Child Labour Versus Education: Poverty Constraints or Income Opportunities?[*]

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Child labour is commonly associated with poverty. However, the empirical evidence on this link is weak. By explicitly integrating the role of household asset profiles we provide a fuller and more nuanced explanation of child labour and schooling decisions. We use a simple agricultural household model with a missing labour market to show how the extent and composition of household asset portfolios simultaneously determine household income and the shadow wage of (demand for) child labour. Child labour-increasing (-decreasing) assets are characterised by a dominant wage (income) effect. A multinomial logit analysis of data from rural Ethiopian households suggests that small livestock and land ownership are child labour-increasing, whereas ownership of oxen, bulls and ploughs, land quality and proximity to a source of water are child labour-decreasing. We conclude that both poverty constraints and income opportunities play important roles in the decision to send children to school or to work. We also find that work and school conflict substantially but not entirely.

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1. Introduction

The relationship between poverty and child time use is complex and controversial. If schooling and leisure are normal consumer goods, demand for them will increase and supply of child work will fall as income rises[1]. If net expected returns to schooling are greater than to child work, income may also encourage schooling and reduce child work by relaxing household credit constraints. Furthermore, returns to schooling may also increase with household income, through social capital or other employment advantages. Although the link between schooling and income is well established, empirical work has generally failed to demonstrate a strong relationship between child work and income[2].

One possible explanation for the weak empirical link between child work and income is that income variables are proxying omitted asset variables, which may have just the opposite effects on child time use. Household income is generally associated with greater access to productive assets. As most child work is performed within the household and smoothly functioning child labour markets are rare, household access to productive assets increases the productivity, and supply, of child work. In several studies, land and livestock ownership and having a family enterprise have been shown to increase child work participation[3]. While household income draws children out of work and into school, the productivity effect of underlying greater asset holdings does the contrary.

This issue is of crucial importance where the reduction of poverty and child work and increased schooling are policy objectives. Recent research on poverty suggests that the most effective manner to combat poverty is to increase the access of the poor to productive assets[4]. According to de Janvry and Sadoulet (1996, abstract), "insufficient access to assets is the main determinant of poverty". To the extent that assets contribute to household income and that poverty constrains child schooling, the policymaker is in a win-win situation of simultaneously reducing poverty, reducing child work and increasing schooling. However, if increased access to assets raises the returns to child work sufficiently, it may instead encourage child work at the

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[1] See, for example, the World Bank's position paper Fallon and Tzannatos (1998) and ILO (1996).

[2] See Bhalotra and Heady (1998), Levison and Moe (1998), Mueller (1984), Psacharopoulos (1997), Rosenzweig (1981) and Ravallion and Wodon (2000)

[3] See Bhalotra and Heady (1998), Canagarajah and Coulombe (1997), De Tray (1983), Levison and Moe (1998), Mergos (1992), Mueller (1984) and Rosenzweig and Evenson (1977). Further evidence of a high elasticity of child work relative to its returns is provided by the market child work literature. Bhalotra and Heady (1998), Mergos (1992), Rosenzweig (1981) and Skoufias (1994) all find a significant and strong positive relationship between child market wage rates and child work participation. As Swaminathan (1998, p. 1514) argues in the case of market child work: "It is the structure of demand, however, that determines the use of child work. When there is demand for child work, poverty ensures that the supply is forthcoming".

expense of schooling by creating profitable income opportunities. In his study of a Bangladeshi village, Cain (1977) finds that "children of owners of productive assets, therefore, can begin work at a considerably earlier age in a large number of directly productive activities requiring assets"[5]. To the extent that reduced schooling prevents the accumulation of human capital, long-term poverty alleviation may even be compromised, creating a lose-lose situation. Efforts should be made to identify the optimal human capital-physical asset combination taking into account their intimate relationship via child work and schooling decisions.

In most cases, the types of activities performed by children are quite different from those performed by adults. In rural Ethiopia, the principal activities of children are fetching wood or water and herding, whereas adult males are primarily involved in farming and adult females in domestic work. It therefore seems likely that the effects on child work will vary considerably depending on the **types** of physical assets targeted in poverty alleviation policies. In particular, targeting assets used in activities commonly performed only by adults may make it possible to avoid increased child work and reduced schooling. Furthermore, child labour-saving assets such as a nearby well or a wheelbarrow can be expected to directly reduce child work **and** poverty.

A simple agricultural household model is used to examine the contrasting income and productivity effects - and the resulting ambiguous net effect - of variations in asset holdings on child work supply. The analysis closely mirrors that of the backward-bending labour supply curve in the neo-classical labour supply model. However, as only 1% of children and less than 10% of adults do any work outside the household (for wages or in-kind payment), a missing market formulation is adopted[6]. We demonstrate how different physical assets have different effects on child labour supply according to their degree of substitution. For example, increased access to physical assets that require relatively more child work, such as small animals, may tend to increase child work participation and reduce child schooling and leisure. In the terms of this chapter's title, the "income opportunities" (or substitution) effect may tend to dominate the

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[4] See also Dercon and Krishnan (1998) and Owens and Hoddinott (1999).

[5] Indeed, he argues: "an important additional factor in determining a child's age of entry into an economic activity is opportunity. A great many activities depend for their performance on such physical assets as land, livestock, tools, or a boat. For households that do not possess the requisite assets, a child's participation can only occur through wage employment, for which, in turn, opportunities may also be limited" (p.213).

[6] Sadoulet and de Janvry (1995, p.149) give rural child work as a typical example of market failure. The importance of the demographic variable in our child time use regressions below gives support to the missing market hypothesis. See Lopez (1984) and Benjamin (1992) for formal tests of separability along these lines.

"poverty constraints" (or income) effect. Consequently, the choice of assets in a poverty alleviation program is important and should take into account the effects on child work and schooling.

All the above-mentioned relationships are analytically ambiguous, and we thus argue the importance of empirical analysis. We contribute to this agenda by estimating a reduced-form child time use equation involving asset ownership and other conditioning variables likely to influence the returns to child work. The exceedingly low enrolment rates and high child work participation in rural Ethiopia, combined with its extreme poverty, make it an ideal region for examining the poverty-asset-child time allocation nexus. Like the wage coefficients in a standard labour supply model, the coefficients on the asset variables encompass both an income effect and a substitution effect. As we observe the net effect, we are able to identify, for each type of asset, which of the two dominates. This allows us to see whether access to each asset affects child time use primarily by relaxing poverty constraints on child schooling or by creating income opportunities for child work.

We first present the theoretical model, then the specific context of our empirical application – rural Ethiopia – and the regression results, before concluding.

2. Theory

2.1 Ambiguous net effect of physical asset holdings on child work supply

To simplify, we consider a model of a one-member agricultural household that produces and consumes one marketable good[7]. In terms of household decision-making, we adopt the unitary approach and neglect intra-household bargaining and distribution issues. We contrast the results with and without a smoothly functioning labour market and show that the effect of physical asset holdings is only ambiguous in the latter case. Let us first assume that a perfect labour market exists:

$$U = U(C,h)$$

$$Q = f(L; K)$$

$$PC = PQ - w(L-L^H) + E = wL^H + \Pi + E$$

$$L^H + h = T$$

where C = consumption, h = non-work (school or leisure) time, Q = production, L = labour time in household production, K = household assets (exogenous), P = the commodity price, w = the

[7] If the produced and consumed goods are different, both their prices appear in the supply and demand functions. If these prices are exogenous, the results will not change. Similarly, the introduction of a

market wage rate, L^H = labour time of household member, E = non-labour income, Π = profits from household production (PQ-wL) and T = time endowment. The budget and time constraints can be combined to obtain the full-income constraint:

$PC = w(T-h) + \Pi + E$

This is the familiar separable household model where production/labour demand decisions are independent of consumption/labour supply decisions. Production is a function of only one endogenous variable, labour supply, which is itself determined independently of consumption/labour supply variables by the following profit-maximising condition: $f_L = W/P$. The value of profits is substituted into the full-income constraint and determines consumption and labour supply according to the following utility maximisation condition:

$U_h/U_c = W/P$

The separability of the model ensures that any variation in household assets (K) will only affect labour supply through its effect on household profits and that its effects will be unambiguous. An increase in household assets will increase the marginal productivity of labour in household production leading to increased labour hiring. However, as the market wage rate is exogenous, the only change on the consumption/labour supply side of the model will be the resulting increase in profits. Assuming that non-labour time is a normal good, this will unambiguously reduce the labour supply of the household member.

Let us see how these results change in the absence of a labour market[8]. In this context, all household labour is devoted to household production ($L=L^H$):

$U = U(C,h)$ $\quad$ $Q = f(L; K)$

$PC = PQ+E$ $\quad$ $L+h = T$

The first-order condition ($U_h/U_C=f_L$) can be represented by the point A^0 in **Figure 1** below. The household's production function is described by the curve Q^0. Utility maximisation occurs at the point of tangency between the household production function (slope=$f_L{}^0$) and its indifference curve U^0 (slope = U_h/U_c).

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second purchased consumer good, as in the standard Singh, Squire et al. (1986) model, does not fundamentally alter our results.

[8] A brief list of studies involving non-separable household models include: de Janvry, Fafchamps et al. (1992), Lambert and Magnac (1992), Nakajima (1986), Sadoulet, de Janvry et al. (1996) and Singh, Squire et al. (1986) particularly Strauss' appendix and Lopez' chapter in this last book. See also Sadoulet and de Janvry (1995).

