment in children within unitary household models (Becker 1965; Becker and Lewis 1973; and Becker and Tomes 1976), agricultural household models developed by Rosenzweig (1977a, 1977b, 1980), Singh et al. (1986), and de Janvry et al. (1991), and more recent models of child labor by Basu and Van (1998), Basu (1999), Baland and Robinson (2000), Cigno and Rosati (2005), and Edmonds (2007).

The third section of this paper develops the econometric strategy for estimating the marginal effects of household and community characteristics and idiosyncratic shocks on schooling, home production, and market-oriented production. Three econometric specifications (a probit model, a probit model with shocks and shock asset interactions, and a multivariate probit model) are investigated with different assumptions about the structure of potential unobserved heterogeneity. These error term assumptions include household-level random effects, village-level random and fixed effects, and cross-equation correlation to check for consistency across parameter estimates. Outcome variables include children's participation in multiple types of activities and the child's role in joint production. These

[1] A child agricultural wage rate was reported in only 7 percent of the villages we surveyed, indicating the lack of a child agricultural labor market. Manufacturing is not a predominant economic activity in northern Mali, so children's manufacturing wages were not collected in the village questionnaires.

[2] See, for example, Strauss and Thomas (1995) and Glewwe (2002), for a review.

[3] See for example Becker and Lewis (1973).

variables allow the examination of substitution effects within the household including the gender-specificity of tasks or the multiplicity of activities that children undertake. This analysis is infeasible when children's activities are aggregated into "work," rather than reported as specific activities in which a child engages. The econometric strategy uses production shocks from harvest-period pest infestations that reduce household income and illnesses within the family that reduce total household labor availability in order to identify substitution patterns of child labor and schooling.

The fourth and fifth sections of the paper describe the survey and the data collected in northern Mali. The sixth section presents the empirical results and investigates the role assets play in insuring against shocks and serving as buffers against the need to increase child labor. Different measures of household assets are constructed to test whether assets indeed serve as buffers against increased child labor in response to shocks. Results from investigating asset-shock interactions suggest that different asset types provoke different substitution effects within the household. To ensure that these results are robust to concerns about unobserved heterogeneity, model specification and endogeneity, robustness checks are conducted that include disaggregating the sample by gender and age, examining the effects of omitting household composition variables, and estimating the probability that a household reports a shock. The last section offers conclusions.

2. MODEL

The purpose of this model is to examine the mechanisms by which children's time is allocated to different activities (education, home production, or market production) within an agricultural household model. The household decision problem is divided into three periods. In the first period, the household decides how many children to have given their existing birth-control possibilities, preferences, social norms, and expectations about the future of raising children. In the second period, the household incurs a fixed cost for each child born as well as the cost of providing food and consumption goods to the child in this period.

The second period requires households to invest in their children, which will determine the child's third period income. Investment in children comes from food and consumption goods provided to children, but also from the amount of schooling that children acquire. Parents allocate the time of their children between school, home production, and market production, deciding simultaneously their participation in these activities and the hours to be worked. The first and second periods can be thought of, in the Beckerian sense, as parental investment in both the quantity and quality of children. The third period ends as parents become old, consuming the return on their assets, and as children earn their own income.

For ease of exposition, consider the last two periods of the allocation process and assume that the household maximizes an additive utility function over these two periods, considering its own consumption in period 2 and a discounted valuation of children's consumption in period 3.

Building on the Cigno and Rosati (2005) model of child labor in a unitary household, let a_2 and a_3 be adult consumption in periods 2 and 3. Children's period 2 consumption and period 3 income are represented by c_2 and y_3. Parents maximize a separable utility function with arguments that include their own periods 2 and 3 consumption as well as a discounted function of their *n* children's period 2 consumption and period 3 income when they become adults and form their own households.

Utility Function: $$U = u(a_2, a_3) + \beta n U^*(c_2, y_3) \quad (1)$$

The household faces a budget constraint in each period. In the second period, the household must divide its revenue from market production and home production between adult consumption and assets or savings, denoted *k*. For each of the *n* children born in period 1, a fixed cost is also incurred, *b*, which includes all the costs of childcare in period 1. Two other costs are borne by the household in period 2, the child's period 2 consumption, c_2, and the cost of schooling for each child who is sent to school, *s*. If *s* is set to zero, then the child does not go to school. In period 3, adults no longer work and children form their own households. The budget constraint for the household in period 3 is simply the return on the household's assets invested from period 2.[4]

Budget Constraint Period 2: $$Y_2 + H_2 + w_A^W T_A^W = a_2 + (b + c_1 + s)n + k \quad (2)$$

Budget Constraint Period 3: $$a_3 = rk \quad (3)$$

Both adults and children have time constraints. Adults divide their time among self-employed market production, T_A^F, home production, T_A^H, the wage labor market, T_A^W, and leisure activities, T_A^L. Children divide their time among schooling, T_C^S, market production, T_C^H, home production, T_C^H, and leisure, T_C^L. Parents choose simultaneously whether children work in a particular activity and the hours

[4] Implicitly, the model makes two assumptions in Equations 2 and 3. The first is that period 1 production, consumption, and labor supply decisions have no impact on period 2 decisions. Second, the absence of credit markets and borrowing are constraints for households. Credit market transactions are small with short term loans that do not exceed one of the periods purposed by the model. Credit contracts of long duration or debt bondage are not considered in this model.

worked. If a child's time is not allocated to a particular activity, the child's time is set to zero. Because there is a low incidence of child wage labor in northern Mali, only the adult's return in the wage labor market is modeled.

The household generates profits from agricultural production or a home business via the market profit function in Equation 4. The revenues from the business are generated by scaling output from the production function, *f,* that converts adult and child labor given the quasi-fixed inputs capital, *K,* and land, *L,* by a vector of output prices, *p*. Adult and child labor inputs are valued at wage rates that represent the opportunity cost of the adult or child's time. Domestic profits are valued according to a home production function minus the labor inputs that generate the final goods. Both production functions have positive first derivatives and negative second derivatives.

Market Profits in Period 2: $$Y_2 = p\delta q(T_C^F, T_A^F \mid K, L) - w_A^F T_A^F - w_C^F T_C^F \quad (4)$$

Domestic Profits in Period 2: $$H_2 = h(T_A^H, T_C^H) - w_A^H T_A^H - w_C^H T_C^H \quad (5)$$

δ is a random production shock included in Equation 4 with E(δ)=1 and an i.i.d. distribution that represents unexpected positive or negative production shocks. These could include rainfall variation, crop losses due to insect or animal infestations, or household illness that affects market production.

The child's period 3 income is the return that the child (now an adult) receives on her labor given her cognitive development, *E* , and period 1 and 2 consumption. The child's period 3 income is a function of her cognitive skills, *E,* which are developed in period 2, and of period 2 consumption, c_2, which determines physical development and work capacity. Childhood nutrition is a critical component of future adult health, which contributes to the adult's work capacity in period 3.

Income Generation in Period 3: $$Y_3 = w_3(E, c_2) \quad (6)$$

Cognitive development is represented by a production function, *E* (Equation 7) with inputs including the child's time in school, T_C^S , schooling inputs such as books, *s*, and the school's quality, *Q*. Following Glewwe (2002), a parameter of the learning efficiency of the child that is exogenously given is specified as *θ*. As *θ* increases, the cognitive development of the child increases. Included in *θ* are unobservable characteristics that increase a child's cognitive development, such as innate ability, the child's motivation, and the parent's motivation to help the child learn. These unobservable characteristics are grouped in the vector *θ*. The interaction between unobservable household characteristics with school quality and time in school produces cognitive skills.

Cognitive Skills: $$E = \theta f(Q, s) g(T_C^S) \quad (7)$$

The full model is outlined in Appendix A, but testable implications are developed from the solution to the household's problem summarizing the conditions under which children's time is allocated to schooling, home production, and market production. The comparative statistics of household shocks on child labor and schooling are also derived, and can be tested with the data.

School

Equation 8 defines the schooling participation equation to be estimated. $S^{C*}_{i,h}$ is a discrete choice that depends on the following factors. First, if the shadow value of the child's time is relatively high, then the demand on the child's time in either the home or market production of the household in period 2 will outweigh any future benefit in period 3 that schooling may provide. Factors that increase child schooling include school quality, which increases the future benefits of cognitive skills. A child's unobservable characteristics and her parent's motivation to help her succeed in school, represented by *θ,* will also increase the benefits of schooling and make the development of cognitive skills more desirable.

Schooling Condition: $$S^{C*}_{i,h} \equiv \beta n \frac{\partial U^*}{\partial y_3} \theta f(Q,s) g'(T_C^S) > \lambda_1 \tag{8}$$

Home Production

The child's participation in home production can be explored by transforming Equation A.8 such that:

$$h'(T_A^H, T_C^H) = \frac{\lambda_1}{\partial u / \partial a_2} + w_C^H \tag{9}$$

Using the Implicit Function Theorem, Equations A.8 could be solved to derive the optimal hours worked by the household's child for the general case. Alternatively, if a Cobb Douglas production function is assumed for *h*, a closed form solution can be derived. By using this functional form, child and adult labor become either complementary or substitutes. Much of the child labor literature suggests that child and adult labor are substitutes. However, complementary adult and child labor seems to be the more intuitively plausible because it is relatively rare to see children working without adult supervision. This proposition is testable using analysis of the asset-shock substitution effects. Using the functional form assumption for the household production function, the household child labor demand becomes:

$$T_C^H = \left[\frac{w_C^H + \frac{\lambda_1}{\partial u / \partial a_2}}{(1-\alpha)(T_A^H)^{\alpha}}\right] \tag{10}$$

If $T_C^H = 0$, then Equation 11 characterizes the equilibrium condition. When the shadow value of the child's time and the increase in the adult's marginal utility from the return on the child's time in home production are greater than the marginal utility from the change in productivity of the home production function due to the child's labor, it is inefficient to allocate the child's time to home production. The child's participation in home production is characterized as a discrete choice, $L^{C*}_{i,h}$.

Home Production Condition: $$L^{C*}_{i,h} \equiv \frac{\partial u}{\partial a_2}\left(h'(T_A^H, T_C^H\right) > \lambda_1 + \frac{\partial u}{\partial a_2} w_C^H \tag{11}$$

Market/Farm Production

The analysis of the allocation of children to the market production activities of the household is similar to the decision rules for the home production activities. However, the household's decisions are driven by the marginal returns of allocating additional hours of child labor to market/farm production and the return to the child of each additional unit supplied. Manipulating Equation A.9 yields:

$$p\delta q'(T_A^F, T_C^F) = \frac{\lambda_1}{\partial u / \partial a_1} + w_C^F \tag{12}$$

A closed form solution, assuming the Cobb-Douglas production function yields:

$$T_C^{\ F} = [\frac{w_C^{\ F} + \frac{\lambda_1}{\partial u / \partial a_1}}{p\delta(1-\alpha)(T_A^{\ F})^{\alpha}}]^{\alpha} \tag{13}$$

If $T_C^{\ F} = 0$, then from the first order conditions Equation 14 must hold which characterizes the discrete choice of child labor in market production:

Market Production Condition: $$L^{C*}_{\ i,h} \equiv \frac{\partial u}{\partial a_2}\left(q'(T_A^{\ F}, T_C^{\ F}\right) > \lambda_1 + \frac{\partial u}{\partial a_2} w_C^{\ F} \tag{14}$$

Equation 14 states that when the marginal utility value of adding an additional unit of child labor to market production exceeds the shadow value of the child's time and the shadow wage, then a child will be allocated to market production. Together with Equation 11, these equations suggest there are thresholds over which children's time is allocated to certain types of market and domestic production. The importance of covariates suggested by these participation conditions on observed child labor decisions are estimated in the sample of children from northern Mali in section 6.

Response to Shocks in Market Production

The changes in child labor in response to market production shocks are characterized by taking the derivative of the child labor demand equation with respect to the production shock:

$$\frac{\partial T_C^F}{\partial \delta} = -\alpha[\frac{w_C^F + \frac{\lambda_1}{\partial u / \partial a_1}}{p\delta(1-\alpha)(T_A^F)^{\alpha}}]^{\alpha-1} \frac{w_C^F + \frac{\lambda_1}{\partial u / \partial a_1}}{p\delta^2(1-\alpha)(\gamma_A)^{\alpha}} < 0 \tag{15}$$

In response to positive production shocks, households decrease child labor supply to market activities. Negative production shocks induce larger allocations of children's time to income generating or subsistence activities. Child and adult productivity shocks have inverse effects on allocation of child time to work. This is because the marginal value of children's labor input increases when less labor is allocated to the production process. The responses of both production and health shocks can be tested empirically in these data.