Figure 1: Labour-increasing physical asset accumulation

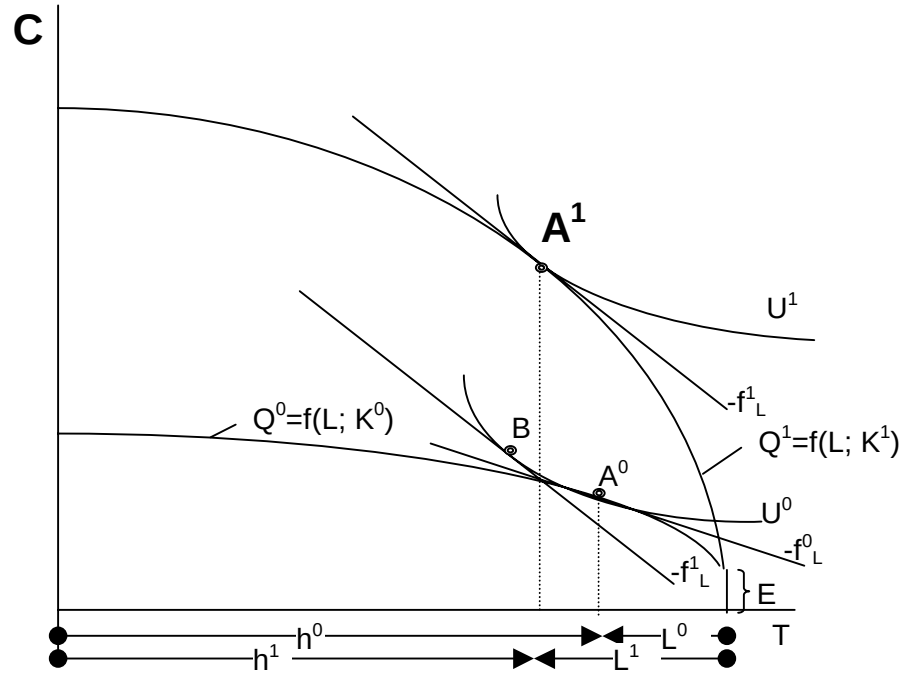
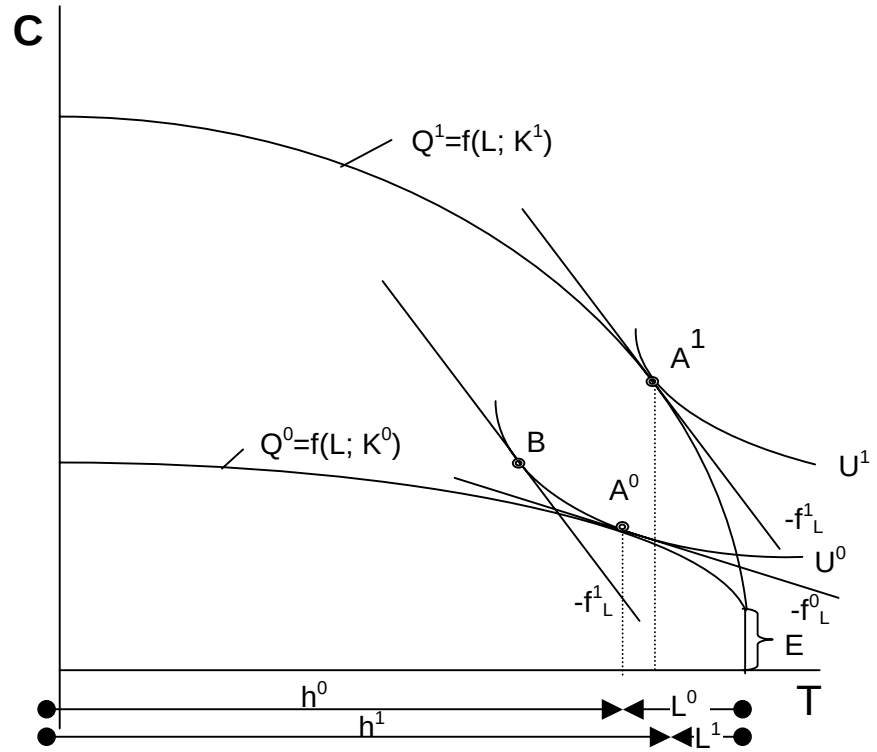


Figure 2: Labour-decreasing physical asset accumulation



If we consider the impact of an increase in the household's physical asset holdings (K), we observe an outward shift in the household production curve. This results in a new optimum at point A^1, which, in this case, is situated, to the left of point A^0 implying an increase in labour time from L^0 to L^1. It is, of course, possible to redraw **Figure 1** with A^1 situated to the right of A^0 (**Figure 2**). The net effect of increased physical asset holdings on labour time is thus ambiguous. This ambiguity is the reflection of two conflicting effects: a negative "income" (more properly, "profit") effect and a positive substitution effect. In a manner similar to the standard Slutsky decomposition, we identify the substitution effect as the utility-constant change in labour supply at the new equilibrium shadow wage (or marginal productivity) rate (f^1_L). This is the movement from point A to B, which unambiguously increases labour supply. By increasing the marginal productivity of labour, increased asset holdings encourage a substitution of labour time for non-labour time. The income effect can be measured by the movement from B to A^1. This income effect unambiguously reduces labour time. In the case of **Figure 1**, the substitution effect dominates and the net effect of increased asset holdings is labour increasing. In the case of **Figure 2**, it is the income effect that dominates and labour time declines.

Let us now derive these results more formally[9]. Assuming an interior solution for h and C, The two first-order conditions (FOC) for utility maximisation are the following:

$f_L = U_h/U_C = Z$; Z=marginal rate of substitution of leisure for consumption

$PC = PQ+E$; P=price of household good.

In order to distinguish substitution and income effects, we first derive the effect of a change in non-labour income by totally differentiating the two FOC with respect to E:

$f_{LL}(\delta L/\delta E)=(\delta Z/\delta L)(\delta L/\delta E)+(\delta Z/\delta C)(\delta C/\delta E)$

$P(\delta C/\delta E) = Pf_L(\delta L/\delta E)+1$

Substituting and simplifying, we obtain:

$\delta L/\delta E = (-1/\beta)(1/p)(\delta Z/\delta C)$

$\delta C/\delta E = (1/\beta)((\delta Z/\delta L)-f_{LL})$, where $\beta = Z(\delta Z/\delta C)+\delta Z/\delta L-f_{LL}$

Following Nakajima (1986), we assume that $(\delta Z/\delta C)$ and $(\delta Z/\delta L)$ are both positive. That is, given the convexity of the indifference curve, the marginal rate of substitution of leisure for consumption (the slope of the indifference curve) increases as labour supply and consumption

[9] The discussion here is based on Nakajima (1986), chpt.4.

increases[10]. We also assume f_{LL} is negative given the concavity of the production function. Thus the sign of the above income effects on labour supply and consumption depend on the sign of β, which can be determined from the second-order condition (SOC) for utility maximisation:

SOC: $df_L/dL - dZ/dL < 0$

thus: $\delta f_L/\delta L-(\delta Z/\delta L)-(\delta Z/\delta C)(\delta C/\delta L) < 0$

or: $f_{LL}-(\delta Z/\delta L)-Z(\delta Z/\delta C)<0$

or: $-\beta<0$ ($\beta>0$)

We can therefore conclude $\delta L/\delta E < 0$ and $\delta C/\delta E>0$.

The effects of a change in physical asset holdings can be examined along similar lines. This time we totally differentiate the FOC with respect to K:

$f_{LL}(\delta L/\delta K) + f_{LK} = (\delta Z/\delta L)(\delta L/\delta K) + (\delta Z/\delta C)(\delta C/\delta K)$

$P(\delta C/\delta K) = Pf_L(\delta L/\delta K) + Pf_K$

We solve, substitute the expressions for $(\delta L/\delta E)$ and $(\delta C/\delta E)$ and simplify to obtain:

$\delta L/\delta K = Pf_K(\delta L/\delta E) + (1/\beta)f_{LK} <>0$

$\delta C/\delta K = Pf_K(\delta C/\delta E) + (1/\beta)f_{LK}Z >0$

The first terms on the right-hand side of each equation are the income effects. The second terms represent the substitution effects. Given $f_K>0$, $(\delta L/\delta E)<0$, $(\delta C/\delta E)>0$, $\beta>0$, $f_{LK}>0$ and $Z>0$, the substitution effects are positive whereas the income effect is negative in the labour equation but positive in the consumption equation. Clearly, the net effect on labour supply is ambiguous and depends on the relative importance of the conflicting income and substitution effects.

In conclusion, when a smoothly functioning labour market is present, increased access to physical assets will unambiguously increase income and reduce child work. However, in the absence of a labour market, we cannot predict the effects on child work, schooling and leisure time. Asset-based poverty alleviation policies may increase child work at the cost of reduced schooling and/or leisure time. In contrast, a lump-sum income transfer will unambiguously increase income, schooling and leisure time while reducing child work regardless of the presence or absence of a labour market.

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[10] Note: $\frac{\delta Z}{\delta C} = \frac{\delta(U_h/U_C)}{\delta C} = \frac{U_C U_{hC} - U_h U_{CC}}{U_C^2}$ and $\frac{\delta Z}{\delta C} = \frac{\delta(U_h/U_C)}{\delta h} = \frac{U_C U_{hh} - U_h U_{Ch}}{U_C^2}$ with $U_C>0$, $U_h>0$, $U_{CC}<0$, $U_{hh}<0$ and $U_{hC}=U_{Ch}>0$ due to the quasi-concavity of the utility function.

2.2 Differing effects of different assets

The basic conditions described by Figures 1 and 2 are valid not only for total household production but also for any specific type of production. Let us distinguish two types of household production (Q_1 and Q_2) with activity-specific physical assets (K_1 and K_2; e.g. land for farming and livestock for herding):

$$U=U(C_1,C_2,h)$$

$$Q_1=f(L_1; K_1)$$

$$Q_2=g(L_2; K_2)$$

$$P_1C_1+P_2C_2=P_1Q_1+P_2Q_2+E$$

$$L_1+L_2+h=T$$

where L_i = labour time devoted to activity i. The first-order conditions become:

$$U_h/U_{C1}=f_L$$

$$U_h/U_{C2}=g_L$$

which can be represented by Figures 1 and 2. It is therefore possible to imagine the two figures as representing two different activities using different physical assets. The formal model resolution is somewhat more complicated but leads to the same basic results.

In conclusion, the effects on child work, schooling and leisure will depend crucially on the type of assets owned by the household. Asset ownership policies aimed at poverty alleviation may target specific types of assets in order to minimise child work and maximise child schooling and leisure.

2.3 Differing effects on different household members

The results up until here have been based on a one-member household model that does not distinguish between children and adults. However, it is straightforward to extend the model to distinguish household members. In so doing, we show that different household members will be affected differently by asset variations if they are not perfect substitutes. Let us consider now a two-member household composed of one adult (superscript A) and one child (superscript C):

$$U=U(C_1,C_2,h^A,h^C)$$

$$Q_1=f(L^A_1,L^C_1; K_1)$$

$$Q_2=g(L^A_2,L^C_2; K_2)$$

$$P_1C_1+P_2C_2=P_1Q_1+P_2Q_2+E$$

$$L^A_1+L^A_2+h^A=T^A$$

$$L^C_1+L^C_2+h^C=T^C$$

First-order conditions for utility maximisation are the following:

$U_{hA}/U_{C1}=f_{LA}$

$U_{hA}/U_{C2}=g_{LA}$

$U_{hB}/U_{C1}=f_{LB}$

$U_{hB}/U_{C2}=g_{LB}$

Figures 1 and 2 can represent each of these conditions. Asset accumulation that is labour-increasing for one member may be labour-decreasing for another. Consider an extreme case where children specialise in herding activities and adults in farming activities. Increased livestock ownership may raise child work through a dominant substitution effect while reducing adult work through a dominant income effect.

In conclusion, the specific characteristics of children and the types of activities in which they participate will determine the time use effects of increased ownership of different assets. Empirical analysis is required to determine which physical assets are child work-increasing and -decreasing and the extent of their respective impacts.