3. ECONOMETRIC SPECIFICATION

Three different econometric specifications are used to investigate allocation of children's time in home production activities such as childcare provision,[5] market activities such as agricultural production and family business labor, and school enrollment. Participation in any of these activities is indicated dichotomously by the latent variables $L^{C*}_{i,h}$ and $S^{C*}_{i,h}$, which were derived above. For simplicity, all child work and school participation decisions are specified as $L^{C*}_{i,h}$ below. The three econometric specifications represent three different sets of identification assumptions about the structure of the disturbance term and the inclusion of crop loss shocks and household health shocks.

Specification 1: Selection into Activities: Probit with Random Effects

To estimate the probability of selection into child labor, a probit model is specified for each of the sectors independently for which a child works, given household and individual specific covariates ($X_{i,h}$), community covariates ($Z_{i,h}$), a household effect on each child (c_h), and a child/household unobservable ($\varepsilon_{i,h}$), which can be combined in a composite error term: $\nu_{i,h} = c_h + \varepsilon_{i,h}$. The following equation is specified such that:

$$L^{C*}_{i,h} = \beta X_{i,h} + \gamma Z_h + \nu_{i,h} \tag{16}$$

where

$$L^{C}_{i,h} = 1 \quad \text{if } L^{C*}_{i,h} > 0 \tag{17}$$

$$= 0 \text{otherwise}$$

and obtain the distribution of $L^{C}_{i,h}$ given $X_{i,h}$, $Z_{i,h}$, and c_h using the familiar result:

$$\begin{aligned} P(L^{C}_{i,h} = 1 \mid X_{i,h}, Z_h, c_h) &= P(L^{C*}_{i,h} > 0 \mid X_{i,h}, Z_h, c_h) \\ &= P(\varepsilon_{i,h} > -\beta X_{i,h} - \gamma Z_h \mid X_{i,h}, Z_h, c_h) \\ &= 1 - \Phi(-\beta X_{i,h} - \gamma Z_h) = \Phi(\beta X_{i,h} + \gamma Z_h) \end{aligned} \tag{18}$$

where $\Phi(.)$ is the standard normal cumulative distribution function. Following Butler and Moffitt (1982), the conditional likelihood function can be derived to estimate the joint distribution of $L^{C}_{i,h}$ conditional on $X_{i,h}$ and Z_h, which requires that the random effect is integrated out of the likelihood function.

The cognitive skills production function (Equation 9) implies that there is an unobservable term, θ, that is household-specific and influences children's learning efficiency. Because this term is determined in part from parental involvement in the child's learning and the child's genetic and psychological disposition to learning, a random effect that potentially varies among children within the household seems to correspond closely to the proposed theoretical model. Besides the theoretical motivation for investigating household-level effects on children's work and schooling, there is empirical evidence that suggests parental preferences have large effects on children's schooling decisions. For example, 54 percent of children aged 11-17 in Senegal reported that they had not been to school because their parents refused to send them, while 19 percent had not attended school because their parents needed their help to meet subsistence requirements (Dumas and Lambert 2004). This suggests that household preferences may influence children's time allocation patterns.

[5] 87 percent of children in our survey reported doing domestic chores, so while this category of work performed by children is the highest category in terms of percentage of children participating, estimation of the determinants of this activity is not possible given the lack of variation in the dependent variable.

Econometrically, there are certain advantages to using probit with random effects to control for household unobservables. Maddala (1987) argues that an unobserved household heterogeneous effect, c_h, for which there is information and/or some a priori belief that it might not be fixed, ought to be treated econometrically as u_{ih}, in order to measure the household-specific effects about which the econometrician is also ignorant. Since fixed effects capture all time-invariant characteristics of the cross-sectional units, no estimate of the effect of parental education or household assets on child work and school participation would be possible.[6] In addition, the household fixed effects estimator suffers from the incidental parameters problem, which renders the maximum likelihood estimates inconsistent.

Random effects estimation is not without innocuous statistical assumptions that require consideration. Identification is conditioned on assumptions regarding the relationship between the random effect and the covariates and distributional assumptions. Precisely, these assumptions are:

1. *Strict Exogeneity*: $P(y_{ih}=1 \mid x_i, c_i) = P(y_{ih}=1 \mid x_{ih}, c_i) = \Phi(\beta x_{ih} + c_i)$
2. $y_{i1}, \ldots, y_{iH}$ are independent, conditional on (x_i, c_i)
3. $c_h \mid x_h \sim Normal(0, \sigma_c^2)$

Given a priori beliefs about the nature of the household's child work and schooling decisions and econometric arguments, three econometric specifications are proposed to measure the effects of children's home production, market production, and schooling given household, parental, child-specific and community covariates, using household random effects. As a robustness check, the results of the random effects and fixed effects estimation at the village level are reported.

Specification 2: Investigating the Impact of Agricultural Shocks and Household Morbidity

Building on specification 1, household-reported sicknesses and production shocks that result in crop losses that are rated in severity by the farmer (large or small) are included in the second specification. The sickness shocks are disaggregated into men's illness, women's illness, and children's illness. Including the shocks in the probit model specified as in Equation 16 yields:

$$L^{C*}_{i,h} = \beta X_{i,h} + \gamma Z_h + \phi Shock_{i,h} + c_h + \varepsilon_{i,h} \tag{19}$$

Exogeneity of Shocks

Self-reported health shocks may not be a reliable measure of health if reporting is correlated with wealth and education (Strauss and Thomas 1995). Production shocks also may be endogenous if households' ex-ante decisions mitigate the expected risk of seasonal variations. A simple test of the plausibility of the shock's exogeneity estimates the probability that a household reports a shock, controlling for observable household characteristics that may likely be correlated with the reporting itself. If these covariates are significant determinants of the probability of experiencing a shock, the shock may not be exogenous. The following specification is estimated:

$$P(shock_h = 1) = f(X_{ih}, Z_h) \tag{20}$$

This exogeneity test examines correlations between household characteristics and self-reported morbidity or crop-loss shocks. Using a small subset of panel data for the survey also produces evidence regarding the strict exogeneity assumption. The specification below controls for previous shocks to illustrate that the effects of self-reported morbidity and crop-loss shocks are transitory. If lagged shocks

[6] Several examples of random effects estimation in the children's health and education literature include Pitt (1997), Glick and Sahn (1999, 2005), or Paxson and Schady (2005).

have persistent effects on the dependent variable, then the strict exogeneity assumption on which the random effects estimate depends would be questionable. Equation 21 includes controls for time-invariant household and community characteristics and includes household fixed effects.

$$L^{C*}_{i,h,2006} = \beta X_{i,h} + \gamma Z_h + \phi_{2006} Shock_{i,h,2006} + \phi_{1997} Shock_{i,h,1997} + \varepsilon_{i,h} \quad (21)$$

Smoothing Shocks: The Role of Assets

Several categories of assets, including the values of the household's durable goods, agricultural capital, and livestock, are of particular interest because of their varying liquidity. Faced with production and health shocks, households may choose to liquidate assets rather than change the allocation of children's time. These shocks are interacted with the asset types in the probit model such that Equation 19 becomes:

$$L^{C*}_{i,h} = \beta X_{i,h}\beta + \gamma Z_h\gamma + \phi Shock_{i,h} + \alpha(Shock_{i,h} \cdot Assets_{i,h}) + c_h + \varepsilon_{i,h} \quad (22)$$

Specification Three: Multivariate Probit

The previous econometric specifications treated the dependent variables as independent decisions in an equation-by-equation specification. However, the theoretical modeling suggests that cross-equation correlation is likely. These cross-equation correlations can be modeled by using a multivariate probit model such that:

$$\begin{aligned}
S_1{}^{C*}_{i,h} &= \beta X_{i,h} + \gamma Z_h + \phi Shock_{i,h} + \varepsilon_{1;i,h} \\
L_2{}^{C*}_{i,h} &= \beta X_{i,h} + \gamma Z_h + \phi Shock_{i,h} + \varepsilon_{2;i,h} \\
L_3{}^{C*}_{i,h} &= \beta X_{i,h} + \gamma Z_h + \phi Shock_{i,h} + \varepsilon_{3;i,h} \\
L_4{}^{C*}_{i,h} &= \beta X_{i,h} + \gamma Z_h + \phi Shock_{i,h} + \varepsilon_{4;i,h}
\end{aligned} \quad (23)$$

where each subscripted equation, $L_m{}^{C*}_{i,h}$, m=1,2,3,4, represents an activity for which a child may participate dichotomously. To facilitate the interpretation of the effects of shocks on schooling for children, $S_1{}^{C*}_{i,h}$ is defined as the discrete choice of whether the child was withdrawn from school in the previous year. Conditional on the child having been enrolled in school the previous year, the interpretation of the shock variables are cleanly identified. The relevant question is whether production and health shocks are causing students to withdraw from school. School enrollment for children not enrolled in school during the last academic year will be unaffected by shocks in the same year.

Restrictions on the residuals, $\varepsilon_{m;i,h}$ require:

$$\begin{aligned}
&E(\varepsilon_{m;i,h} \mid X_{i,h}, Z_h) = 0 \\
&Var[\varepsilon_{m,i,h} \mid X_{i,h}, Z_h] = 1 \\
&Cov[\varepsilon_{m;i,h}, \varepsilon_{m+1;i,h} \mid X_{i,h}, Z_h] = \rho \text{ where } \rho_{jk} = \rho_{kj}
\end{aligned} \quad (24)$$

Using the Geweke-Hajivassiliou-Keane (GHK) simulator, the system of equations in (24) can be estimated by evaluating the four-dimensional normal integrals in a likelihood function (Geweke et al. 1994).

4. DATA DESCRIPTION

The Survey Area: Northern Mali

The regions of Tombouctou, Gao, and Kidal lie in the arid and semi-arid regions of northern Mali. The most southwesterly communes of the region of Tombouctou are located in the inner Niger Delta, where the Niger River breaks into multiple streams to irrigate small ponds and lakes that supply water to otherwise parched soils that are increasingly sandy from the climactic forces of desertification. The defining geographic feature of this region is the juxtaposition between the vast and desolate Saharan desert and the third largest river in Africa, the Niger, which meanders northeasterly until it reaches its most northern point in the commune of Bourem before descending past the ancient city of Gao into the country of Niger. Besides providing the primary water source in an otherwise arid zone, the Niger River is a primary transportation route, enables fishing for food and the cultivation of floating rice, and provides grasses called *bourgou* (Echinochloa stignina) for the alimentation of livestock.

Rainfall in the three regions is scarce and intermittent during the rainy season which is generally considered to span July to September. The Saharan zone (desert or arid regions) receives less than 150 millimeters of rainfall per year. This varies starkly with the Sahelien zone (grassland or semi-arid regions), which receives 200-600 millimeters per year, and the south of Mali, which can receive between 600 and 1200 millimeters per year (Christiaensen 1998). Depending on the date of planting, the primary harvest begins in October and could last into December or early January. Grains, particularly rice, sorghum, and millet are the primary crops cultivated. December and January are the coldest periods, which lead to the hot and hunger seasons that span from February to June. During this period, a limited number of counter-seasonal crops are produced, but these are cultivated mostly from smaller garden plots than from the larger plots used for grain cultivation during the primary agricultural season. The school year usually begins in September and ends in June, leaving children available for planting, but potentially occupied with schooling during the harvest season. Rainfall scarcity is counterbalanced by irrigation from the Niger River and lake recession agriculture in the inner Niger delta. The source of the Niger River, Tembakounda, lies in the Djallon Mountains of Guinea, where rainfall is siphoned into the river, determining its volume for the most part.[7] But after the rainy season in the mountains ends, river levels diminish, exacerbating water scarcity in northern Mali. As a result, primary and secondary tributaries along the river's primary bed dry up completely.

Seventy-three percent of households in our survey participate in agriculture as a primary activity. Primary activities are predominantly determined by ethnicity, with the Sonray, Soninké, and Bambara being the primary cultivators; the Peuhl, Tamasheq, Berabich, and Maures the traditional pastoralists; and the Sorko, Korongoy, and the Bozo deriving their livelihood from fishing. However, there is idiosyncratic variation across communities, most notably among selected Tamasheqs, who, after the Touareg rebellion of 1990-96, increasingly have become more sedentary as part of governmental and nongovernmental interventions.