3. Data and setting

Ethiopia is a country of extremes. The second poorest nation in the World (GNP per capita = $US 100), it also has the third highest fertility rate (seven children per woman) and the lowest school enrolment rates (24% net primary school enrolment rate)[11]. Variations in rainfall can be dramatic even within regions and render rural Ethiopian households particularly vulnerable. Famines, a lengthy and ruinous civil war ending in 1991 and current tensions with Eritrea further exacerbate the resulting climate of uncertainty. All these characteristics are even more acute in rural areas. Although separating cause from effect is difficult, they are almost surely related to another lesser-known but equally remarkable characteristic of Ethiopia, particularly rural Ethiopia: an extraordinarily high incidence of child work[12].

We study the time use of children aged 6 to 15 using data from three rounds of detailed surveys of 1477 rural households from 15 villages throughout rural Ethiopia[13]. Practically all of these children participate in household farm or domestic work activities and school attendance is extremely low (18%), particularly among girls (14%). Given that practically all children do

[11] World Bank (1998).
[12] ILO (1995) and ILO (1996) provide general overviews of the child work situation in Ethiopia.
[13] The Centre for the Study of African Economies (CSAE) and the Economics Department of Addis Ababa University (AAU) executed the three rounds of surveys over an 18-month period beginning March 1994. The database is available at:
http://www.economics.ox.ac.uk/CSAEadmin/datasets/Ethiopia-ERHS/ERHS-main.html

some labour activities, we focus on the choice of a child's main activity, which better captures the child work-schooling trade-off.

From Table 1 below, we can see that more than half of all children (and almost 80% of 11- to 15- year old girls) have work **as** their main activity (Table 1)[14]. Only 18% of children attend school[15]. Education is not compulsory for children in Ethiopia. Finally, a large share of, primarily younger, children does not attend school and does not have work as their main activity. Figure 3 provides a detailed age profile of child activities.

Table 1: Children's main activities in rural Ethiopia
(Percentage of children with the main activity indicated)

	Ages 6 to 10			Ages 11 to 15			All children		
	Boys	**Girls**	**Total**	**Boys**	**Girls**	**Total**	**Boys**	**Girls**	**Total**
Work	47.5	51.4	**49.5**	63.5	78.1	**70.9**	54.5	63.1	**58.9**
School	15.2	10.6	**12.8**	31.7	18.0	**24.8**	22.4	13.8	**18.1**
Inactive	37.3	38.0	**37.7**	4.8	3.9	**4.3**	23.1	23.1	**23.1**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Count	(678)	(700)	**(1378)**	(526)	(544)	**(1070)**	(1204)	(1244)	**(2448)**

Figure 3: Main activities of children and young adults in rural Ethiopia
(Percentage of children with the main activity indicated)

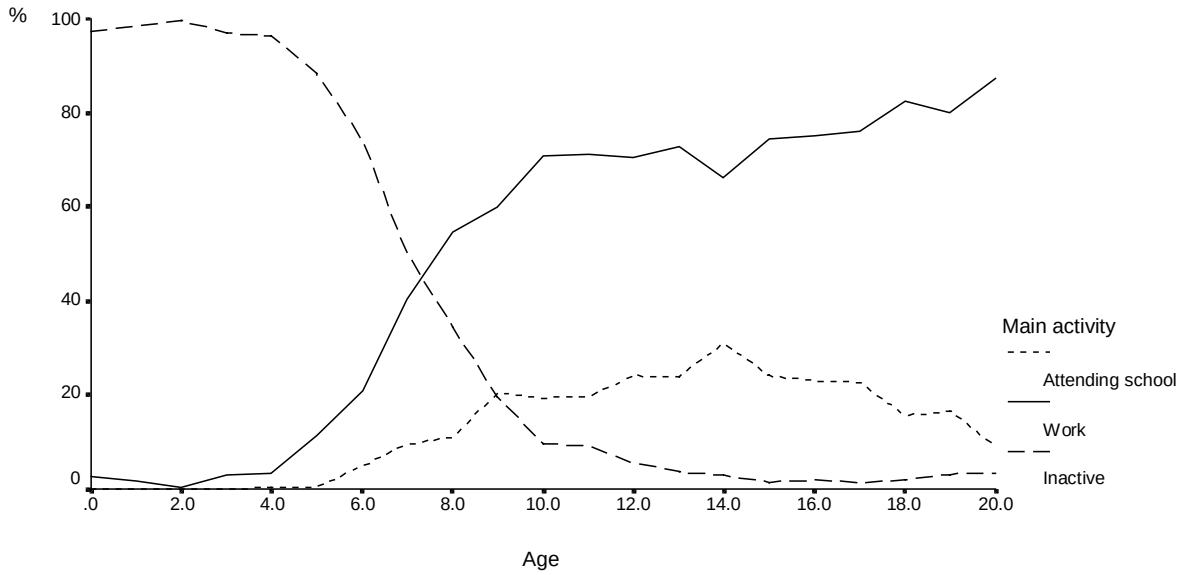

Table 2 provides a summary of types of activities performed by children in rural Ethiopia.

[14] In the case of herding, irrespective of age and sex, child herders work 7-8 hours per day six days per week.
[15] All children who attend school have school as their main activity and vice versa.

Table 2: Primary work activities of children
(Percentage of children performing the activity indicated as principal work activity)

	Boys			Girls			All children		
	6-10	11-15	Total	6-10	11-15	Total	6-10	11-15	Total
Fetching wood/water	25.9	17.3	22.5	44.1	45.7	44.8	35.2	31.7	33.8
Herding	54.2	29.9	44.6	20.1	9.1	15.8	36.8	19.4	29.9
Farm work	10.5	44.0	23.8	2.5	3.9	3.1	6.5	23.7	13.3
Domestic work	2.3	2.5	2.4	19.1	29.2	23.1	10.9	16.0	12.9
Minding children	5.9	.8	3.9	12.0	2.7	8.4	9.0	1.7	6.2
Family business work	.7	4.3	2.1	1.3	7.6	3.8	1.0	6.0	2.9
Other	.5	1.4	.8	.8	1.6	1.2	.7	1.4	.6
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Existing studies on schooling in rural Ethiopia suggest that the income opportunities provided by – opportunity costs of – child work constitute a major, perhaps the principal, reason for low school enrolment[16]. In our sample of rural households, work was cited as the primary reason for non-attendance in 35% of all responses and in over half the responses concerning children aged 11 to 15 (
Table 3). If we ignore children considered too young to attend school, work-related reasons are cited in over half of all responses. The sex difference in children's work activities emerges clearly with boys required for farm activities and girls for other household, presumably domestic, activities.

Table 3: Primary reason for not attending school by age group and sex
(Percent of all primary reasons given for non-attending children)

	Ages 6-10			Ages 11-15			All ages		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Required for farm activities	19	6	**12**	45	13	**26**	27	9	**17**
Required for other hh activities	7	16	**11**	8	40	**27**	7	25	**17**
Required to care for sick/elderly	1	0	**1**	0	1	**0**	1	0	**1**
Required to work for wages	0	0	**0**	1	1	**1**	0	0	**0**
All work-related reasons	**26**	**22**	**24**	**54**	**54**	**54**	**36**	**34**	**35**
- excluding "too young"	56	49	**52**	59	59	**59**	57	55	**56**
Too young	53	55	**54**	9	7	**8**	38	37	**37**
Too expensive	10	11	**10**	22	19	**20**	14	14	**14**
School availability	5	6	**6**	8	11	**10**	6	8	**7**
Other reasons	6	6	**6**	7	8	**8**	6	7	**6**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Characterisation of children according to their main activity and their household income and asset profiles illustrates the contrasting productivity and income effects discussed in the introduction (Table 4). It is no surprise that school-going children come from the highest income households. However, these households' wealth appears to be based especially on the ownership of oxen, bulls, cows and ploughs, which are basically labour-saving assets not directly involving children. Working children come from significantly lower income households, yet these

households have the highest ownership of land and small livestock, two complementary assets that we could expect to increase the demand for, and returns to, child work as herders. Inactive children are clearly a distinct group characterised by the low levels of income and asset ownership in their households. These households appear to have neither the income to send their children to school, nor the productive assets to create income-earning opportunities.

Table 4: Asset ownership and income by child's main activity
(Average values for the households of children, by main activity of children)

	All kids			Boys			Girls		
	Work	**School**	**Inactive**	**Work**	**School**	**Inactive**	**Work**	**School**	**Inactive**
Land (ha)	2.42	1.63	1.66	2.43	1.66	1.51	2.42	1.57	1.81
Small livestock (#)	4.53	3.25	2.87	4.81	3.62	2.61	4.30	2.67	3.13
Oxen/bulls (#)	1.55	1.56	1.23	1.61	1.54	1.23	1.49	1.60	1.24
Cows (#)	2.63	3.21	1.96	2.77	3.16	1.86	2.51	3.28	2.06
Ploughs (#)	1.10	1.29	0.95	1.12	1.27	0.91	1.09	1.32	0.99
Hoes (#)	0.92	0.99	0.81	0.93	1.04	0.81	0.91	0.92	0.80
Sickles (#)	1.04	1.03	0.75	1.09	1.11	0.68	1.00	0.91	0.82
Income*	56.40	70.74	50.71	57.82	66.83	46.59	55.2	76.88	54.72
Observations	(1441)	(442)	(565)	(656)	(270)	(278)	(785)	(172)	(287)

*Income measured by real food expenditure per adult equivalent.

4. Empirical modelling

Like participation decisions, main activity decisions are discrete choices, reflecting underlying latent variables. The latent variable in the case of the main activity decision is the unobserved level of participation. Three main activities - work, leisure or inactivity ("leisure") - are considered, giving rise to a polychotomous choice framework. As these choices are mutually exclusive - there can only be one **main** activity - a bivariate probit analysis of school/work decisions, akin to Canagarajah and Coulombe (1997) or Nielsen (1998), is ruled out. Grootaert and Patrinos (1998) assume that the participation decision-making process is sequential with the decision to participate in schooling preceding the decision to work, although there does not appear to be any strong reason to do so[17].

A multinomial logit approach is a straightforward solution[18]. We define the probability of a child having main activity j (j=1 (work); 2 (school); 3 (inactive)) as:

$$P_j = \frac{e^{\alpha_j + \beta_j X}}{\Sigma_k e^{\alpha_k + \beta_k X_k}}; \; j, k = 1,2,3$$

[16] See Rose and Al-Samarrai (1997), USAID (1994) and Weir (1997).
[17] Unlike Grootaert and Patrinos' participation analysis, our concern with the choice of main activities implies that the work decision branch would stem only from those not attending school.

We normalise $\alpha_3 = \beta_3 = 0$ and take the logs of the relative probabilities with respect to P_3[19]:

$$\ln(P_1/P_3)=\alpha_1+\beta_1 X \qquad \ln(P_2/P_3)=\alpha_2+\beta_2 X$$

where X is a vector of i characteristics of each child.