Poverty is a widespread phenomenon in Mali, but specifically in the rural regions of northern Mali. The region has known several significant economic shocks, including widespread drought and famine in 1914, 1973, and 1984, as well as the civil conflict noted above in the early 1990s. The Government of Mali's *Poverty Reduction Strategy Paper 2002* reports a national poverty rate of 63.8 percent, with severe poverty in the country at the 21 percent level. Indicators from the *Rapport National 2003 sur le développement humain durable au Mali* (RNDH 2003) illustrate the entrenchment of rural poverty at the communal level in the north, as compared to other regions of Mali. Because northern Mali

[7] Christiaensen (1998) provides a detailed description of river levels and rainfall data that illustrates this relationship. In particular, this is why rainfall data is unlikely to be correlated with production yields. According to the EPSANM 2006, 22 percent of farmers use irrigation drawn from the Niger River (Dillon 2006). The timing and levels of this flooding and water recession are the critical covariates in these production systems. They determine water availability and thus agricultural income, not local rainfall.

is geographically isolated and considered to have less potential than other regions of Mali, differences in public investment are stark.[8] According to the 2003 *Rapport National*, 33 percent of communes in Tombouctou, 30 percent in Kidal, and 35 percent in Gao had no access to primary schools in 1998. Other regions further south and west of these northern regions had far lower percentages of communes without access: Kayes (13 percent), Koulikoro (1 percent), Sikasso (6 percent), Segou (4 percent), and Mopti (7 percent).

Survey Design

The data for this paper were collected as part of the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali (EPSANM) 2006*. This multi-topic household survey was implemented to study household behavior related to human capital formation and household production activities, including agriculture, herding, and nonfarm activities in northern Mali. A representative household survey of 2,155 households in 151 villages was undertaken from February 2006 to October 2006 in seven *cercles* or states (Niafunke, Goundam, Dire, Tombouctou, Rharous, Bourem, and Kidal) in the regions of Tombouctou, Gao, and Kidal. Households were drawn randomly using a two-stage cluster sample. Detailed documentation of the survey design and methodology can be found in Dillon (2006).

The data set is composed of a village questionnaire and a tripartite household questionnaire. The village questionnaire was administered to village leaders in each village or town covered by the study. The household questionnaire comprised modules for an adult male, adult female, and child. Survey modules concerning the household's composition, education, primary activities, migration, and history of positive and negative shocks were addressed to the household head, usually a man. Questions concerning the household's food consumption, health, and dietary diversity were addressed to women. Sections concerning possessions, nonfood expenditures, agricultural production, herding activities, credit, and time allocation were addressed to both men and women. The children's modules were addressed to children aged 10-17 years old with questions about their participation in multiple household and market production activities and schooling, the hours worked during the past week in these activities, and the time spent on a set of activities in order to determine the distribution of time amongst work, school, and leisure. A second section of questions collected more detailed schooling information for all children enrolled in school.

[8] The concept of *Le Mali inutile* became a popular characterization of northern Mali, which was considered useless due to low production possibilities as deemed by USAID and the World Bank, especially after the 1974 droughts. See Poulton and ag Youssouf (1998) for a detailed recent history of northern Mali.

5. DESCRIPTIVE STATISTICS

Children's participation rates in schooling, home production, and market-oriented production are summarized in Table B.1[9]. Thirty-three percent of children in our survey are currently in school, the lowest percentage of any category of activity. Another indicator of children's schooling status is whether children were withdrawn from school in the last academic year. Of students who were enrolled, 18 percent were withdrawn. Most children (87 percent) do some household work, while 45 percent are responsible for watching other children within the family. Market-oriented productive activities also have high child participation rates, with farm work occupying 54 percent of children in the survey and work in the family business[10] occupying almost 68 percent. Children's joint production activities are also summarized in Table B.1. Twenty-five percent of children combine some market work with school. Twenty-eight percent combine domestic work with school, while only 20 percent of children perform some market work and domestic work.

Northern Mali's child labor rates are higher than regional means. The ILO estimates that 26.4 percent of children in Sub-Saharan Africa performed some type of economic activity in 2004 (ILO 2006). Within West Africa, Dumas and Lambert (2004) report that of children aged 11-17 in Senegal, 67 percent attended school, 69 percent reported participating in domestic work, and 25 percent participated in non-domestic work.[11] Higher mean participation rates in work activities and lower schooling rates may reflect higher poverty levels and less public infrastructure in northern Mali relative to other African countries. While Sub-Saharan African children have the highest incidence rates of economic activity, Asian children have the largest absolute number of economically active children, according to the ILO.

Table B.2 presents disaggregated children's participation rates across activities by sex and urban/rural area. Girls bear most of the responsibility for domestic work as defined by both watching other children in the household and doing domestic chores. A higher percentage of urban girls than rural girls participate in domestic work, although the differences between participation rates is most striking for domestic childcare that girls provide to the family. Forty-nine percent of rural girls watch other children in the family, while 74 percent of urban girls do so. The distinction between urban and rural boys is also wide with 36 percent of rural boys and 61 percent or urban boys being responsible for watching other children. Ninety percent of urban boys also do some sort of domestic chores, whereas 79 percent of rural boys do so. Rates of participation in domestic chores for girls are high in both urban and rural areas, with rates of 97 percent and 95 percent, respectively. Studies from Ghana, such as Bhalotra and Heady (2003), report rural school participation rates for girls and boys at 68.9 percent and 76.5 percent; farm work at 34.4 percent and 40.5 percent; and joint participation in school and farm work at 29.9 percent and 24.6 percent, respectively[12].

Work in the family business does not differ with respect to urban and rural areas. However, participation in the family business differs between girls and boys by a rate of almost 11 percent. Another market-oriented activity, farm work, shows distinct rural/urban and boy/girl differences. Rural boys and urban boys farm with rates of participation of 73 percent and 50 percent, respectively, whereas only 38 percent of rural girls and 23 percent of urban girls work on the farm. With regard to children's participation in schooling, rates of schooling differ across rural and urban areas, but they are similar between girls and boys. Forth-six percent of urban children go to school while only 32 percent of rural children are currently being schooled. Girl and boy school participation rates differ by only 2 percent, with boys favored slightly.

[9] The percentage of idle children in our survey is only 2 percent. That is, children who neither work nor go to school.

[10] In northern Mali, family businesses are primarily run by women who have small enterprises, usually manufacturing condiments for food, artisanal goods, or housewares such as mats or kitchen tools. Products are sold on weekly market days as a supplement to household income.

[11] L'Enquete Education et Bien-Etre des Menages au Senegal 2003 investigates multiple types of children's domestic and market-oriented activities (Dumas and Lambert 2004), suggesting that these results are a good comparison for EPSNAM 2006.

[12] Bhalotra and Heady (2003) use the rural sample from the Ghana Living Standards Survey 1991/92 for children aged 7-14.

Summary statistics of the child, parental, and household characteristics are summarized in Table B.3. Boys comprise 54.5 percent of the children in the sample.[13] The distribution of ages, restricted to children between 10 and 17 years old, is presented as indicator variables of each age reported from the household roster. Because official administrative record-keeping has only recently become common at the commune level in Mali and a high percentage of natural births outside of hospitals are common, correct reporting of a child's age can be difficult. There seems to be some grouping of children's ages around even numbers (10, 12, 14, and 16 year olds), with odd ages reporting lower numbers. There is no particular natural phenomenon that could explain this pattern, so the interpretation of age-specific results should be conducted with caution in light of potential measurement error in the age variable. In addition to age, sex, and ethnicity, the child's relationship to the head of household is reported. The household head is plausibly the primary decisionmaker whose influence on the child's work and schooling may in part be dictated by social relationships. Eighty percent of children are the biological offspring of the head of household.

Household composition is potentially a critical determinant of children's schooling and work activities. The number of household members may determine total labor availability to allocate to various market and domestic activities. The mean number of boys is 1.7, girls 1.4, women 1.7 and men 1.6.[14] Adult characteristics such as the ages of the household head and spouse are also included in the econometric analysis. These variables capture potential life-cycle influences of the primary decisionmakers who influence children's time allocation. The household's human capital is measured by parental education. Education is measured as an indicator variable of the parent ever having completed a grade level of education. Only 5 percent of mothers have any education whereas fathers have an education rate of 10 percent.[15]

Household assets and unearned income are reported in the second column of Table B.3. Four types of assets are reported: herd size, herd value, agricultural capital value, and household durables value.[16] Herd size captures the number of animals that require supervision, resulting in higher child labor demand. However, herd value captures the value of animals as an asset. Hence, households may choose to store their wealth in fewer, high-value animals that are less liquid, or a larger number of low-value animals. Households have a mean of 19.25 animals with a value of 532,000 FCFA, slightly more than US$ 1,000. Agricultural capital had much lower mean household value, less than US$ 100, or 47,000 FCFA. Durable goods, which include furniture, radios, motorcycles, and other house wares, had a mean value of 303,000 FCFA, or less than US$ 600. These assets represent varying levels of liquidity, which may affect whether households choose them to smooth consumption or choose instead to increase children's work. A primary component of unearned income is captured by migrant remittances that have a mean value of 40,508 FCFA, but with a high standard deviation across households.

The incidence of household shocks is summarized in Tables A2.3 and A2.6. Twenty-five percent of households reported a large crop shock caused by insects or birds eating pre-harvest crops, a common problem in northern Mali over which farmers have limited control. Fifty-three percent of farmers reported no crop losses, while another 22 percent reported only minor crop losses. Households also reported which members had been sick in the previous month. Adult males had an illness incidence rate of 13 percent.

[13] This deviation from proximate parity in the sex ratio suggests that girls and boys may have characteristics which systematically differ, causing higher migration out of northern Mali or higher mortality rates. The assumption of pooling both genders will be relaxed in the forthcoming econometric investigation to test this proposition.

[14] Adults include any person aged 18 or older in the household. This may not necessarily be congruent with the social conception of how households themselves may view members, since persons aren't usually considered adults until after marriage. However, for the purposes of investigating work, persons aged 18 have reached full physical development and are usually out of school to be freely allocated to different activities. Children aged 17 or under may still be developing and/or have obligations to school, which may differentially impact their time allocation.

[15] Parental education is potentially endogenous, but we have no plausible instruments, such as grandparent's education, to identify this relationship. The schooling participation of grandparents reported in the study is close to zero. Concerns about this source of potential endogeneity may be assuaged by the low incidence of parental education in these data.

[16] The value of all assets is reported in local currency, the CFA Franc (FCFA). During the period of the survey, US$ 1 = 515 FCFA approximately.

Twenty-one percent of women reported that they were sick in the previous month, while 14 percent of children were reported to have been sick. The distribution of these shocks across the regions studied also provides evidence of the variability of their incidence in different zones. Table B.6 shows that the incidence rates of large crop losses by *cercle* are highest in Rharous, Bourem, and Niafunke, with Rharous being particularly hard hit by crop losses in the last agricultural season.[17] The rates of male, female, and child sickness display a different regional distribution than the production shocks. The highest rates of male illness rates come from Rharous, Tombouctou, and Dire, while female illness rates are highest in Bourem, Tombouctou, and Dire. Children's illness rates are highest in Bourem, Rharous, and Tombouctou.

There are two types of community characteristics that are also included in the econometric specifications: characteristics that proxy for market development and the potential of children's work opportunities and school quality, and characteristics that increase the efficiency of children's learning, i.e., the cognitive skills attained per unit of time spent in school (Table B.5). Table B.4 presents the community characteristics that include whether the child comes from an urban or rural area, a regional indicator, and variables indicating whether the child's village or town has access to the Niger River or an improved road. Access to either the river or an improved road increases the commercial potential of a village or town because transportation and communication links increase. Commune-level data is also collected to indicate the size of potential markets as a function of the commune's total population and the concentration of this population by the number of villages per commune. These community characteristics may have alternative effects on the allocation of children's time across different activities. Greater access to income-generating activities may increase the child's market-oriented work as households struggle to meet subsistence requirements. Alternatively, access to income-generating activities may cause adults to work more, decreasing children's market-oriented work, but increasing their domestic work as adults leave the household to pursue income opportunities. Exactly how these income and substitution effects, both on children and adults, affect the allocation of children's time to different activities is an empirical question.

[17] Despite the high incidence rates in Bourem, only 7 percent of the villages surveyed come from this area, reflecting perhaps a more isolated incident than the percentage of households affected may seem to indicate if the sample were evenly distributed across the *cercles*.

6. ESTIMATION RESULTS

The effects of household characteristics—assets and household composition, parental and child characteristics, community characteristics such as school quality, and crop and health shocks—on participation across schooling, home production, and market-oriented production[18] are presented in this section. All reported coefficients in the tables are marginal effects.

Probit Model with Random Effects[19]

Table C.1 presents the results from the random effects model.[20] Gender has significant impacts on the selection of children into farm work, the family business, and child care. Joint production of market work and schooling also becomes significant at the 10 percent level after controlling for random effects. Boys are more likely to engage in farm work and joint production of market work and schooling. However, boys are less likely to engage in work in the family business and child care activities. As expected, age effects are positive for schooling at age 11 and negative for older children (16 and 17 year olds).

Household characteristics and composition are also important determinants of children's participation in work and schooling activities.[21] Controlling for random effects, the probability of being selected into schooling increases by .282 for biological children,[22] indicating that foster or adopted children may not receive the same investments in human capital. The number of boys, girls, and adults in the household determines the household's labor availability. The higher the number of girls, the lower the probability that they will be selected for farm work, but the higher the probability that they will be selected for childcare. An increase in the number of boys also increases the probability that a child will be selected into childcare. Higher numbers of adult men in the household lower selection of children into all work activities and schooling except farm work, while higher numbers of adult women lowers child selection into childcare.

Household assets are less important factors of selection into children's work and schooling activities. For selection into schooling, herd value positively affects schooling participation, while herd size negatively affects it. These marginal effects suggest that while livestock form assets that correlate positively with children's schooling, they require constant supervision, a task that may be delegated to children. Hence, livestock holdings influence the internal mechanisms of household labor supply and demand.

Parental education has large and significant effects on children's work and schooling. Children of educated fathers have higher selection probabilities into schooling and lower selection probabilities into the family business and joint market and home production. However, children of educated fathers face higher selection probabilities for the other two joint production variables. Mother's education has significant effects for all activities except farming. This suggests that educated parents may have increased income-generating opportunities that require not only additional labor from their children in

[18] The outcome variables we consider include indicators for school, farm work, working in the family business, domestic work, watching other children, and three joint-production categories: market production and school, home production and school, and market production and home production. Full regression results are presented in Appendix 3: Tables A3.1-A3.7.

[19] Probit model regression results without random effects are displayed in Table A3.8. Their discussion is excluded here for brevity.

[20] The domestic work equation has been dropped because its high positive response rate made the random effects estimation unable to converge.

[21] The number of children within the household and whether the child is fostered into the household may be endogenous, even controlling for household random effects. We relax this assumption later and perform a robustness check on the stability of the coefficients without these variables included in the regression.

[22] This suggests that foster or adopted children may not receive uniform investments in human capital, but the causality may not be directly related to foster parents. If birth parents have already withheld children from enrolling in school, it may be prohibitively costly or impossible for foster parents to reverse this decision. See for example, Akresh (2007a and 2007b) on the decision to foster and the impact of foster on children's schooling.

market-oriented activities, but also in home production. This hypothesis is reinforced by the finding that children of educated mothers have higher selection probabilities into joint production.

Examining the commune-level demographic and school characteristics data, the presence of a primary school in a village increases the probability that a child is selected into schooling. In the random effects specification, the presence of a high school also increases this probability. The latter may reflect parents' expectations that having their child finish high school would provide a higher return than stopping at primary education. The presence of a primary school also increases participation in joint production, both market-oriented and home production with schooling, as well as in domestic work and family business work. The latter two are time-insensitive activities that can accommodate schedules outside of school hours. School quality characteristics also influence selection into school. For example, an increased student teacher ratio in primary schools lowers selection into schools by .014.

Impact of Health and Crop Loss Shocks on Children's Work and Schooling

Before estimating the effects of production and morbidity shocks on child labor and schooling variables, the exogeneity test described by Equation 22 was conducted. Table C.2 reports these results. The probability that a production or morbidity shock was reported does not increase with parental education in this sample. Reporting of large production shocks actually decreases with parental education by 8 percent for mothers and 6 percent for fathers. Some asset variables are correlated with production shocks and male morbidity. However, all but one of the four significant results is positive. Within this sample, there is not a strong argument for the endogenity of these reported shocks based on observable household characteristics.

Controlling for random effects, the effects of shocks are statistically significant for agricultural shocks and health shocks to women making participation decisions across schooling and work activities. Table C.3 presents the results of the probit model with random effects and shocks. Large and small crop shocks induce higher participation by children in farm work. Both types of crop shocks decrease the probability of working in the family business, with large crop losses having much larger magnitudes than small crop losses. Large crop losses also significantly decrease children's participation in school, providing childcare to other children, and the joint production of market and schooling activities and of home production and schooling activities. Small crop losses increase children's childcare to other children in the household, but the effect is opposite for large crop losses. This may confirm the hypothesis that adults when fully occupied responding to smaller crop losses, leave children to increasingly care for themselves in these minor crises. However, as the magnitude of the shock increases, the household may be forced to mobilize all available labor to either salvage a harvest quickly or replant before the rainy season passes completely.

Health shocks to women have large substitution effects on the participation of children across school and work. A sick adult women in the household increases the probability that a child will be withdrawn from school by .73. Female illness also increases the probability that a child will work in the family business, which women mostly supervise, and that a child will provide more childcare. These results suggest that children are substitutes for women when female labor supply is reduced in the household.

Shock-Asset Interactions with Random Effects

Tables A3.4 and A3.5 present the results that investigate the role of assets in mitigating shocks, controlling for random effects. The value of asset stocks have significant effects when interacted with crop shocks. Agricultural capital interacted with the large crop loss shock lowers the selection of children into childcare or into the joint production of market and home production with schooling. Livestock values interacted with small crop losses increase child participation in joint market production and

schooling. This household response may be motivated by coping strategies that rely on increasing market production to compensate for income shortfalls from small production shocks.

Assets are also fundamental to the household's ex-post response to health shocks. Durables stocks decrease the probability that a child works on the farm in response to the sickness of an adult male in the household. Durables also decrease selection into childcare and the joint activities of market and home production. When adult men fall ill, livestock values interacted with the shocks increase child participation in farming, childcare, and joint market and home production. When adult females fall ill, livestock values interacted with the shock increase participation in joint home production and schooling. This suggests that child labor and some asset types may be complementary, in contrast to the literature on consumption smoothing, which suggests assets help insure households against falling into poverty. While this may be true in the short term, if shocks induce households to withdraw children from school and assets provide no insurance against this response to shocks, lower human capital of children may lead to increased levels of future poverty. When adults fall ill, assets, specifically durables, are the only types of assets that insure children against higher participation in market and home production activities.

Verifying the Assumptions of the Random Effects Estimator

The assumptions of strict exogeneity, independence of dependent variables conditioned on the unobservable effect and independent variables, and independence of the independent variables and the unobservable effect are strong. But these assumptions are necessary given the extensive literature that suggests that household effects such as parental education and assets influence child labor and schooling participation. While likelihood ratio tests that the unobserved effect is absent were rejected in all equations at the 5 percent significance level, this only confirms the presence of an unobservable, not the conditions under which it can consistently estimate the parameters.

Using a small subset of child panel data with observations from 1997 and 2006, estimates of Equation 23 are reported in Table C.6. While sickness data for all household members from 1997 is not available, crop loss shock data is available. If strict exogeneity is violated, coefficients from crop loss shocks in 1997 should have significant effects. However, this is not the case in the data. Asset-shock interactions for 1997 are also not significant in regression results. While this evidence supports the strict exogeneity hypothesis, the absence of significant effects may be due to the relatively small sample size rather than the actual absence of a lagged effect.

To provide additional evidence for the strict exogeneity hypothesis, the sample was disaggregated according to younger (ages 10-13) and older (ages 14-17) cohorts using the full cross-section. If strict exogeneity is violated, there should be distinct differences in parameter estimates for asset stocks and household composition variables if changes in these variables in subsequent periods have persistent effects on current child time allocation. Presumably, the older cohort would have been exposed to more of these lagged changes, which would result in systematic differences between the two cohorts. However, this pattern does not appear in the sample[23]. Parameter estimates, especially for assets, have small differences in magnitude and do not differ in significance across cohorts.

Pooling Child Labor and Schooling Equations by Gender

Given the importance of gender in our initial estimates of child labor and schooling, the sample was disaggregated to evaluate differences in parameter estimates by gender and the pooling of girls and boys. These results are presented in Table C.7. Differences between boys and girls are most pronounced in the schooling participation equation. Girls that are biological children of the head of household are 50 percent more likely to attend school than girls who are not biological children. Asset values measured either by livestock value or durable goods increase boys' school participation by 5-6 percent per increase of 100 000 FCFA, while assets have no effect on girls' schooling. Parental education also has differential

[23] These regression results are available on request, but are suppressed for brevity.

impacts on girls and boys. Any mother's education increases by 69 percent the selection probability on boys' schooling than for girls' schooling. Any father's education has a 53 percent greater impact on girls. Despite these differences in magnitude, having either an educated mother or father greatly increases the child's probability of attending school.

Robustness Check: Family Composition

Because of additions of new family members either through fostering or new child births, family composition variables should be considered endogenous in a structural model of household decisionmaking. These data do not contain plausible instruments to correct for the possible correlation between family composition variables and unobservables. To test whether this potential endogeneity affects parameter estimates, the previous probit model with household level random effects is re-estimated by omitting various combinations of the family composition variables to test the stability of the parameters[24]. The parameters of assets, parental education, gender, age effects, and community characteristics are stable across various combinations of assumptions about the family composition variables. All variables that had previously been significant remained significant with parameter estimates that were within reasonable levels of variation.

Controlling for Village-Level Fixed and Random Effects

An alternative to the household level random effects model previously estimated is to assume that there are no household-level effects, but only village-level effects that influence child time allocation. These village effects could be social norms or political influence. Social norms may affect whether children are encouraged to go to school as a result of the village overriding parental preferences that may differ with the norm. Political influence may determine whether the village is able to attract public investment such as schools, roads, or market location, which affects children's opportunity costs of attending school and working.

Table C.8 presents the results under the assumption of no village effects, village fixed effects, and village random effects. There are differences in both parameter estimates and the significance of parameters under these three assumptions. This suggests that appropriately specifying the equation of interest is quite important to the empirical results. Regardless of specification, gender is a significant determinant of participation with similar signs across the specifications, but different parameter estimates. The number of adult men is significant under the random effects specification for schooling, while under the fixed effects specification the number of adult men is significant in the farm equation. Village random effects also suggest significance at the 1 percent level for mother's and father's education, whereas fixed effects only capture a significant effect for father's education. The parameter estimates in the fixed effects specification are also quite similar to the no effects specification. The village random effects specification yields parameter estimates that are approximately three times as large as the fixed effects estimates for parental education.

The Multivariate Probit Model

The final econometric specification to be estimated controls for cross-equation correlations using a multivariate probit model (Table C.9). Parameter estimates are generally smaller than in the household-level random effects specification, but patterns of significance among the covariates are similar. One notable exception is mother's education, which is significant in the household level random effects specification, but insignificant under the multivariate probit. Migrant remittances have negative effects on the probability that a child participates in farm work, which is not captured in the random effects specification.

[24] These regression results are available on request, but omitted for brevity.

The results of the shock estimates (Table C.3) under the multivariate probit model are quite similar to the estimates from the household random effects model. The parameter estimates are lower, but the patterns of significance remain constant. Of particular interest is the change in the child's participation in the family business in response to large crop loss shocks. The parameter estimate is almost four times less under the multivariate probit specification. Tables A3.10 and A3.11 present the results for the asset-shock interactions. These results differ significantly from the household-level random effects specification. For the crop loss shocks, durables have a duplicitous role depending on the magnitude of the shock. Interactions with large crop loss shocks have significant and negative impacts on the child's selection into the family business. Durable-small crop loss shock interactions raise the probability that a child will work in the family business. Livestock values interacted with large crop shocks lower the probability a child is withdrawn from school, suggesting that assets that are more liquid may serve as an alternative to changes in children's time allocation in response to crop shocks. In response to adult sicknesses, durables lower the probability that children are withdrawn from school when men are sick and the probability children work in the family business when women are sick. Livestock values have opposite effects on the probability a child is withdrawn from school when adults are sick. When men are sick, increased livestock value increases the probability a child is withdrawn from school, reflecting the increased labor demand to care for animals. When women are sick, increased livestock value lowers the probability a child is withdrawn from school.

7. CONCLUSION

Understanding the mechanisms by which children's time is allocated to school, home production, and market production is fundamental to the development of a broader economics of children and the competing opportunity costs of their time. Children conduct multiple domestic and market-oriented production activities for their households. These activities directly contribute to income generation or free other household members to conduct renumerative activities. Most children in the world who work contribute to household income or to meeting subsistence needs without being employed in the worst forms of child labor. However, participation in work outside of the worst forms can have differential effects; etiher increasing children's human capital from increased work experience or limiting their total time in school or the quality of schooling due to work requirements. Our understanding of child participation in market and domestic activities and these welfare effects are relatively underdeveloped compared to adult labor supply.

The model of children's work and schooling that is developed in Section 2 of this paper explains selection into different activities based on the shadow value of a child's time. In the econometric specifications, proxies for the myriad of factors that may alter the value of the child's shadow wage include household composition, labor market opportunities represented by demographic variables, and school quality characteristics. Household composition and asset values, specifically livestock values, influence selection into work and schooling. Despite low incidences of formal education in northern Mali, father's and mother's education have large, significant point estimates. Proximity to school influences selection into school under all of our econometric specifications.