Regression coefficients are hard to interpret – they measure the impact on the log of the odds ratio – but we can measure the impact on the level of the odds ratios by taking the exponent of each coefficient[20]. Like regressions coefficients, odds ratios are independent of the point of evaluation. Both, however, have the disadvantage of being measured relative to a given outcome (inactivity in our case). Thus, if the odds ratio for the work outcome is positive for a given explanatory variable, this indicates that it increases the probability of a child working **relative** to the probability of the child being inactive. This need not imply that the **absolute** probability of the child working increases, as the impact on the probability of the child attending school may be positive and overwhelming. One way to complete the picture is to measure the odds ratios of each outcome relative to reference outcome but also relative to each other. Thus, we present not only the odds ratios for the outcomes work and school relative to the outcome inactivity, but also the odds ratio of the outcome work relative to the outcome school.

We also measure the impact on absolute probabilities directly. However, this impact is not independent of the level of the explanatory variable and must be measured at the margin. This marginal effect is obtained by the following formula:

$$ME_{j,x} = \delta P_j/\delta X_i = P_j(\beta_{ji}-\Sigma_k P_k \beta_{ki}) \; k \neq j$$

which must be evaluated at a specific point, typically the mean values of all variables. Marginal effects thus vary between children[21].

In terms of explanatory variables, the theoretical model above suggests that we should focus on household income and on variables affecting child work productivity, in particular productive asset ownership and household composition (Table 5). In rural Ethiopia, land and livestock are the principal physical assets. Boys and girls are studied separately as their partici-

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[18] The classic application of this approach by Schmidt and Strauss (1975) considers a similar issue: the prediction of an individual's occupation.

[19] See Greene (1997) and Maddala (1983) for introductions to the multinomial logit model.

[20] See Long (1993), p.168-170.

[21] It can be shown (proof on request) that marginal effects and the odds ratio (OR) are related:

$$OR_{j,x} = 1+(ME_{r,x}/P_r)-(ME_{j,x}/P_j)$$

where r is the reference outcome, j is any other outcome, x is an explanatory variable and all variables are evaluated at the same point.

pation rates (Table 1) and work activities (Table 2) differ substantially and pooling restrictions are not respected[22].

Table 5: Definition of variables

Variable	Definition
Mainact	Main activity of child: Work(1); School(2); Inactive(3)
Log of income	Log of real food expenditure per adult equivalent
Log of age	Log of age (in years)
Child of head	Dummy; =1 if child of the household head
# Infants	Number of infants (aged 0 to 4) in the household
# Females	Number of female adults (aged 16 to 59) in the household
# Males	Number of male adults (aged 16 to 59) in the household
# Elderly	Number of elderly (aged 60 and over) in the household
# Younger boys	Number of younger boys (aged 4 to 15) in the household
# Younger girls	Number of younger girls (aged 4 to 15) in the household
# Older boys	Number of older boys (aged 4 to 15) in the household
# Older girls	Number of older girls (aged 4 to 15) in the household
Female head	Dummy; =1 if household head is female
Age of head	Age (in years) of household head
Education of head	Years of formal schooling of household head
Land owned	**Hectares of land owned by household**
Land fertility	**Land fertility index; 1=infertile to 3=fertile**
Land slope	**Land slope index; 1=flat to 3=steep**
Permanent crop	**Dummy; =1 if household owns permanent crop plants**
# Small animals	**Number of small animals owned by the household**
# Bull/oxen	**Number of bulls and oxen owned by the household**
# Cows/calves	**Number of cows and calves owned by the household**
# Hoes	**Number of hoes owned by the household**
# Ploughs	**Number of ploughs owned by the household**
# Sickles	**Number of sickles owned by the household**
Minutes to water	**Number of minutes to walk to nearest source of water**

5. Results

We first examine the odds ratios before turning our attention to the marginal effects. Then, in attempt to evaluate the magnitude of these effects, we calculate the change in these probabilities resulting from a one-standard deviation increase in the value of each explanatory

[22] We use the dummy variable approach (Gujarati (1970a)). An unrestricted regression is run on the pooled data with a full set of intercept and slope dummies for boys, thus allowing all coefficients to differ by sex. A second regression is run on the pooled data without interactive dummies, restricting the coefficients to be equal. A likelihood ratio test rejects pooling at the 0.1% confidence level ($Chi^2(78)=144.26$).

variable, relative to their respective mean values[23]. Descriptive statistics for the regression variables are presented in the table below.

Table 6: Descriptive statistics

	BOYS						GIRLS					
	All		Aged 6-10		Aged 11-15		All		Aged 6-10		Aged 11-15	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Income	57.25	54.96	56.01	56.50	58.87	52.93	58.09	55.48	58.39	53.34	57.70	58.17
Age	10.25	2.87	8.06	1.45	13.08	1.39	10.25	2.90	8.02	1.43	13.13	1.40
Child of head	0.83	0.38	0.86	0.35	0.79	0.41	0.83	0.38	0.84	0.37	0.82	0.39
# Infants	1.23	1.12	1.30	1.11	1.14	1.12	1.21	1.05	1.35	1.08	1.04	1.00
# Females	1.57	0.96	1.57	0.93	1.56	1.00	1.56	0.98	1.54	0.97	1.59	0.99
# Males	1.48	1.01	1.43	0.96	1.53	1.07	1.44	0.99	1.41	0.97	1.49	1.02
# Elderly	0.33	0.54	0.30	0.52	0.36	0.57	0.34	0.56	0.32	0.54	0.37	0.59
Dependency ratio	1.88	1.14	1.91	1.18	1.84	1.09	1.90	1.20	1.96	1.21	1.81	1.18
# Younger boys	0.52	0.79	0.26	0.50	0.87	0.95	0.56	0.81	0.28	0.56	0.92	0.93
# Younger girls	0.53	0.78	0.28	0.52	0.86	0.92	0.52	0.78	0.25	0.51	0.86	0.92
# Older boys	0.52	0.79	0.76	0.90	0.21	0.46	0.52	0.83	0.77	0.94	0.19	0.48
# Older girls	0.58	0.80	0.84	0.90	0.24	0.45	0.52	0.78	0.79	0.89	0.17	0.40
Female head	0.17	0.37	0.16	0.36	0.18	0.38	0.17	0.38	0.17	0.38	0.17	0.38
Age of head	47.41	13.22	46.61	12.87	48.46	13.60	47.95	13.26	46.77	13.07	49.47	13.37
Education of head	1.44	2.71	1.42	2.64	1.46	2.80	1.40	2.58	1.47	2.60	1.31	2.55
Land owned	**2.04**	**2.71**	**2.00**	**2.21**	**2.10**	**3.24**	**2.16**	**3.88**	**2.10**	**4.31**	**2.24**	**3.25**
Land fertility	**1.72**	**0.67**	**1.74**	**0.66**	**1.70**	**0.67**	**1.75**	**0.65**	**1.72**	**0.65**	**1.78**	**0.66**
Land slope	**1.35**	**0.48**	**1.34**	**0.46**	**1.35**	**0.50**	**1.36**	**0.50**	**1.36**	**0.49**	**1.36**	**0.51**
Permanent crop	**0.64**	**0.48**	**0.63**	**0.48**	**0.65**	**0.48**	**0.65**	**0.48**	**0.67**	**0.47**	**0.63**	**0.48**
# Small animals	**4.04**	**6.95**	**3.90**	**6.69**	**4.22**	**7.26**	**3.81**	**6.96**	**3.69**	**6.87**	**3.95**	**7.07**
# Bull/oxen	**1.51**	**1.61**	**1.42**	**1.50**	**1.61**	**1.74**	**1.45**	**1.55**	**1.37**	**1.48**	**1.55**	**1.64**
# Cows/calves	**2.64**	**3.18**	**2.59**	**3.26**	**2.71**	**3.07**	**2.52**	**2.94**	**2.40**	**2.99**	**2.66**	**2.87**
# Hoes	**0.93**	**1.05**	**0.92**	**1.06**	**0.94**	**1.04**	**0.89**	**0.96**	**0.85**	**0.91**	**0.93**	**1.02**
# Ploughs	**1.10**	**1.50**	**0.99**	**0.94**	**1.25**	**1.99**	**1.10**	**1.32**	**1.04**	**1.15**	**1.17**	**1.52**
# Sickles	**1.00**	**1.60**	**0.95**	**1.55**	**1.07**	**1.67**	**0.94**	**1.50**	**0.85**	**1.38**	**1.07**	**1.63**
Minutes to water	**18.54**	**20.26**	**18.72**	**20.99**	**18.31**	**19.30**	**17.53**	**15.43**	**17.27**	**15.08**	**17.87**	**15.87**
#Observations	**1204**		**678**		**526**		**1244**		**700**		**544**	

Notes: S.D.=Standard deviation

5.1 Odds ratios

We look at the influence of individual and household characteristics, before focusing on the role of household productive asset ownership. Site dummies (not shown) are included for

[23] The multinomial logit model postulates the independence of irrelevant alternatives: removing any of the alternatives in the model should not alter the relative probabilities of choosing the remaining alternatives. Tests of this hypothesis tend to reject it in our regressions, although they are not conclusive. For example, in the uninstrumented versions for both boys and girls, the Hausman test statistics (see Hausman and McFadden (1984)) are negative – indicating that the differences in the covariance matrices are not positive definite – or insignificant. Several authors (e.g. Long (1993)) interpret a negative Hausman statistic as evidence that IIA holds. However, the alternative Small-Hsiao IIA test Small and Hsiao (1985) suggests that IIA can confidently be rejected for at least one excluded alternative. Results vary when alternative instruments are used, but generally suggest that IIA does not hold for at least one excluded alternative. Detailed results are available on request. Given these results, it would be interesting to explore the use of the multinomial probit.

the 15 sample sites and are highly significant in several cases, indicating community effects such as school availability. Unfortunately, the number of sites is too small to allow any statistical analysis of the role of community variables and these site dummies act purely as control variables. We first look at the results without instruments and then, at the end of this section, we examine how the results change with the introduction of instruments for livestock and income variables. Ratios that are significant at the 20% level are flagged, not as statistically significant, but as suggestive of results we might obtain with a larger data set and with reliable data on hours of child work. Note, finally, that the unstandardised odds ratio expresses the probability of outcome j (P_j) relative to the reference (r) outcome (inactivity) after a one unit increase in the explanatory variable i over this same relative probability before the increase:

$$\text{Odds ratio}_{j,i} = \frac{\frac{P_j}{P_r}(X_1, X_2, ..., X_i + 1, ..., X_n)}{\frac{P_j}{P_r}(X_1, X_2, ..., X_i, ..., X_n)}$$

An odds ratio superior to 1 implies an increase in the relative probability of observing outcome j. The null hypothesis for significance tests is that the odds ratio is 1.

The probability of a child attending school increases rapidly with **age** relative to the probabilities of the child working or being inactive (Table 7). The impact on the probability of a child working is unclear as it increases relative to inactivity but falls relative to school attendance. **Sons** of the household head are more likely to attend school than to be inactive or to work, as compared to boys who are more distant relatives or unrelated to the head (Case (1999)). **Daughters** of the household head are more likely to attend school than to work, in comparison to other girls in the household.