The importance of shocks on child welfare cannot be underestimated. While substitution into and out of market and domestic work is relatively innocuous, save the impact of the additional hours, substitution out of schooling has relatively long-term welfare consequences for the production of human capital. Children, once withdrawn from school, may have difficulty returning even after a few months of absence. To recuperate the loss of schooling time, children may have to completely repeat grade levels. This "ratchet" effect, that is, the shock's role of completely halting the process of human capital accumulation, holds more serious welfare implications than moving into or out of work activities. From a policy perspective, constructing insurance schemes to protect households against shocks have implications not only for household consumption, but also for children's work and schooling. In addition, these results illustrate that when women fall ill, children are substitutes for their home and market production. Investing in women's health care may have the secondary benefits of lifting households out of long-term poverty because children's schooling would not be reduced as often by immediate household labor demands.

As documented in the literature by such papers as Beegle et al. (2006), assets play a substantial role in protecting children from the negative effects of shocks. This paper provides additional support for this empirical finding with one important caveat: types of assets may differ in providing insurance against shocks. Not only does the type of shock matter (income or labor productivity shock), but so does the question of whether the asset in question is complementary to child labor or a substitute for it. These results show that increasing assets such as livestock may have differential effects on child labor and schooling, depending on type of shock and who it affects within the household. However, household durables do insure children against adult illness and to a lesser extent, production shocks. More research to understand the interactions between asset types and the impact of shocks on child labor and schooling can improve interventions targeted at households that live in risky environments in order to reduce poverty in the long term by keeping children in school.

APPENDIX A: MODEL

To summarize the household's problem, the parents must choose the following variables for the respective period:

Period 1: n

Period 2: $c_2,\ T_A^F, T_A^H, T_C^F, T_C^H, T_C^S, s,\ k$

The household's problem can be reduced in complexity by substitution of the home and market production equations (4 and 5) into the second period budget constraint. Equations 2 and 3 can be substituted into the monotonically increasing utility function as it will bind at the optimum. The cognitive skills production function (Equation 7) can be substituted in Equation 6, the period 3 income of the child, which can directly replace its argument in the utility function. After these substitutions, the household's problem reduces to a three equation system with a utility function and two time constraints (adult and child):

$$\text{MAX} \quad u[p\delta q(T_A^F, T_C^F \mid K, L) - w_A^F T_A^F - w_C^F T_C^F + h(T_A^H, T_C^H) - w_A^H T_A^H - w_C^H T_C^H + w_A^W T_A^W - (b + c_1 + s)n - k, rk] + \beta n U^*(c_2, y_3(c_2, E))]$$

$$\left\{ c_2, T_A^F, T_A^H, T_A^W, T_C^F, T_C^H, T_C^S, k \right\}$$

s.t.

(A.1)

$$T_C \equiv T_C^F + T_C^H + T_C^S + T_C^L$$

(A.2)

$$T_A \equiv T_A^F + T_A^H + T_A^W + T_A^L$$

(A.3)

The Lagrangian function can be written as follows after which the first order conditions are as follows:

$$£ = \text{U} + \lambda_1 (T_C - T_C^F - T_C^H - T_C^S - T_C^L) + \lambda_2 (T_A - T_A^F - T_A^H - T_A^L)$$

(A.4)

FOC (if $\lambda_1, \lambda_2 > 0$)

n: $$\beta U^*(c_2, y_3) = \frac{\partial u}{\partial a_2} (b + c_1 + s)$$

(A.5)

s: $$\beta \frac{\partial U^*}{\partial y_3} \frac{\partial y_3}{\partial E} \theta f'(Q, s) g(T_C^S) = \frac{\partial u}{\partial a_2}$$

(A.6)

T_C^S: $$\beta n \frac{\partial U^*}{\partial y_3} \frac{\partial y_3}{\partial E} \theta f(Q, s) g'(T_C^S) = \lambda_1$$

(A.7)

$$T_C^{\,H}: \quad \frac{\partial u}{\partial a_2}[\ h'(T_A^{\,H}, T_C^{\,H}) - w_C^{\,H}\ ] = \lambda_1$$

(A.8)

$$T_C^{\,F}: \quad \frac{\partial u}{\partial a_2}[\ p\delta q'(T_A^{\,F}, T_C^{\,F}) - w_C^{\,F}\ ] = \lambda_1$$

(A.9)

k: $$\frac{\partial u}{\partial a_2} = \frac{\partial u}{\partial a_3} r$$

(A.10)

Equations A.5-A.11 characterize the allocation of the household's optimal number of children, the distribution of adult and child time across activities, the child's period 2 consumption and the allocation of assets for period 3 adult consumption. The household's decisions are examined given these first order conditions, including the optimal number of children and child participation in schooling, domestic production, and market production.

Fertility Conditions

Rearranging Equation A.5 yields the condition by which the household chooses its optimal number of children, n*. For each additional child, the income equivalent of an additional child is equated to the marginal cost of the child. The cost of each additional child includes period 1 costs, *b*, of the child's birth and early child care costs including medical care, clothes, period 1 consumption, period 2 consumption, and the cost of school if the household elects to send the child.

$$\frac{\beta U^*(c_2, y_3)}{\partial u \big/ \partial a_2} = b + c_1 + s$$

(A.11)

APPENDIX B: DESCRIPTIVE STATISTICS

Table B.1. Participation by activity, children 10-17 years

	Mean	Std. Err.
Participation by Activity		
Child Care	0.449	0.016
Domestic Chores	0.870	0.010
Work in the Family Business	0.677	0.015
Farm Work	0.542	0.015
School	0.334	0.015
Child Care + Domestic Chores	0.880	0.010
Family Business + Farm Work	0.845	0.011
Joint Production		
Market Work + School	0.247	0.014
Domestic Work + School	0.278	0.014
Market Work + Homework	0.204	0.013
Changes in Child's School Enrollment		
Withdrawn from School in the Last Year (N=786)	0.179	0.019

Notes: For all variables, N=1920, except Withdrawn from School (N=786).
Withdrawn from school last year is conditional on the child having been enrolled in the previous school year.
Discrete variables, domestic work and market work, are aggregated from children's activities: Market Work = Family Business + Farm Work and Domestic Work= Child Care + Domestic Chores.
All variables are population weighted means and the standard errors are corrected for clustering.

Table B.2. Participation rates of boys and girls (10-17 years) in rural and urban areas

Activity		Rural	Urban	Girls	Boys	Rural Girl	Urban Girl	Rural Boy	Urban Boy
Child Care									
	Mean	0.4164	0.6698	0.5219	0.3871	0.4893	0.7398	0.3559	0.6082
	Std. Error	0.0483	0.0715	0.0526	0.0466	0.0560	0.0603	0.0477	0.0845
Domestic Work									
	Mean	0.8600	0.9352	0.9531	0.7997	0.9501	0.9730	0.7853	0.9019
	Std. Error	0.0242	0.0342	0.0122	0.0330	0.0136	0.0130	0.0357	0.0568
Work in the Family Business									
	Mean	0.6747	0.6813	0.7325	0.6278	0.7366	0.7051	0.6232	0.6603
	Std. Error	0.0440	0.0722	0.0367	0.0450	0.0413	0.0576	0.0498	0.0855
Farm Work									
	Mean	0.5687	0.3706	0.3565	0.7001	0.3762	0.2254	0.7285	0.4984
	Std. Error	0.0285	0.0827	0.0418	0.0316	0.0434	0.0927	0.0311	0.0778
School									
	Mean	0.3177	0.4619	0.3233	0.3465	0.3117	0.4009	0.3227	0.5157
	Std. Error	0.0405	0.0530	0.0410	0.0395	0.0464	0.0700	0.0445	0.0446
Joint Production									
Market Activities and School									
	Mean	0.2390	0.3029	0.2162	0.2729	0.2135	0.2345	0.2602	0.3631
	Std. Error	0.0343	0.0365	0.0381	0.0336	0.0435	0.0412	0.0380	0.0386
Domestic Activities and School									
	Mean	0.2564	0.4354	0.2936	0.2670	0.2802	0.3829	0.2367	0.4815
	Std. Error	0.0328	0.0519	0.0406	0.0301	0.0458	0.0659	0.0313	0.0493
Market and Domestic Activities									
	Mean	0.2009	0.2281	0.2216	0.1899	0.2250	0.1982	0.1808	0.2544
	Std. Error	0.0358	0.0723	0.0401	0.0315	0.0438	0.0915	0.0344	0.0678

Notes: All variables are population weighted means and the standard errors are corrected for clustering.
For all variables, N=1920.

Table B.3. Descriptive statistics: Household and child characteristics

	Mean	Std. Dev.		Mean	Std. Dev.
Child Characteristics			***Household Composition***		
Sex (Boy=1)	0.545	0.498	Own Child	0.803	0.398
Ethnicity			Number of Girls in HH	1.407	1.215
Sonrai	0.665	0.472	Number of Boys in HH	1.722	1.361
Tamasheq	0.134	0.341	Number of Adult Women in HH	1.697	1.277
Peuhl	0.111	0.313	Number of Adult Men in HH	1.638	1.148
Bambara	0.040	0.196	***Household Assets and Unearned Income***		
Other Ethnicity	0.050	0.217	Herd Size	19.18	19.54
Age Dummies			Herd Value (FCFA)	531946	57044
Age 10	0.201	0.401	Agricultural Capital (FCFA)	47051	12744
Age 11	0.075	0.264	Durables (FCFA)	302671	69356
Age 12	0.138	0.345	Migrant Remittances (FCFA)	40508	114356
Age 13	0.085	0.279	***Shocks***		
Age 14	0.135	0.342	*Production Shock*		
Age 15	0.129	0.335	No Crop Loss	0.533	0.042
Age 16	0.145	0.353	Small Crop Loss	0.217	0.034
Age 17	0.091	0.287	Large Crop Loss	0.250	0.036
Adult Characteristics			*Labor Availability Shock*		
Mother's Education (1 if any education)	0.055	0.227	Adult Male Sick	0.131	0.019
Father's Education (1 if any education)	0.106	0.308	Adult Female Sick	0.212	0.045
Age of Household Head	41.2	21.6	Child Sick	0.144	0.037
Age of Household Head's spouse	33.7	14.7			

Notes: All variables are population weighted means and the standard errors are corrected for clustering.
For all variables, N=1920.

Table B.4. Descriptive statistics: Community characteristics

Variable	Obs.	Mean	Std. Dev.
Regional Characteristics and Distribution			
Urban	151	0.086	0.281
River Access	151	0.331	0.472
Regional Indicators			
Niafunke	151	0.377	0.486
Goundam	151	0.166	0.373
Dire	151	0.159	0.367
Tombouctou	151	0.099	0.300
Rharous	151	0.073	0.261
Bourem	151	0.119	0.325
Kidal	151	0.007	0.081
Access to Roads			
Road Connects with Village	151	0.139	0.347
within 1-10km	151	0.417	0.495
within 11-20km	151	0.232	0.423
more than 20km	151	0.212	0.410
Commune Population			
less than 5000	151	0.093	0.291
5001-10000	151	0.225	0.419
10001-20000	151	0.391	0.490
20001-30000	151	0.146	0.354
more than 30000	151	0.146	0.354
Villages per Commune			
Less than 10	151	0.152	0.361
11-20	151	0.205	0.405
21-30	151	0.285	0.453
more than 30	151	0.358	0.481

Table B.5. School characteristics

Primary School Characteristics			
Variable	Obs.	Mean	Std. Dev.
No Primary School Access	151	0.258	0.439
Primary School in Village	151	0.563	0.498
less than 5 km	151	0.099	0.300
greater than 5 km	151	0.079	0.271
Multiple Primary Schools in Village	151	0.132	0.395
Student-Teacher Ratio--Primary	107	45.496	20.418
Repetition Rate—Primary	98	0.305	0.148
Boys Exam Pass Rate--Primary	71	0.651	0.266
Girls Exam Pass Rate--Primary	67	0.590	0.325
Secondary School Characteristics			
Secondary School in Village	151	0.159	0.367
High School Characteristics			
High School in Village	151	0.026	0.161

Table B.6. Distribution of shocks by region

Region	Male Illness	Female Illness	Child Illness	Small Crop Shocks	Large Crop Shocks
Niafunke	0.107	0.082	0.082	0.138	0.198
Goundam	0.079	0.041	0.011	0.185	0.166
Dire	0.183	0.165	0.018	0.064	0.009
Tombouctou	0.270	0.255	0.102	0.153	0.163
Rharous	0.329	0.146	0.195	0.000	0.890
Bourem	0.071	0.503	0.420	0.330	0.260