An additional **infant** in the household increases the probability of boys and girls working relative to being inactive, which is congruent with their role as child minders. It also increases the probability of boys attending school relative to being inactive. This may reflect a birth order effect in favour of the eldest children. The numbers of **male, female** and elderly household members have no significant impact on child time use. This lack of labour substitution between children and adults is not surprising given the age-based labour division observed in Ethiopia, where children specialise in specific activities such as fetching wood/water and herding (see Table 2). However, it does contrast with our finding of perfect substitution between male, female and child work in chapter 4.

Table 7: Odds ratios

	WITHOUT INSTRUMENTS			WITH INSTRUMENTS		
Outcome of interest:	**Work**	**School**	**Work**	**Work**	**School**	**Work**
Reference outcome:	**Inactive**	**Inactive**	**School**	**Inactive**	**Inactive**	**School**
	BOYS					
Log of age	327.86***	881.07***	0.37**	418.54***	1,468.01***	0.29**
Child of head	1.21	2.69***	0.45***	1.01	2.20**	0.46***
#Infants	1.34***	1.28**	1.04	1.33**	1.60***	0.83*
#Females	0.94	0.91	1.03	0.92	1.06	0.87
#Males	1.07	1.06	1.01	1.15	1.55***	0.74***
#Elderly	0.84	1.04	0.80	0.81	1.13	0.71†
#Younger boys	1.05	1.28	0.83*	0.94	1.99***	0.47***
#Younger girls	1.37†	1.62**	0.85	1.22	1.93***	0.63***
#Older boys	0.77**	0.71**	1.08†	0.75**	1.14	0.66**
#Older girls	1.11	1.36*	0.82†	1.17	1.92***	0.61***
Female head	1.05	1.61†	0.65*	1.04	1.93*	0.54**
Age of head	1.00	1.00	1.00	1.00	1.01	0.99
Education of head	0.96	1.11**	0.87***	0.96	1.03	0.93*
Log of income	**1.32***	**1.39***	**0.94**	**1.19**	**18.63*****	**0.06*****
Land owned	**1.03**	**1.01**	**1.01**	**1.04**	**1.01**	**1.03**
Land fertility	**0.97**	**1.24**	**0.79**†	**1.00**	**1.37**†	**0.73***
Land slope	**0.86**	**0.65**†	**1.34**†	**0.87**	**0.73**	**1.20**
Permanent crop	**1.78***	**1.48**	**1.21**	**1.84***	**1.12**	**1.65**†
#Small livestock	**1.02**	**1.02**	**1.00**	**0.88**	**0.81**†	**1.08**
#Ox/bull	**0.83***	**0.96**	**0.86***	**1.39**†	**1.00**	**1.39**†
#Cows	**1.00**	**0.97**	**1.03**	**0.94**	**1.38**†	**0.68****
#Hoes	**1.25***	**1.23**†	**1.02**	**1.22**†	**1.12**	**1.09**
#Ploughs	**0.91**	**1.13**†	**0.80*****	**0.90**	**0.93**	**0.97**
#Sickles	**1.10**	**1.27****	**0.87***	**1.17**†	**1.11**	**1.06**
Minutes to water	**1.00**	**1.00**	**1.01**	**1.01**	**0.99**†	**1.02*****
	GIRLS					
Log of age	316.55***	374.85***	0.84	273.67***	501.79***	0.55
Child of head	0.92	1.44	0.64†	1.21	1.93*	0.63†
#Infants	1.18*	1.11	1.06	1.09	1.39**	0.78**
#Females	1.02	0.90	1.14	0.90	1.09	0.83†
#Males	0.98	0.88	1.11	0.96	1.19	0.81†
#Elderly	1.11	0.86	1.30	1.18	1.40	0.84
#Younger boys	1.42*	1.77***	0.80*	1.32†	2.43***	0.54***
#Younger girls	1.22	1.38†	0.89	1.06	1.57*	0.67**
#Older boys	0.92	0.98	0.94	0.83†	1.40*	0.59***
#Older girls	0.92	0.93	0.99	0.79*	1.22	0.64**
Female head	0.79	1.11	0.71	0.67†	1.33	0.51**
Age of head	0.99	1.02*	0.97**	1.00	1.04**	0.96***
Education of head	0.97	1.15***	0.84***	0.97	1.07	0.91**
Log of income	**1.13**	**1.52****	**0.74****	**0.82**	**16.79*****	**0.05*****
Land owned	**1.00**	**0.90**	**1.11**	**1.00**	**0.89**	**1.12**
Land fertility	**0.95**	**1.51***	**0.63****	**0.99**	**1.58***	**0.63****
Land slope	**1.12**	**0.64**†	**1.74****	**1.15**	**0.73**	**1.58***
Permanent crop	**0.93**	**0.54**†	**1.71**†	**1.03**	**0.47***	**2.18****
#Small livestock	**1.02**	**0.99**	**1.03**	**1.02**	**0.99**	**1.03**
#Ox/bull	**0.92**	**0.97**	**0.95**	**0.76**	**0.69**	**1.10**
#Cows	**0.99**	**1.00**	**0.99**	**1.09**	**1.13**	**0.96**
#Hoes	**1.15**	**1.17**	**0.98**	**1.14**	**1.05**	**1.09**
#Ploughs	**0.98**	**1.06**	**0.93**	**1.05**	**0.95**	**1.11**
#Sickles	**1.05**	**0.98**	**1.07**	**1.00**	**0.88**	**1.14**†
Minutes to water	**1.00**	**0.98***	**1.01**†	**0.99**	**0.97*****	**1.02****

Significant at 20% level: †; 10% level: *; 5% level: **; 1% level: ***.

The results concerning siblings suggest that there are schooling biases in favour of first-borns and boys, and that there may be some labour substitution between children. The likelihood that a child will attend school increases with the presence of **younger siblings**, suggesting a birth order effect. The impact of younger siblings on the probability of a child working is unclear as this increase relative to inactivity but falls with respect to the probability of a child attending school. The presence of **older siblings** has no statistically significant effect on the time use of girls but it does affect the time use of boys. Boys are less likely to attend school as the number of older boys increases, suggesting labour substitution and/or a birth order effect. However, the presence of older girls increases the probability a boy will attend school rather than work or be inactive, perhaps due to a combination of labour substitution and a gender bias in school investments. Note that the importance of these household composition effects constitutes a validation of our missing child labour market hypothesis (Benjamin (1992)).

Let us now turn our attention to the impact of the characteristics of the household head. Children are more likely to attend school in **female-headed households**, although this result is only statistically significant in the case of boys. This may reflect differing gender attitudes or fewer income-earning opportunities in female-headed households[24]. The relative probability of a girl attending school increases with the **head's age**, whereas her probability of working falls. No similar effect is noted for boys. This result may reflect aspects of household wealth not captured by our income variable or growing gender bias among younger household heads. Finally, as found in many other studies, the **education of the head** significantly increases the relative probability of a child attending school and appears to reduce the probability of children working. This may reflect different attitudes of educated heads or unobserved household-specific variables affecting, for example, the returns to schooling.

We have included an **income** variable in the regression despite the obvious dangers of endogeneity. While we will discuss possible instrumentation of this variable further on, it is important here to underline that the presence of this variable in the regression has very little impact on the other coefficients in the regression. It is not surprising to note that income has a positive impact on the relative probability of children attending school. This increased school attendance appears to be the result of reduced inactivity, rather than reduced child work, particularly in the case of boys[25]. Indeed, the impact of income on child work is ambiguous as its probability increases relative to inactivity but falls with respect to child schooling. This ambigu-

[24] Many studies find that female heads educate their children more than male heads. Appleton, Chessa et al. (1999) find, in Uganda, that women also have a stronger gender bias in favour of boys than do men.
[25] Ravallion and Wodon (2000) find a similar result.

ous result comes despite our careful introduction of asset variables to ensure that household income does not proxy for the marginal productivity of children. The endogeneity of household income is one possible explanation. As child work contributes to household income, we might expect that our estimates of the impacts on child work be biased upward[26]. As we will see, when we instrument household income, it is found to clearly reduce the probability of child work. These results suggest that the weak empirical evidence in the literature on the income-child work link is due, not to the omission of asset variables, but rather to the failure to properly account for the endogeneity of income[27].

Now let us turn our attention to our principal preoccupation: the impact of productive assets on child time use. As discussed in the theoretical section, household income and the productivity of children (and adults) both tend to increase as access to productive assets increases. While the income effect will tend to reduce child work in favour of school and leisure activities, the productivity effect will tend to increase child work. The importance of the income effect will depend on the income contribution of the asset itself and on the income elasticity of child time use decisions. The productivity effect, for its part, will depend on the degree of complementarity, or substitutability, between child work and the specific asset. Assets used in activities traditionally performed by children, such as herding, are expected to have a stronger productivity effect on child work than assets used in adult labour-intensive activities, such as farming. For an asset to have a significant effect on child time use decisions, one of the income and productivity effects must strongly dominate. In our analysis, we define assets broadly as all non-labour household production factors. Consequently, we include variables such as land fertility and slope and the proximity to a source of water.

Our results indicate that child time use is sensitive to both income opportunities and poverty constraints, although the effects vary significantly according to the specific asset involved. Note that insignificant coefficients do not necessarily imply the absence of income and productivity effects as they may simply offset each other so that the net effect is insignificant. To examine this proposition, we would need to break down the two effects, which is beyond the scope of our analysis.

Past land redistribution policies have substantially reduced intra-site variation in landholdings, which may explain the lack of statistically significant of it impact**.** When the 15 site dummies are not included in the regression, land ownership has a strong and highly significant positive effect on child work participation. Without a larger sample of villages, we cannot clearly

[26] See chapter 2 of the thesis for an analysis of children's income contributions.

separate the respective role of land ownership and unobserved site characteristics. However, in the sites with the largest landholdings, child work participation is very high and herding is the primary child occupation. Land quality, which increases with **land fertility** and falls with **land slope**, increases the relative probability of children attending school and reduces the probability of children working. As high quality, fertile and flat land is conducive to farming, which primarily draws on adult labour, rather than herding, it is reasonable to expect its positive income effect to dominate.

Households with **permanent crops** are more likely to send their boys to work and are less likely to send their girls to school, relative to having them inactive. This result is somewhat surprising as permanent crops are not particularly labour intensive. This variable may also be proxying some unobserved site variables as permanent crop ownership is concentrated in a few specific sites.

In terms of livestock, only the ownership of **oxen and bulls** appear to be important, reducing the relative probability of boys working due, presumably, to a dominant income effect.

These animals are important stores of wealth in the context of rural Ethiopia. Also, in terms of labour, they are used mostly by male adults for ploughing.

Of the three farm tools analysed, **ploughs and sickles** increase the likelihood of boys attending school and reduces the chances that they work. The ownership of **hoes** appear to increase the probability that a boy will work, although its impact on school attendance is ambiguous. This is not surprising as boys are more likely to work with a hoe than with a plough or sickle. The time use of girls is unaffected by the ownership of farm tools, which reflects their lesser participation in these activities.

As fetching wood/water is the primary work activity of children in rural Ethiopia, an important asset is a nearby source. We find that the relative probability of girls attending school decreases with the **distance (in minutes) to the nearest source of water**[28]. Thus, the digging of wells or better water distribution may increase school attendance.

In the analysis up until here, there is a clear danger that some household asset levels are determined simultaneously with child time use decisions. To some extent this problem is reduced by our use of asset ownership rather than asset use. We also noted that household income is simultaneously determined. To explore these issues, we instrument some of these variables. The most obvious instruments for asset ownership are lagged values. We tried using data on inheritances and dowries but they had practically no explanatory power. Recall data on

[27] See Bhalotra (1999) for a discussion of this issue.

livestock ownership two years earlier were available and had strong explanatory power[29]. Of course, this only reduces rather than totally eliminating the problem of endogeneity. No obvious instruments were found for the other household assets. This is more likely to be a problem for farm tools than for land, as land ownership is essentially fixed. When only livestock are instruments are included, the results (not shown) change very little, although ownership of **small animals** emerges as a positive determinant of the probability of girls working at the 20% significance level[30].

Household income is instrumented with a number of variables reflecting the long-term wealth of the household: value of non-productive assets (jewellery, etc.), number of rooms in house, dummy for material used in walls of house and a subjective question on the household's own perception of its level of wealth. Several other instruments were explored but only these were statistically significant. The instrumenting equation had a R^2 of 0.24 and the Hausman test strongly rejects the hypothesis of exogeneity[31].

The results presented in Table 7 are those obtained when both livestock ownership and household income are instrumented. We note that **income** has a much stronger positive impact on the relative probability of attending school, for both boys and girls. Also, income is found to reduce the probability of a child working relative to attending school or being inactive, although the latter odds ratio is not statistically significant. This supports the finding of Bhalotra (1999) of an upward bias of uninstrumented income coefficients in standard child work studies.

The results for livestock variables change for boys in dramatic and somewhat puzzling ways. **Small livestock** emerges as a negative determinant of school attendance among boys, particularly with respect to inactivity. This is understandable given that herding of small animals is predominantly performed by younger boys, who are more likely to be inactive then to have work as their main activity. Ownership of **cows** appears to reduce labour and increase school attendance among boys, suggesting a predominant income effect. This is a bit surprising when we consider the importance of herding activities for children, but may be due to the role of cows as a store of – and thus a proxy for – household wealth. Most surprising is the clear positive impact of **ox/bull** ownership on the probability of boys working, as boys are not often involved in ploughing.

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[28] Mason and Khandker (1995, p.21-22) find similar results in Tanzania.
[29] R^2=0.55 in the case of oxen/bulls, for example. Full results of the instrumenting equations are available on request.
[30] We were unable to test the exogeneity of these assets as the difference in the covariance matrix was not positive definite as required for the Hausman test.
[31] $Chi^2(79)=254.69$, which is significant at the 1% level.

In terms of household assets, we note that, in the instrumented equations, the **distance to the nearest source of water** emerges more clearly as a positive determinant of child work and as a negative determinant of child schooling. The magnitude and significance of the odds ratios for a number of other variables are also affected by the instrumentation of income in a variety of ways. In particular, we find stronger evidence of labour substitution between children and adults, as the number of adults (**males, females, elderly**) increases the likelihood of children attending school and, in most cases, reduces the likelihood of them working.

5.2 Marginal effects

As discussed earlier, the odds ratio does not measure the absolute impact of explanatory variables on child time use decisions, as they are expressed relative to a base outcome (inactivity in our case). Indeed, we observed many ambiguous results in the discussion above. To eliminate these ambiguities and obtain a direct estimation of the absolute impact of each variable on child time use, we measure the marginal effect of each dependent variable on the probability of a "mean" or "average" child performing each of the main activities (Table 8). Results obtained with instrumented livestock and income are discussed at the end of this section (Table 9).

As mentioned above, given the non-linear nature of the multinomial logit model, marginal effects vary according to the point of evaluation and, consequently, between children. Through experimentation, it becomes clear that marginal effects vary strongly with age. Consequently, for each sex, we calculate marginal effects at three different values: the mean values of the regressors for all children (aged 6 to 15), for young children (aged 6 to 10) and for older children (aged 11 to 15)[32]. This also allows us to look in more detail at the age profile of child time use determinants.

We saw with the odds ratios that the impact of **age** on the probability of a child working is ambiguous. This probability fell with respect to schooling, yet it increased with respect to inactivity. In observing marginal effects, we see that the probability of working unambiguously increases with age among younger children but not older children. The positive impact of age on school attendance is also stronger among younger children. Marginal effects also allow us to

[32] As many of the regressors are closely related to the age of the child – e.g. the number of younger and older siblings – we use the mean values of **all** regressors within each age group and not simply the mean age. There were an insufficient number of observations for carrying out age group-specific regressions for each sex. We also tried including an age group dummy in interaction with various regressors but found that none of these interactive terms was significant. The non-linear nature of the model and the age variable capture most of the age-specific differences.

Table 8: Marginal effects: Without instruments

	WORK			SCHOOL			INACTIVE		
	All	6-10	11-15	All	6-10	11-15	All	6-10	11-15
BOYS									
Log of age	0.202**	0.921***	-0.117	0.270***	0.341***	0.229**	-0.472***	-1.262***	-0.112***
Child of head	-0.107**	-0.026	-0.154***	0.136***	0.098***	0.161***	-0.03†	-0.072	-0.008†
#Infants	0.023†	0.053***	0.011	-0.001	0.007	-0.006	-0.022***	-0.060***	-0.005**
#Females	0.001	-0.008	0.005	-0.006	-0.006	-0.007	0.006	0.015	0.001
#Males	0.006	0.012	0.003	-0.001	0.001	-0.002	-0.005	-0.014	-0.001
#Elderly	-0.044	-0.047	-0.046	0.034	0.018	0.044	0.010	0.029	0.002
#Younger boys	-0.025	-0.005	-0.037*	0.033*	0.024*	0.039*	-0.008	-0.019	-0.002
#Younger girls	-0.005	0.043	-0.028	0.033*	0.031**	0.035†	-0.028*	-0.074*	-0.007*
#Older boys	-0.004	-0.039†	0.012	-0.018	-0.019	-0.017	0.022**	0.058**	0.005**
#Older girls	-0.024	0.003	-0.038†	0.036†	0.027*	0.041†	-0.012	-0.030	-0.003
Female head	-0.062†	-0.024	-0.084†	0.073*	0.051*	0.087*	-0.011	-0.027	-0.003
Age of head	0.000	0.001	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
Education of head	-0.023***	-0.017*	-0.028***	0.023***	0.014***	0.028***	0.000	0.003	0.000
Log of income	0.008	0.043†	-0.008	0.015	0.017	0.013	-0.023**	-0.060**	-0.005**
Land owned	0.004	0.006	0.003	-0.002	0.000	-0.003	-0.002	-0.005	0.000
Land fertility	-0.037	-0.022	-0.047†	0.04†	0.026†	0.048†	-0.002	-0.004	-0.001
Land slope	0.034	-0.004	0.055†	-0.051†	-0.039*	-0.059†	0.017	0.042	0.004
Permanent crop	0.063	0.113*	0.045	-0.021	0.002	-0.035	-0.042†	-0.115†	-0.01†
#Small livestock	0.001	0.004	0.000	0.000	0.001	0.000	-0.002	-0.004	0.000
#Ox/bull	-0.033**	-0.043**	-0.032*	0.022†	0.010	0.029*	0.012†	0.033†	0.003†
#Cows	0.004	0.002	0.005	-0.005	-0.003	-0.005	0.000	0.001	0.000
#Hoes	0.016	0.04†	0.007	0.001	0.007	-0.003	-0.017*	-0.046*	-0.004†
#Ploughs	-0.039**	-0.033†	-0.045***	0.035***	0.021***	0.044***	0.004	0.012	0.001
#Sickles	-0.016	0.006	-0.027*	0.026**	0.020**	0.029*	-0.01†	-0.026	-0.002†
Minutes to water	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000
GIRLS									
Log of age	0.390***	1.133***	0.065	0.067	0.129***	0.034	-0.457***	-1.262***	-0.099***
Child of head	-0.043†	-0.033	-0.053†	0.041†	0.025†	0.053†	0.002	0.008	0.000
#Infants	0.017†	0.036*	0.010	-0.004	0.000	-0.007	-0.013*	-0.036*	-0.003†
#Females	0.012	0.009	0.015	-0.012	-0.007	-0.015	-0.001	-0.002	0.000
#Males	0.007	0.000	0.012	-0.010	-0.007	-0.012	0.003	0.007	0.001
#Elderly	0.029	0.030	0.031	-0.023	-0.013	-0.030	-0.006	-0.017	-0.001
#Younger boys	0.006	0.06†	-0.021†	0.024**	0.021**	0.027*	-0.030**	-0.081*	-0.006**
#Younger girls	0.004	0.035	-0.011	0.013	0.011	0.015	-0.017	-0.046	-0.004
#Older boys	-0.011	-0.019	-0.009	0.005	0.002	0.008	0.006	0.017	0.001
#Older girls	-0.007	-0.018	-0.002	0.000	-0.001	0.001	0.007	0.019	0.001
Female head	-0.045†	-0.060	-0.043	0.030	0.016	0.040	0.016	0.044	0.003
Age of head	-0.003**	-0.002	-0.003**	0.003**	0.002**	0.003**	0.000	0.001	0.000
Education of head	-0.017***	-0.013†	-0.020***	0.016***	0.010***	0.020***	0.001	0.004	0.000
Log of income	-0.017	0.012	-0.033*	0.029*	0.020**	0.036*	-0.012	-0.032	-0.003
Land owned	0.009	0.005	0.012	-0.010	-0.006	-0.013	0.001	0.002	0.000
Land fertility	-0.042*	-0.028	-0.054**	0.042**	0.027**	0.054**	0.000	0.001	0.000
Land slope	0.054**	0.043	0.066**	-0.050**	-0.031**	-0.065**	-0.004	-0.012	-0.001
Permanent crop	0.040	0.007	0.061†	-0.05†	-0.034†	-0.064†	0.010	0.026	0.002
#Small livestock	0.004*	0.006†	0.004†	-0.003	-0.001	-0.003	-0.002	-0.005	0.000
#Ox/bull	-0.010	-0.018	-0.007	0.004	0.002	0.006	0.006	0.016	0.001
#Cows	-0.002	-0.002	-0.001	0.001	0.000	0.001	0.001	0.002	0.000
#Hoes	0.008	0.026	0.000	0.003	0.004	0.002	-0.011	-0.030	-0.002
#Ploughs	-0.007	-0.006	-0.009	0.006	0.004	0.008	0.001	0.002	0.000
#Sickles	0.009	0.012	0.009	-0.006	-0.003	-0.008	-0.003	-0.009	-0.001
Minutes to water	0.001	0.000	0.002†	-0.001*	-0.001*	-0.002†	0.000	0.001	0.000

Notes: 6-10=children aged 6-10 years; 11-15=children aged 11-15 years.

establish that, in addition to being more likely to attend school, **sons of the household head** are less likely to work, particularly if they are older.