APPENDIX C: REGRESSION RESULTS

Table C.1. Probit—Random effects

	School	Farm	Family Business	Childcare	Market Production and School	Home Production and School	Market and Home Production
Boy Indicator	0.073	1.812	-0.315	-0.653	0.281	-0.044	0.233
	(0.125)	(0.139)***	(0.159)**	(0.145)***	(0.133)**	(0.126)	(0.158)
Ages							
age11	0.369	0.326	0.004	0.262	-0.065	0.405	0.102
	(0.225)	(0.238)	(0.291)	(0.262)	(0.246)	(0.227)*	(0.282)
age12	0.022	0.532	0.293	0.287	-0.105	0.212	0.303
	(0.183)	(0.193)***	(0.236)	(0.227)	(0.198)	(0.188)	(0.245)
age13	0.277	0.066	0.071	0.189	0.041	0.418	-0.017
	(0.213)	(0.219)	(0.277)	(0.244)	(0.226)	(0.215)*	(0.257)
age14	-0.082	0.182	0.005	-0.072	-0.238	0.057	-0.181
	(0.194)	(0.198)	(0.241)	(0.229)	(0.205)	(0.197)	(0.268)
age15	-0.472	0.751	0.509	0.003	-0.419	-0.342	0.198
	(0.216)**	(0.215)***	(0.268)*	(0.234)	(0.230)*	(0.219)	(0.250)
age16	-0.639	0.22	0.389	-0.17	-0.617	-0.4	-0.167
	(0.200)***	(0.197)	(0.249)	(0.228)	(0.212)***	(0.202)**	(0.250)
age17	-1.01	0.41	0.32	0.178	-1.155	-0.942	0.013
	(0.244)***	(0.241)*	(0.287)	(0.266)	(0.269)***	(0.255)***	(0.289)
Household Composition							
Biological child indicator	0.282	0.008	-0.124	-0.393	0.171	0.084	-0.116
	(0.168)*	(0.170)	(0.209)	(0.188)**	(0.182)	(0.170)	(0.204)
Number of girls	0.061	-0.183	-0.037	0.417	0.006	0.106	-0.01
	(0.062)	(0.067)***	(0.087)	(0.079)***	(0.070)	(0.063)*	(0.077)
Number of boys	0.025	-0.092	-0.02	0.15	0.028	0.044	-0.104
	(0.056)	(0.056)	(0.075)	(0.063)**	(0.063)	(0.057)	(0.072)
Number of adult men	-0.092	0.057	-0.146	-0.343	-0.14	-0.147	-0.102
	(0.073)	(0.072)	(0.091)	(0.082)***	(0.082)*	(0.077)*	(0.094)
Number of adult women	0.059	0.12	0.005	-0.141	0.111	0.007	0.003
	(0.077)	(0.079)	(0.105)	(0.090)	(0.085)	(0.080)	(0.100)
Household Assets and Unearned Income							
Livestock Value (FCFA)	0.033	-0.011	-0.013	-0.025	0.008	0.021	-0.02
	(0.013)**	(0.014)	(0.016)	(0.019)	(0.015)	(0.013)	(0.022)
Herd Size (Number of Animals)	-0.012	0.007	-0.004	0.003	-0.001	-0.011	0.008
	(0.006)**	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)*	(0.007)
Agricultural Capital (FCFA)	0.006	0.011	0	0.012	0.01	0.006	0.011
	(0.010)	(0.010)	(0.015)	(0.016)	(0.011)	(0.010)	(0.011)
Household Durables (FCFA)	0.005	-0.02	0.004	0.009	0.006	0.018	-0.019
	(0.008)	(0.017)	(0.005)	(0.013)	(0.007)	(0.011)	(0.023)
Migrant Remittances (FCFA)	-0.051	-0.054	-0.009	-0.023	-0.059	-0.106	-0.083
	(0.030)*	(0.041)	(0.040)	(0.051)	(0.035)*	(0.038)***	(0.095)

Table C.1. Continued

	School	Farm	Family Business	Childcare	Market Production and School	Home Production and School	Market and Home Production
Any Mother's Education	1.041	0.279	1.005	1.265	0.674	1.095	1.5
(1=Yes)	(0.291)***	(0.320)	(0.419)**	(0.382)***	(0.307)**	(0.285)***	(0.374)***
Any Father's Education	0.918	-0.218	-0.936	-0.095	0.695	0.617	-0.731
(1=Yes)	(0.221)***	(0.241)	(0.311)***	(0.270)	(0.242)***	(0.220)***	(0.326)**
Age of HH Head	-0.004	0.004	-0.007	0.013	-0.004	-0.004	0.001
	(0.004)	(0.004)	(0.005)	(0.004)***	(0.004)	(0.004)	(0.005)
Age of HH Head's spouse	0.004	-0.012	0.015	0.001	0.002	0.008	0.011
	(0.005)	(0.006)**	(0.007)**	(0.006)	(0.006)	(0.006)	(0.007)
Community Characteristics							
Access to River	-0.149	-0.781	0.438	-0.022	-0.04	0.078	-0.651
(1=Yes)	(0.241)	(0.239)***	(0.309)	(0.266)	(0.273)	(0.242)	(0.328)**
Roads							
within 1-10km	0.123	0.669	0.3	1.165	0.232	-0.114	1.354
	(0.271)	(0.256)***	(0.326)	(0.312)***	(0.309)	(0.272)	(0.361)***
within 11-20km	0.583	0.552	-0.014	0.676	0.553	0.141	0.948
	(0.341)*	(0.315)*	(0.414)	(0.362)*	(0.390)	(0.349)	(0.413)**
greater than 20km	0.483	1.162	1.332	1.356	0.472	0.416	1.481
	(0.376)	(0.373)***	(0.536)**	(0.402)***	(0.422)	(0.375)	(0.451)***
School Characteristics							
Primary School in Village	1.818	-0.07	1.404	-0.052	2.211	2.408	0.902
	(0.489)***	(0.433)	(0.601)**	(0.484)	(0.552)***	(0.502)***	(0.532)*
Primary School within 1-5km	0.198	-0.128	1.593	-0.719	0.002	0.689	0.387
	(0.639)	(0.502)	(0.702)**	(0.546)	(0.770)	(0.652)	(0.604)
Primary School farther than 5km	-0.322	-0.093	1.356	-0.192	0.847	0.368	0.854
	(0.725)	(0.610)	(0.785)*	(0.664)	(0.818)	(0.743)	(0.807)
Multiple Primary Schools	0.34	0.284	-0.308	0.291	0.013	0.145	0.201
(1=Yes)	(0.266)	(0.242)	(0.312)	(0.269)	(0.306)	(0.267)	(0.327)
Student-Teacher Ratio	-0.014	-0.003	-0.011	-0.008	-0.021	-0.017	-0.021
	(0.006)**	(0.006)	(0.008)	(0.006)	(0.006)***	(0.006)***	(0.007)***
Repetition Rate	-0.117	0.907	0.554	1.297	0.398	-0.618	1.678
	(0.619)	(0.638)	(0.866)	(0.699)*	(0.694)	(0.626)	(0.815)**
Exam Pass Rate-Boys	0.131	-0.558	-0.109	-0.647	-0.443	0.203	0.197
	(0.523)	(0.517)	(0.705)	(0.607)	(0.606)	(0.548)	(0.693)
Exam Pass Rate-Girls	0.144	-0.184	-0.123	-0.62	0.361	-0.283	-1.354
	(0.496)	(0.500)	(0.669)	(0.592)	(0.576)	(0.520)	(0.715)*
Secondary School in Village	0.676	-0.784	-0.305	-0.062	0.615	0.159	-1.145
	(0.213)***	(0.225)***	(0.299)	(0.257)	(0.239)**	(0.218)	(0.331)***
High School in Village	0.618	0.062	-0.729	2.033	0.998	0.955	1.596
	(0.416)	(0.427)	(0.602)	(0.482)***	(0.470)**	(0.419)**	(0.575)***
Constant	-1.358	-1.691	1.819	-1.987	-2.254	-1.657	-4.274
	(0.652)**	(0.630)***	(0.879)**	(0.725)***	(0.727)***	(0.657)**	(0.828)***
Observations	1920	1920	1920	1920	1920	1920	1920
Number of hid	1045	1045	1045	1045	1045	1045	1045

Notes: Standard errors are in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
All coefficients are marginal effects. All coefficients of variables valued in FCFA are multiplied by 100000 FCFA, roughly 200 US$
District population, number of villages per commune, and ethnicity indicators are included in the regression, but results are not displayed.

Table C.2. Determinants of the incidence of shocks

	Large Production Shocks	Small Production Shocks	Adult Male Sick	Adult Female Sick	Child Sick
Household Composition					
Number of girls	0.005	-0.004	0.003	0.034	0.024
	(0.012)	(0.014)	(0.010)	(0.011)***	(0.009)***
Number of boys	0.024	-0.002	0.008	0.008	0.018
	(0.012)**	(0.011)	(0.007)	(0.009)	(0.007)**
Number of adult men	0.015	0.004	0.001	0.02	0.014
	(0.012)	(0.012)	(0.010)	(0.011)*	(0.008)*
Number of adult women	0.053	-0.008	-0.001	0.005	-0.029
	(0.016)***	(0.013)	(0.011)	(0.012)	(0.010)***
Household Assets					
Livestock Value (FCFA)	-0.011	0.009	0.001	0.006	0
	(0.004)**	(0.003)***	(0.002)	(0.004)	(0.001)
Herd Size (Number of Animals)	0.001	-0.001	-0.002	-0.001	0
	(0.001)	(0.001)	(0.001)***	(0.001)	0
Agricultural Capital (FCFA)	-0.001	-0.001	0.001	0	-0.001
	(0.017)	(0.001)	(0.001)	(0.001)	(0.002)
Household Durables (FCFA)	-0.004	0.001	-0.003	-0.005	-0.001
	(0.004)	0	(0.003)	(0.003)*	(0.001)
Migrant Remittances (FCFA)	-0.004	0.002	-0.025	0.017	0.007
	(0.008)	(0.003)	(0.013)*	(0.008)**	(0.003)**
Parental Education					
Any Mother's Education	-0.08	0.017	-0.014	0.035	0.013
(1=Yes)	(0.045)*	(0.057)	(0.036)	(0.067)	(0.034)
Any Father's Education	-0.059	0.07	0.006	0.005	-0.036
(1=Yes)	(0.034)*	(0.046)	(0.038)	(0.038)	(0.019)*
Age of HH Head	-0.001	-0.003	0	0.004	0.001
	(0.001)	(0.001)***	(0.001)	(0.001)***	(0.001)*
Age of HH Head's spouse	0.002	0.003	0.002	-0.002	-0.001
	(0.001)**	(0.001)***	(0.001)***	(0.001)***	-0.001
Community Characteristics					
Access to River	-0.24	-0.01	-0.017	-0.027	0.034
(1=Yes)	(0.062)***	(0.062)	(0.042)	(0.053)	(0.038)
Observations	1920	1920	1920	1920	1920
Pseudo-R^2					

Notes: Robust standard errors are in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table C.3. Marginal effects of shocks on children's participation in work and school

Probit— Shocks with Random Effects

	Withdrawn from School	Farm Work	Family Business	Child Care	Market-School	Home-School	Market-Home
Large Crop Loss	1.084	0.845	-1.673	-0.433	-0.68	-0.371	-0.327
	(0.476)**	(0.246)***	(0.296)***	(0.264)	(0.284)**	(0.255)	(0.307)
Small Crop Loss	0.111	0.71	-0.791	0.335	0.449	0.313	-0.128
	(0.450)	(0.235)***	(0.280)***	(0.257)	(0.256)*	(0.234)	(0.296)
Adult Male Sick	0.584	0.232	-0.17	0.005	0.019	0.272	-0.166
(1=Yes)	(0.456)	(0.241)	(0.314)	(0.248)	(0.259)	(0.233)	(0.299)
Adult Female Sick	0.734	0.241	0.983	0.596	0.204	0.343	1.32
(1=Yes)	(0.425)*	(0.258)	(0.346)***	(0.298)**	(0.273)	(0.245)	(0.367)***
Child Sick	-0.253	-0.182	-0.53	-0.007	-0.12	-0.145	0.118
(1=Yes)	(0.512)	(0.284)	(0.349)	(0.316)	(0.308)	(0.277)	(0.397)
Observations	786	1920	1920	1920	1920	1920	1920
Number of hid	483	1045	1045	1045	1045	1045	1045

Notes: Absolute value of z statistics are in parentheses.
* significant at 10% ** significant at 5%; *** significant at 1%
All coefficients are marginal effects.
All coefficients of variables valued in FCFA are multiplied by 100000 FCFA, roughly 200 US$.
All covariates are estimated in the regression, but only the shock results are displayed.