The presence of **infants** is shown to increase work primarily among younger kids, which reflects the importance of child minding activities for them (see Table 2). As we saw with the odds ratio, the numbers of **males**, **females** and **elderly** household members have no significant effect on child time use.

The presence of **younger siblings** unambiguously increases school attendance but has an ambiguous impact on child work according to the odds ratio. Marginal effects establish that the presence of younger boys reduces the probability of working among older boys and girls, suggesting labour substitution and a birth order effect. However, the presence of younger boys increases work among younger girls, perhaps due to gender bias. The number of younger girls has no significant work effects. **Older siblings** do not influence the time use of girls. Older boys reduce work among younger boys whereas older girls reduce work among older boys.

Marginal effects confirm the positive schooling effect of **female-headed households**. They also clarify the ambiguity of their work effect, indicating that children are less likely to work in these households, although this result is only significant for boys. The **age of the household head** is confirmed as a positive influence on girls' schooling and a negative influence on girls' work. Furthermore, **education of the household head** clearly emerges as reducing child work and increasing child schooling.

Household income unambiguously reduces child inactivity. It also appears to increase school attendance, although this impact is only significant for girls. However, its impact on child work remains far from clear, varying from negative for older girls to positive for younger boys with insignificant impacts on older boys and younger girls.

Let us now consider the marginal effects of household assets. **Land ownership** remains insignificant when site variables are not excluded. **Land quality** is confirmed as a positive determinant of child schooling and a negative determinant of child work. The results for **permanent crops** are of weak statistical significance but suggest that these crops are negatively related to child schooling and positively related to child work. **Oxen ownership** clearly reduces child work among boys, in favour of schooling for older boys and inactivity among younger boys. The impacts on girls and the impacts of **small animal** and **cow** ownership on all children are statistically insignificant. Finally, the ownership of **ploughs and sickles** clearly increase school attendance. The **distance to the nearest source of water** reduces school attendance among girls. All of these results suggest that asset ownership acts on child time use primarily through a positive income effect, increasing school attendance and reducing child work.

The instrumenting of livestock and income variables has a few notable consequences (Table 9). **Income** emerges as a strong positive determinant of child schooling and as an

Table 9: Marginal effects: Instrumented income and livestock

	WORK			SCHOOL			INACTIVE		
	All	**6-10**	**11-15**	**All**	**6-10**	**11-15**	**All**	**6-10**	**11-15**
				BOYS					
Log of age	0.083	0.834***	-0.226*	0.403***	0.495***	0.340***	-0.486***	-1.330***	-0.114***
Child of head	-0.142**	-0.071	-0.181***	0.162***	0.113***	0.186***	-0.019	-0.042	-0.006
#Infants	-0.019	0.027	-0.040*	0.045**	0.042***	0.046**	-0.026***	-0.069***	-0.006***
#Females	-0.031	-0.027	-0.034	0.028	0.016	0.034	0.003	0.011	0.001
#Males	-0.048**	-0.006	-0.068**	0.066***	0.051***	0.073***	-0.018*	-0.044*	-0.004*
#Elderly	-0.072†	-0.064	-0.08†	0.064	0.037	0.078†	0.008	0.027	0.001
#Younger boys	-0.141***	-0.080**	-0.175***	0.154***	0.105***	0.179***	-0.013	-0.025	-0.004
#Younger girls	-0.073**	-0.011	-0.104***	0.099***	0.076***	0.110***	-0.026†	-0.065†	-0.007*
#Older boys	-0.091***	-0.084***	-0.100**	0.080**	0.046*	0.098**	0.012	0.038†	0.002
#Older girls	-0.082**	-0.020	-0.112***	0.105***	0.079***	0.118***	-0.024**	-0.059**	-0.006**
Female head	-0.111**	-0.051	-0.143**	0.129**	0.091**	0.148**	-0.018	-0.040	-0.005
Age of head	-0.002	-0.001	-0.003	0.003	0.002	0.003	0.000	-0.001	0.000
Education of head	-0.014*	-0.012	-0.016*	0.013†	0.008†	0.016*	0.001	0.004	0.000
Log of income	**-0.492*** **	**-0.225*** **	**-0.633*** **	**0.571*** **	**0.405*** **	**0.655*** **	**-0.079*** **	**-0.180*** **	**-0.022*** **
Land owned	**0.007**	**0.008**	**0.006**	**-0.004**	**-0.002**	**-0.006**	**-0.002**	**-0.006**	**0.000**
Land fertility	**-0.057†**	**-0.029**	**-0.073***	**0.065***	**0.045***	**0.075***	**-0.008**	**-0.017**	**-0.002**
Land slope	**0.026**	**-0.005**	**0.040**	**-0.040**	**-0.033**	**-0.043**	**0.015**	**0.038**	**0.004**
Permanent crop	**0.122***	**0.142** **	**0.121†**	**-0.088**	**-0.040**	**-0.114†**	**-0.034†**	**-0.102†**	**-0.007**
#Small livestock	**0.008**	**-0.013**	**0.017**	**-0.020**	**-0.018†**	**-0.020**	**0.012†**	**0.031†**	**0.003†**
#Ox/bull	**0.078***	**0.082***	**0.080***	**-0.061†**	**-0.031**	**-0.077†**	**-0.017**	**-0.052**	**-0.003**
#Cows	**-0.075** **	**-0.046**	**-0.091** **	**0.079** **	**0.053** **	**0.093** **	**-0.004**	**-0.007**	**-0.002**
#Hoes	**0.026**	**0.039†**	**0.022**	**-0.013**	**-0.002**	**-0.019**	**-0.013**	**-0.037†**	**-0.003**
#Ploughs	**-0.012**	**-0.020**	**-0.009**	**0.005**	**-0.001**	**0.007**	**0.007**	**0.020**	**0.002**
#Sickles	**0.018**	**0.03†**	**0.015**	**-0.008**	**0.000**	**-0.012**	**-0.010**	**-0.030**	**-0.002**
Minutes to water	**0.003*** **	**0.003** **	**0.004*** **	**-0.003*** **	**-0.002** **	**-0.004*** **	**0.000**	**-0.001**	**0.000**
				GIRLS					
Log of age	0.338***	1.070***	-0.006	0.148**	0.209***	0.112	-0.486***	-1.279***	-0.106***
Child of head	-0.037	0.014	-0.067†	0.059*	0.042*	0.072†	-0.022	-0.056	-0.005
#Infants	-0.020	0.005	-0.035*	0.031**	0.021**	0.038**	-0.011	-0.027	-0.002
#Females	-0.028†	-0.030	-0.03†	0.022	0.012	0.029†	0.007	0.019	0.001
#Males	-0.025†	-0.017	-0.031†	0.025†	0.015†	0.031†	0.000	0.002	0.000
#Elderly	-0.006	0.024	-0.023	0.023	0.018	0.026	-0.016	-0.042	-0.004
#Younger boys	-0.045*	0.025	-0.086***	0.077***	0.055***	0.094***	-0.032*	-0.081*	-0.007**
#Younger girls	-0.039†	-0.008	-0.058**	0.049**	0.032**	0.061**	-0.010	-0.024	-0.002
#Older boys	-0.070***	-0.062**	-0.081***	0.061**	0.035**	0.079***	0.009	0.027	0.002
#Older girls	-0.065**	-0.069**	-0.069**	0.050**	0.027*	0.067**	0.015	0.041†	0.003
Female head	-0.102**	-0.111*	-0.108**	0.077**	0.041†	0.103**	0.025	0.070	0.005
Age of head	-0.005***	-0.003	-0.006***	0.005***	0.003***	0.006***	0.000	0.000	0.000
Education of head	-0.012*	-0.010	-0.015**	0.011**	0.007**	0.014**	0.001	0.003	0.000
Log of income	-0.340***	-0.185**	-0.452***	0.363***	0.228***	0.459***	-0.023	-0.043	-0.007
Land owned	0.012	0.005	0.017	-0.014	-0.009	-0.018	0.002	0.004	0.000
Land fertility	-0.050*	-0.024	-0.069**	0.056**	0.036**	0.071**	-0.006	-0.012	-0.002
Land slope	0.059*	0.049	0.070*	-0.054†	-0.031†	-0.069*	-0.006	-0.018	-0.001
Permanent crop	0.087*	0.044	0.117**	-0.094**	-0.060**	-0.119**	0.008	0.015	0.002
#Small livestock	0.005	0.006	0.005	-0.003	-0.002	-0.005	-0.002	-0.004	0.000
#Ox/bull	-0.009	-0.048	0.011	-0.016	-0.016	-0.016	0.024	0.064	0.005
#Cows	0.002	0.014	-0.004	0.005	0.005	0.006	-0.007	-0.020	-0.002
#Hoes	0.018	0.030	0.014	-0.008	-0.003	-0.012	-0.010	-0.027	-0.002
#Ploughs	0.015	0.015	0.016	-0.012	-0.007	-0.016	-0.003	-0.008	-0.001
#Sickles	0.014	0.006	0.020	-0.016†	-0.010	-0.02†	0.002	0.004	0.000
Minutes to water	0.002*	0.000	0.004**	-0.003**	-0.002**	-0.004**	0.001†	0.002†	0†

Notes: 6-10=children aged 6-10 years; 11-15=children aged 11-15 years.

equally strong negative determinant of child work. This suggests that failure to instrument this variable may explain many of the ambiguous results obtained in other studies. The negative

impact of **small animal ownership** on school attendance is restricted to younger boys, as we expected given that these are the children who do most of the herding. Note that it appears that this workload is sufficient to draw children out of school but not to make work their main activity. Ownership of **cows** increase boy schooling and reduce their workload, presumably due to a dominant income effect. Once again, we see the puzzling positive effect of **oxen** ownership on the probability of boys working and a corresponding negative impact on their likelihood of attending school.

We also note that the child-**adult** labour substitution results observed in the odds ratio apply primarily to older children, as could be expected. Marginal effects also suggest clear work substitution among children as the **numbers of siblings**, regardless of age or sex, increase (reduce) the likelihood of a child attending school (work).