Multivariate Probit Estimates

	Withdrawl	Farm Work	Family Business	Child Care
Large Crop Loss	0.824	0.974	-1.025	-0.872
	(0.289)***	(0.293)***	(0.299)***	(0.509)*
Small Crop Loss	0.232	0.673	0.102	-0.345
	(0.257)	(0.301)**	(0.229)	(0.322)
Adult Male Sick	0.463	0.185	0.305	0.275
(1=Yes)	(0.350)	(0.239)	(0.360)	(0.216)
Adult Female Sick	0.512	0.111	0.702	0.548
(1=Yes)	(0.246)**	(0.221)	(0.238)***	(0.252)**
Child Sick	-0.054	0.17	-0.19	0.051
(1=Yes)	(0.257)	(0.269)	(0.265)	(0.332)
Observations		786		

Notes: Robust standard errors are in parentheses. All coefficients are marginal effects.
* significant at 10%; ** significant at 5%; *** significant at 1%
All coefficients of variables valued in FCFA are multiplied by 100000 FCFA, roughly 200 US$.
All covariates are estimated in the regression, but only the shock results are displayed.

Table C.4. Probit—Crop shocks with asset interactions and random effects

	Withdrawn from School	Farm Work	Child Care	Market-School	Home-School	Market-Home
Durables x	-0.32	-0.099	0.062	0.091	0.053	-0.018
Large Crop Loss	(0.207)	(0.066)	(0.076)	(0.079)	(0.090)	(0.094)
Durables x	-0.024	-0.068	-0.033	0.034	0.023	-0.21
Small Crop Loss	(0.133)	(0.054)	(0.023)	(0.040)	(0.039)	(0.127)*
Agricultural	1.6	-0.168	-1.855	-1.134	-1.888	-0.948
Capital x	(1.124)	(0.505)	(0.664)***	(0.636)*	(0.779)**	(0.737)
Large Crop Loss						
Agricultural	0.609	-0.255	0.765	0.135	-0.293	-0.208
Capital x	(1.063)	(0.417)	(0.629)	(0.393)	(0.419)	(0.502)
Small Crop Loss						
Livestock Value x	-0.18	0	0.019	0.057	0.064	0.051
Large Crop Loss	(0.137)	(0.047)	(0.052)	(0.054)	(0.054)	(0.061)
Livestock Value x	-0.055	-0.048	-0.022	0.048	0.006	0.012
Small Crop Loss	(0.067)	(0.025)*	(0.032)	(0.024)**	(0.022)	(0.036)
Observations	786	1920	1920	1920	1920	1920
Number of hid	483	1045	1045	1045	1045	1045

Notes: Absolute value of z statistics are in parenthesis All coefficients are marginal effects.
* significant at 10%; ** significant at 5%; *** significant at 1%
All coefficients of variables valued in FCFA are multiplied by 100000 FCFA, roughly 200 US$.
All covariates estimated in the regression, but only asset interactions are displayed.

Table C.5. Probit—Health shocks with asset interactions and random effects

	Withdrawn from School	Farm Work	Child Care	Market-School	Home-School	Market-Home
Durables x	-0.253	-0.194	-0.132	-0.075	0.042	-0.187
Sick Male	(0.193)	(0.089)**	(0.079)*	(0.085)	(0.078)	(0.103)*
Durables x	0.198	0.048	-0.073	-0.087	-0.107	-0.121
Sick Female	(0.165)	(0.084)	(0.098)	(0.098)	(0.097)	(0.136)
Durables x	0.248	0.007	0.05	0.002	-0.025	-0.007
Sick Child	(0.206)	(0.049)	(0.102)	(0.033)	(0.043)	(0.135)
Agricultural	0.029	0.065	0.02	0.045	0.002	-0.012
Capital X	(0.549)	(0.051)	(0.069)	(0.070)	(0.053)	(0.111)
Sick Male						
Agricultural	0.542	0.024	0.997	0.83	0.332	0.786
Capital x	(0.871)	(0.514)	(0.571)*	(0.556)	(0.520)	(0.768)
Sick Female						
Agricultural	-0.193	-0.087	-1.352	-0.669	-0.282	-0.993
Capital x	(1.513)	(0.649)	(0.712)*	(0.678)	(0.646)	(0.860)
Sick Child						
Livestock Value	0.077	0.153	0.114	0.071	0.04	0.098
x Sick Male	(0.078)	(0.055)***	(0.047)**	(0.045)	(0.042)	(0.053)*
Livestock Value	-0.174	-0.076	-0.051	0.072	0.127	0.019
x Sick Female	(0.106)	(0.046)	(0.054)	(0.047)	(0.047)***	(0.072)
Livestock Value	-0.167	-0.038	0.054	-0.028	-0.125	0.009
X Sick Child	(0.180)	(0.060)	(0.066)	(0.048)	(0.049)**	(0.078)
Observations	786	1920	1920	1920	1920	1920
Number of hid	483	1045	1045	1045	1045	1045

Notes: Absolute value of z statistics are in parentheses.
* significant at 10% ** significant at 5%; *** significant at 1%
All coefficients are marginal effects.
All coefficients of variables valued in FCFA are multiplied by 100 000 FCFA, roughly 200 US$.
All covariates estimated in the regression, but only asset interaction results displayed

Table C.6. Panel estimates

	School	Farm	Family Business	Child Care
Large Crop Loss 2006	0.0003	-0.069	0.076	-0.366
	(.0004)**	(0.273)	(0.115)	(0.135)***
Large Crop Loss 1997	6.60E-07	0.043	-0.305	-0.053
	(0.000)	(0.076)	(0.227)	(0.206)
Asset-Shock Interaction 2006	-5.50E-06	0.099	0.043	-0.112
	(0.000)***	(0.019)***	(0.020)**	(0.042)***
Asset-Shock Interaction 1997	6.65E-08	-0.0613	0.115	-0.05
	(0.000)	(0.099)	(0.048)**	(-.085)
Observations	186	186	186	186

Notes: Regression controls for gender, ethnicity, and parent's education.
Robust standard errors in parentheses are clustered at the village level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table C.7. Participation equations controlling for household random effects, disaggregated by gender

	School			Farm			Family Business			Child Care		
Sample Restriction	Girls	Boys	Difference	Girls	Boys	Difference	Girls	Boys	Difference	Girls	Boys	Difference
Household Composition												
Biological child indicator	0.597	0.1	0.497	0.033	-0.172	0.205	-0.24	0.197	-0.437	-0.349	-0.499	0.15
	(0.237)**	(0.215)		(0.253)	(0.267)		(0.292)	(0.333)		(0.257)	(0.261)*	
Number of girls	-0.008	0.103	-0.111	-0.11	-0.165	0.055	-0.2	0.03	-0.23	0.371	0.416	-0.045
	(0.081)	(0.077)		(0.094)	(0.097)*		(0.122)	(0.125)		(0.108)***	(0.098)***	
Number of boys	-0.01	0.035	-0.045	0.049	-0.179	0.228	0.096	-0.019	0.115	0.17	0.071	0.099
	(0.074)	(0.067)		(0.077)	(0.081)**		(0.100)	(0.108)		(0.082)**	(0.080)	
Number of adult men	-0.027	-0.184	0.157	0.038	0.072	-0.034	-0.066	-0.27	0.204	-0.307	-0.366	0.059
	(0.095)	(0.084)**		(0.104)	(0.099)		(0.123)	(0.124)**		(0.112)***	(0.098)***	
Number of adult women	-0.003	0.085	-0.088	0.125	0.094	0.031	-0.101	0.252	-0.353	-0.251	-0.03	-0.221
	(0.094)	(0.095)		(0.103)	(0.117)		(0.139)	(0.156)		(0.122)**	(0.108)	
Household Assets and Unearned Income												
Livestock Value (FCFA)	0.02	0.063	-0.043	-0.018	-0.009	-0.009	-0.01	-0.031	0.021	-0.011	-0.044	0.033
	(0.016)	(0.023)***		(0.020)	(0.018)		(0.020)	(0.017)*		(0.023)	(0.028)	
Herd Size (Number of Animals)	-0.013	-0.013	0	0.012	0.008	0.004	-0.006	-0.002	-0.004	-0.007	0.015	-0.022
	(0.007)*	(0.008)*		(0.007)*	(0.008)		(0.009)	(0.009)		(0.008)	(0.009)	
Agricultural Capital (FCFA)	-0.009	0	-0.009	-0.031	0.037	-0.068	0.007	0	0.007	0.015	0.008	0.007
	(0.024)	(0.009)		(0.145)	(0.044)		(0.038)	(0.017)		(0.025)	(0.016)	
Household Durables (FCFA)	0.004	0.049	-0.045	-0.028	-0.004	-0.024	0.003	0.005	-0.002	0.015	0.013	0.002
	(0.006)	(0.027)*		(0.028)	(0.008)		(0.005)	(0.008)		(0.016)	(0.023)	
Migrant Remittances (FCFA)	-0.064	-0.024	-0.04	-0.016	-0.082	0.066	-0.044	0.048	-0.092	-0.049	-0.036	-0.013
	(0.035)*	(0.039)		(0.059)	(0.049)*		(0.050)	(0.048)		(0.058)	(0.077)	

Table C.7. Continued

	School			Farm			Family Business			Child Care		
Sample Restriction	Girls	Boys	Difference	Girls	Boys	Difference	Girls	Boys	Difference	Girls	Boys	Difference
Adult Characteristics												
Any Mother's Education	0.764	1.452	-0.688	0.749	-0.113	0.862	1.138	0.576	0.562	1.24	1.62	-0.38
(1=Yes)	(0.362)**	(0.369)***		(0.430)*	(0.423)		(0.531)**	(0.595)		(0.512)**	(0.478)***	
Any Father's Education	1.102	0.576	0.526	-0.31	-0.208	-0.102	-0.922	-0.698	-0.224	0.111	-0.445	0.556
(1=Yes)	(0.273)***	(0.263)**		(0.331)	(0.320)		(0.390)**	(0.457)		(0.344)	(0.346)	
Age of HH Head	-0.002	-0.008	0.006	0.002	0.007	-0.005	-0.008	-0.004	-0.004	0.01	0.015	-0.005
	(0.005)	(0.004)*		(0.005)	(0.005)		(0.007)	(0.007)		(0.006)*	(0.006)***	
Age of HH Head's spouse	0.007	0.005	0.002	-0.011	-0.014	0.003	0.02	0.012	0.008	-0.001	0.002	-0.003
	(0.007)	(0.007)		(0.008)	(0.008)*		(0.009)**	(0.010)		(0.008)	(0.008)	
School Characteristics												
Primary School in Village	1.438	1.865	-0.427	0.012	-1.052	1.064	1.963	1.151	0.812	-0.136	0.321	-0.457
	(0.625)**	(0.599)***		(0.633)	(0.666)		(0.882)**	(0.826)		(0.653)	(0.603)	
Secondary School in Village	0.094	0.909	-0.815	-0.855	-0.573	-0.282	0.007	-0.272	0.279	-0.534	0.362	-0.896
	(0.286)	(0.247)***		(0.329)***	(0.302)*		(0.407)	(0.414)		(0.335)	(0.319)	
High School in Village	1.107	-0.153	1.26	0.398	-0.251	0.649	-0.388	-1.39	1.002	2.193	1.866	0.327
	(0.556)**	(0.503)		(0.631)	(0.571)		(0.828)	(0.855)		(0.646)***	(0.601)***	
Constant	-0.642	-1.357	0.715	-1.546	0.689	-2.235	1.997	1.261	0.736	-2.576	-2.289	-0.287
	(0.855)	(0.784)*		(0.861)*	(0.939)		(1.235)	(1.240)		(0.953)***	(0.937)**	
Observations	864	1056		864	1056		864	1056		864	1056	
Number of hid	629	704		629	704		629	704		629	704	

Notes: Robust standard errors are in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
All covariates are included in the regression.

Table C.8. Comparison of no village level effects, fixed effects and random effects estimates

	School			Farm			Family Business			Child Care		
Unobservables Assumption	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects
Boy Indicator	-0.007	-0.032	0.025	0.415	0.495	1.035	-0.077	-0.105	-0.152	-0.156	-0.207	-0.331
	(0.039)	(0.058)	(0.086)	(0.053)***	(0.067)***	(0.082)***	(0.021)***	(0.037)***	(0.097)	(0.044)***	(0.055)***	(0.094)***
Household Composition												
Biological child indicator	0.053	0.03	0.121	0.063	0.031	0.04	0.037	0.034	-0.131	-0.02	-0.063	-0.29
	(0.041)	(0.064)	(0.097)	(0.046)	(0.056)	(0.090)	(0.036)	(0.064)	(0.105)	(0.049)	(0.075)	(0.103)***
Number of girls	0.015	0.025	0.038	-0.049	-0.049	-0.073	0.007	0	-0.09	0.096	0.108	0.212
	(0.014)	(0.019)	(0.032)	(0.015)***	(0.021)**	(0.030)**	(0.012)	(0.023)	(0.037)**	(0.025)***	(0.036)***	(0.037)***
Number of boys	0.002	0.04	0.042	-0.041	-0.04	-0.033	-0.015	-0.008	0.011	0.051	0.083	0.054
	(0.011)	(0.018)**	(0.028)	(0.016)**	(0.022)*	(0.025)	(0.01)	(0.019)	(0.031)	(0.020)***	(0.029)***	(0.029)*
Number of adult men	-0.015	-0.027	-0.063	0.025	0.045	0.023	-0.013	0.013	-0.006	-0.051	-0.064	-0.191
	(0.014)	(0.020)	(0.037)*	(0.018)	(0.025)*	(0.033)	(0.012)	(0.023)	(0.042)	(0.022)**	(0.032)**	(0.041)***
Number of adult women	0.01	-0.018	0.002	0.059	0.063	0.047	0.002	-0.011	0.029	-0.04	-0.037	-0.085
	(0.019)	(0.030)	(0.039)	(0.021)***	(0.025)**	(0.036)	(0.016)	(0.034)	(0.048)	(0.018)**	(0.031)	(0.045)*
Household Assets and Unearned Income												
Livestock Value (FCFA)	0.008	0.005	0.015	-0.002	-0.01	-0.007	0	-0.002	-0.01	-0.008	-0.01	-0.018
	(0.003)**	(0.004)	(0.007)**	(0.004)	(0.005)*	(0.006)	-0.002	(0.003)	(0.006)*	(0.005)	(0.007)	(0.010)*
Herd Size (Number of Animals)	-0.001	-0.001	-0.005	0.002	0.002	0.002	-0.001	0.002	0	0.001	0.005	0.007
	(0.001)	(0.002)	(0.003)*	(0.001)*	(0.002)	(0.003)	-0.001	(0.001)**	(0.003)	(0.002)	(0.003)*	(0.004)*
Agricultural Capital (FCFA)	0.001	0.002	0.002	0.003	0.004	0.008	-0.001	-0.001	0.002	0.004	0.004	0.008
	(0.001)	(0.002)	(0.005)	(0.001)**	(0.001)***	(0.005)	-0.002	(0.002)	(0.006)	(0.002)	(0.002)**	(0.007)
Household Durables (FCFA)	0.001	0.002	0.005	-0.006	-0.006	-0.009	0	0.001	0.002	0.003	0.001	0.006
	(0.001)	(0.002)	(0.005)	(0.005)	(0.006)	(0.008)	0	(0.001)	(0.002)	(0.003)	(0.003)	(0.007)
Migrant Remittances (FCFA)	-0.008	-0.011	-0.026	-0.025	-0.029	-0.032	0.005	0.008	0.011	-0.011	-0.009	-0.029
	(0.005)	(0.008)	(0.014)*	(0.008)***	(0.006)***	(0.018)*	(0.007)	(0.010)	(0.013)	(0.011)	(0.012)	(0.024)

Table C.8. Continued

	School			Farm			Family Business			Child Care		
Unobservables Assumption	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects	No effects	Village Fixed Effects	Village Random Effects
Adult Characteristics												
Any Mother's Education	0.153	0.132	0.569	-0.07	-0.082	0.187	0.077	0.056	0.435	0.07	0.13	0.789
(1=Yes)	(0.107)	(0.116)	(0.137)***	(0.114)	(0.152)	(0.143)	(0.053)	(0.117)	(0.160)***	(0.11)	(0.112)	(0.180)***
Any Father's Education	0.124	0.168	0.464	-0.076	-0.105	-0.213	-0.113	-0.103	-0.258	0.042	0.072	-0.004
(1=Yes)	(0.068)*	(0.082)**	(0.104)***	(0.065)	(0.080)	(0.106)**	(0.067)*	(0.104)	(0.122)**	(0.079)	(0.092)	(0.124)
Age of HH Head	0	0	-0.002	0	0.002	0.003	-0.001	-0.003	-0.007	0.002	0.002	0.005
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)*	(0.001)	(0.002)	(0.002)***	(0.001)*	(0.002)	(0.002)**
Age of HH Head's spouse	0.002	0.004	0.004	-0.004	-0.005	-0.006	0	-0.002	0.008	0	-0.001	0
	(0.001)	(0.002)*	(0.003)	(0.001)***	(0.002)***	(0.003)**	(0.001)	(0.002)	(0.003)**	(0.001)	(0.002)	(0.003)
School Characteristics												
Primary School in Village	0.34	-0.34	1.195	-0.076	0.253	-0.068	0.321	0.055	0.751	0.062	0.093	0.166
	(0.051)***	(0.049)***	(0.415)***	(0.113)	(0.154)	(0.299)	(0.158)**	(0.241)	(0.624)	(0.129)	(0.085)	(0.429)
Secondary School in Village	0.167	-0.129	0.351	-0.058	-0.426	-0.353	-0.095	0.55	-0.054	-0.017	-0.26	0.13
	(0.061)***	(0.060)**	(0.226)	(0.066)	(0.033)***	(0.188)*	(0.081)	(0.059)***	(0.398)	(0.07)	(0.060)***	(0.280)
High School in Village	0.052	0.435	0.315	0.151	-0.193	-0.307	-0.165	0.153	-0.318	0.539	0.487	1.548
	(0.118)	(0.065)***	(0.444)	(0.162)	(0.233)	(0.387)	(0.236)	(0.083)*	(0.705)	(0.096)***	(0.087)***	(0.543)***
Observations	1920	1474	1920	1920	1766	1920	1920	1321	1920	1920	1422	1920

Notes: Robust standard errors are in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
All covariates are included in the regression.

Table C.9. Multivariate probit estimates

	School	Farm Work	Family Business	Child Care
Boy Indicator	-0.029	1.095	-0.28	-0.419
	(0.120)	(0.154)***	(0.077)***	(0.115)***
Household Composition				
Biological child indicator	0.146	0.157	0.14	-0.056
	(0.133)	(0.114)	(0.123)	(0.124)
Number of girls	0.047	-0.122	0.022	0.244
	(0.042)	(0.038)***	(0.044)	(0.065)***
Number of boys	0.01	-0.103	-0.057	0.137
	(0.034)	(0.041)**	(0.038)	(0.052)***
Number of adult men	-0.037	0.057	-0.047	-0.138
	(0.041)	(0.046)	(0.041)	(0.056)**
Number of adult women	0.02	0.15	0.012	-0.098
	(0.059)	(0.053)***	(0.060)	(0.048)**
Household Assets and Unearned Income				
Livestock Value (FCFA)	0.024	-0.005	0.001	-0.022
	(0.011)**	(0.010)	(0.009)	(0.013)*
Herd Size (Number of Animals)	-0.004	0.005	-0.002	0.002
	(0.004)	(0.003)*	(0.003)	(0.005)
Agricultural Capital (FCFA)	0.004	0.006	-0.005	0.009
	(0.004)	(0.003)**	(0.007)	(0.006)
Household Durables (FCFA)	0.002	-0.011	0.001	0.009
	(0.003)	(0.011)	(0.002)	(0.007)
Migrant Remittances (FCFA)	-0.026	-0.066	0.017	-0.021
	(0.016)	(0.020)***	(0.025)	(0.024)
Parental Education				
Any Mother's Education	0.412	-0.177	0.315	0.25
(1=Yes)	(0.280)	(0.290)	(0.253)	(0.264)
Any Father's Education	0.378	-0.198	-0.348	0.07
(1=Yes)	(0.176)**	(0.168)	(0.193)*	(0.197)
Age of HH Head	-0.001	0.001	-0.002	0.005
	(0.002)	(0.003)	(0.003)	(0.003)
Age of HH Head's spouse	0.005	-0.011	0.001	-0.001
	(0.004)	(0.003)***	(0.004)	(0.004)
Community Characteristics				
Access to River	-0.16	-0.257	0.085	0.182
(1=Yes)	(0.175)	(0.193)	(0.248)	(0.184)

Table C.9. Continued

	School	Farm Work	Family Business	Child Care
Roads				
within 1-10km	0.525	0.355	0.092	0.677
	(0.168)***	(0.285)	(0.265)	(0.304)**
within 11-20km	0.542	0.238	0.114	0.536
	(0.205)***	(0.281)	(0.393)	(0.330)
greater than 20km	0.926	0.436	0.386	0.83
	(0.261)***	(0.340)	(0.362)	(0.344)**
Commune Population				
less than 5000 people	0.744	-0.142	-0.122	-0.919
	(0.474)	(0.372)	(0.589)	(0.473)*
5-10,000 people	-0.1	-0.595	1.158	-0.422
	(0.329)	(0.289)**	(0.411)***	(0.379)
10-20,000 people	0.185	0.823	-0.802	-0.823
	(0.265)	(0.232)***	(0.326)**	(0.244)***
Villages per Commune				
fewer than 10	0.616	1.912	-2.166	-0.934
	(0.486)	(0.406)***	(0.626)***	(0.541)*
11-20 villages	0.652	1.31	-1.821	-0.582
	(0.331)**	(0.335)***	(0.502)***	(0.404)
21-30 villages	0.253	0.453	-0.881	0.347
	(0.287)	(0.291)	(0.446)**	(0.324)
School Characteristics: Primary				
Primary School in Village	1.612	-0.172	0.955	0.206
	(0.482)***	(0.294)	(0.430)**	(0.343)
Primary School within 1-5km	0.938	-0.01	0.754	-0.013
	(0.549)*	(0.343)	(0.425)*	(0.362)
Primary School farther than 5km	-0.194	-0.174	1.045	0.173
	(0.610)	(0.434)	(0.588)*	(0.476)
Multiple Primary Schools	0.745	0.017	-0.006	-0.138
(1=Yes)	(0.201)***	(0.237)	(0.335)	(0.302)
Student-Teacher Ratio	-0.011	0.001	-0.011	-0.004
	(0.006)*	(0.004)	(0.006)*	(0.005)
Secondary School in Village	0.482	-0.153	-0.336	-0.058
	(0.166)***	(0.167)	(0.258)	(0.184)
High School in Village	0.149	0.368	-0.47	1.7
	(0.331)	(0.450)	(0.667)	(0.585)***
Constant	-2.281	-1.628	1.254	-1.98
	(0.588)***	(0.555)***	(0.694)*	(0.617)***
Observations	1920	1920	1920	1920

Notes: Robust standard errors are in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table C.10. Multivariate probit asset-Crop loss shock interactions

Interactions	Withdrawn from School	Farm Work	Family Business	Child Care
Durables x	-0.082	-0.019	-0.409	0.045
Large Crop Loss	(1.140)	(0.240)	(2.84)**	(0.330)
Durables x	-0.002	-0.023	0.25	0.01
Small Crop Loss	(0.080)	(1.320)	(2.47)*	(0.380)
Agricultural	0.618	-0.041	-1.778	-0.416
Capital x	(1.110)	(0.060)	(1.910)	(0.410)
Large Crop Loss				
Agricultural	-0.858	0.247	0.492	-0.616
Capital x	(1.340)	(0.550)	(0.750)	(0.870)
Small Crop Loss				
Livestock Value x	-0.17	-0.026	0.055	-0.238
Large Crop Loss	(2.46)*	(0.510)	(1.070)	(1.590)
Livestock Value x	-0.073	0.003	0.039	0.017
Small Crop Loss	(1.240)	(0.080)	(1.130)	(0.430)
Observations	786			

Notes: Robust z statistics are in parentheses.
* significant at 5%; ** significant at 1%
All covariates estimated are in the regression.

Table C.11. Multivariate probit estimates: Asset-illness shock interactions

Interactions	Withdrawn from School	Farm Work	Family Business	Child Care
Durables x	-0.734	-0.102	-0.049	-0.088
Sick Male	(2.75)**	(1.370)	(0.540)	(1.540)
Durables x	0.189	0.087	-0.19	-0.024
Sick Female	(1.900)	(1.420)	(2.75)**	(0.490)
Durables x	0.149	0.059	0.161	0.105
Sick Child	(0.860)	(0.380)	(1.400)	(0.530)
Agricultural	-0.735	0.235	-1.605	-0.19
Capital X	(0.690)	(0.350)	(1.600)	(1.99)*
Sick Male				
Agricultural	-0.742	-0.284	-0.128	-0.212
Capital x	(1.340)	(0.590)	(0.290)	(0.440)
Sick Female				
Agricultural	1.432	-0.738	1.331	-1.273
Capital x	(1.340)	(0.830)	(1.420)	(1.560)
Sick Child				
Livestock Value	0.136	0.074	0.013	0.05
x Sick Male	(3.75)**	(1.890)	(0.210)	(2.12)*
Livestock Value	-0.141	-0.095	-0.002	-0.042
x Sick Female	(2.54)*	(2.35)*	(0.040)	(1.520)
Livestock Value	-0.158	0.056	-0.002	-0.034
X Sick Child	(1.440)	(1.280)	(0.040)	(0.480)
Observations	786			

Notes: Robust z statistics are in parentheses.
* significant at 5%; ** significant at 1%
All covariates are included in the regression.

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