5.3 Predicted probabilities

The analysis up until now has focused on the direction of impacts but not their magnitude. Without this information it is difficult to fully appreciate the roles of each determinant or to identify which are the most important determinants. Indeed, marginal effects depend on the unit used to measure the explanatory variable. If distance to water were expressed in hours instead of minutes, the marginal effect (of an additional unit) would be 60 times bigger. More generally, the importance of variables with low mean values (Table 6) is exaggerated by marginal effect measures alone.

However, in determining the importance of determinants, we must also take into account their sample variability. The larger is this variability, the bigger the role the variable will play in determining child time use decisions. To take this fact into account we measure the change in the predicted probability of a child performing each of the three main activities when the value of a given variable increases by one standard deviation relative to its mean value[33]. In the cases of dummy variables – child of head (dumkid), female head and permanent crops – we look at the change in probability when the dummy goes from zero to one.

The descriptive statistics presented in Table 6 indicate that the dispersion of the explanatory variables can be quite large. Variables with particularly high standard deviations, relative to their respective means, include the education of the household head; the numbers of small animals, hectares of land and tools owned by the household, and the numbers of siblings and elderly. Land quality variables have the smallest dispersion.

[33] Behrman and Knowles (2000) use this approach to study income effects on child schooling in Vietnam.

Ignoring the dummy variables for the moment, the **education of the household head** emerges as the single most important determinant of child time use (
Table 10). A standard deviation increase in the education of the household head - roughly two and a half more years of schooling - reduces the probability of a child working and increase the child's likelihood of attending school by 3 to 9 per cent, depending on the child's age group and sex. Household **income**, in contrast, is shown to have very mild effects.

Table 10: Standardised predicted probabilities: Without instruments
(Variation following a one standard deviation increase in each explanatory variable

	BOYS						GIRLS					
	Work			School			Work			School		
	All	6-10	11-15	All	6-10	11-15	All	6-10	11-15	All	6-10	11-15
Age	0.5	11.1	-1.5	6.0	5.3	2.3	5.3	14.9	0.5	1.2	1.8	0.3
# Infants	2.4	5.5	1.2	-0.2	0.7	-0.7	1.7	3.8	0.9	-0.5	0.0	-0.7
# Females	0.1	-0.8	0.5	-0.6	-0.6	-0.7	1.1	0.9	1.4	-1.1	-0.7	-1.4
# Males	0.6	1.2	0.3	-0.1	0.1	-0.2	0.7	-0.1	1.2	-0.9	-0.6	-1.2
# Elderly	-2.4	-2.5	-2.7	1.9	1.0	2.5	1.5	1.6	1.8	-1.2	-0.7	-1.7
# Younger boys	-2.1	-0.3	-3.6	2.7	1.2	3.8	0.1	3.2	-2.2	2.1	1.2	2.8
# Younger girls	-0.7	2.0	-2.7	2.6	1.7	3.3	0.2	1.7	-1.1	1.0	0.6	1.4
# Older boys	-0.5	-3.7	0.5	-1.4	-1.7	-0.8	-0.9	-1.8	-0.4	0.4	0.2	0.4
# Older girls	-2.1	0.0	-1.8	3.0	2.6	1.9	-0.6	-1.6	-0.1	0.0	-0.1	0.0
Age of head	0.6	1.1	0.5	-0.3	0.0	-0.4	-4.3	-3.1	-5.4	4.1	2.5	5.3
Education of head	-6.8	-4.7	-8.4	6.8	4.3	8.5	-5.0	-3.8	-6.1	4.8	3.0	6.0
Income	**0.4**	**2.8**	**-0.5**	**1.0**	**1.2**	**0.8**	**-1.3**	**0.6**	**-2.5**	**2.1**	**1.5**	**2.7**
Land owned	**1.0**	**1.2**	**0.9**	**-0.5**	**-0.1**	**-0.8**	**3.0**	**1.7**	**3.5**	**-3.2**	**-2.2**	**-3.6**
Land fertility	**-2.6**	**-1.5**	**-3.3**	**2.8**	**1.8**	**3.3**	**-3.0**	**-1.9**	**-3.9**	**3.1**	**1.9**	**4.0**
Land slope	**1.5**	**-0.3**	**2.6**	**-2.3**	**-1.7**	**-2.8**	**2.5**	**2.0**	**3.0**	**-2.3**	**-1.4**	**-3.0**
# Small animals	**0.9**	**2.3**	**0.2**	**0.2**	**0.5**	**0.0**	**2.7**	**4.0**	**2.5**	**-1.7**	**-0.9**	**-2.3**
# Bull/oxen	**-5.6**	**-6.5**	**-5.8**	**3.6**	**1.4**	**5.3**	**-1.6**	**-2.7**	**-1.2**	**0.7**	**0.2**	**1.0**
# Cows/calves	**1.3**	**0.7**	**1.6**	**-1.4**	**-1.0**	**-1.6**	**-0.5**	**-0.7**	**-0.4**	**0.3**	**0.1**	**0.4**
# Hoes	**1.6**	**4.1**	**0.7**	**0.0**	**0.6**	**-0.3**	**0.7**	**2.3**	**0.0**	**0.3**	**0.4**	**0.3**
# Ploughs	**-6.2**	**-3.2**	**-9.7**	**5.8**	**2.1**	**9.6**	**-1.0**	**-0.7**	**-1.3**	**0.9**	**0.5**	**1.3**
# Sickles	**-2.9**	**0.5**	**-4.7**	**4.4**	**3.4**	**5.1**	**1.3**	**1.6**	**1.4**	**-0.9**	**-0.4**	**-1.3**
Minutes to water	**2.4**	**2.3**	**2.5**	**-2.0**	**-1.2**	**-2.5**	**1.2**	**-0.6**	**2.3**	**-1.9**	**-1.3**	**-2.5**
Dummies (percentage variation in predicted probabilities when the dummy goes from 0 to 1)												
Child of head	-8.7	-1.0	-13.6	11.6	7.9	14.4	-3.9	-3.2	-4.8	3.6	2.2	4.8
Female head	-6.7	-2.9	-8.9	7.9	5.7	9.2	-4.8	-6.1	-4.7	3.2	1.7	4.3
Permanent crop	**6.5**	**11.5**	**4.5**	**-2.0**	**0.3**	**-3.5**	**4.3**	**1.0**	**6.5**	**-5.4**	**-3.7**	**-6.7**

Among household assets, ownership of **oxen** and **ploughs** strongly increase the schooling of boys while substantially reducing their chance of working. **Land quality** surfaces as a moderately strong positive determinant of school attendance and negative determinant of labour participation, whereas **land area** has the opposite effects. The strongest factors influencing the labour participation of young girls are quite different from older girls. A one standard deviation increase in the number of **younger boys**, **infants** and **small animals** are all shown to increase labour participation among young girls by 3 to 4 per cent. This reflects a possible gender bias

and the importance of girls' child minding and herding tasks. **Infants** also increase child work among younger boys. The other variables have weaker impacts.

Among the dummy variables, being the **child of the household head** strongly increases the likelihood of attending school and not working. This is particularly true for older boys, among whom sons of the head are 14.4% more likely to attend school and 13.6% less likely to work. This apparent discrimination in favour of own children can be explained either by preferences or by a smaller commitment problem with regards to the eventual returns to the schooling investment[34]. Children from **female-headed household** are up to 8.9% less likely to work and up to 9.2% more likely to attend school. Finally, household ownership of **permanent crops** has quite different effects according to the age and sex of the child. Whereas young boys experience a 12% increase in their likelihood of working, the effect on young girls is negligible (0.2%).

Use of livestock and income instruments modifies some of these results, particularly among boys (Table 11). Income becomes a hugely important determinant of child time use. A standard deviation increase in **income** – which roughly represents a doubling of mean income – generates a 40% increase in the probability that a child will attend school and a corresponding 40% reduction in his/her likelihood of working. The impact of **cow ownership** closely follows that of household income of boys, with similar magnitudes. This result may be explained by the fact that cows are an important stock of wealth. A standard deviation increase in **small animal** ownership reduces the probability of boys attending school by more than 10 per cent. Oddly, it also reduces the probability of working among younger boys, suggesting that herding might be a predominantly part-time activity; sufficient to conflict with schooling but not to become the child's main activity. Finally, a standard deviation increase in the number of younger boys raises the chances of an older boy attending school by roughly 20 per cent and commensurately reduces the likelihood of him working.

6. Conclusion

In conclusion, our analysis indicates that most household assets act on child time use decisions primarily by reducing poverty constraints and thus contribute to reducing child work (e.g. land fertility, oxen, ploughs and proximity to water) and/or increasing school attendance (e.g. land quality, ploughs, proximity to water). These results suggest that as rural Ethiopian households increase their access to these assets, they are likely to use the resulting income to send children to school or withdraw them from child work activities.

[34] See Baland and Robinson (1998) for a discussion, and model, of the commitment problem.

Table 11: Standardised predicted probabilities: With instruments
(Variation following a one standard deviation increase in each explanatory variable

	BOYS						GIRLS					
	Work			School			Work			School		
	All	6-10	11-15	All	6-10	11-15	All	6-10	11-15	All	6-10	11-15
Age	-2.5	9.2	-2.5	9.0	7.8	3.4	3.8	14.0	-0.3	3.1	3.2	1.1
# Infants	-3.0	3.3	-8.5	5.5	3.2	9.2	-2.2	0.6	-3.9	3.3	2.2	4.1
# Females	-3.3	-1.7	-7.2	3.0	0.1	7.3	-2.6	-2.7	-3.2	2.0	0.8	3.1
# Males	-5.6	-0.1	-11.4	7.4	3.7	11.9	-2.4	-1.5	-3.5	2.3	1.2	3.5
# Elderly	-4.3	-2.5	-8.4	3.9	0.5	8.5	-0.2	1.5	-1.5	1.0	0.7	1.7
# Younger boys	-12.5	-3.4	-20.9	13.8	4.2	21.5	-4.7	1.2	-9.8	7.1	3.2	10.4
# Younger girls	-6.7	0.1	-13.8	8.6	2.7	14.4	-3.2	-0.3	-6.1	3.9	1.4	6.3
# Older boys	-7.8	-6.8	-8.5	7.0	2.7	8.5	-6.1	-5.8	-4.3	5.5	3.5	4.2
# Older girls	-7.5	-1.7	-9.0	9.4	6.4	9.4	-5.2	-6.0	-3.0	4.1	2.3	2.9
Age of head	-3.5	-0.5	-7.9	4.0	1.1	8.2	-6.9	-3.8	-9.5	7.3	4.4	9.6
Education of head	-4.2	-2.4	-8.3	3.9	0.6	8.4	-3.1	-2.4	-4.1	2.8	1.5	4.0
Income	**-38.4**	**-24.5**	**-41.1**	**43.8**	**40.2**	**42.4**	**-36.6**	**-20.0**	**-45.8**	**40.4**	**29.0**	**46.7**
Land owned	**1.5**	**2.5**	**-1.6**	**-0.9**	**-1.8**	**1.9**	**4.2**	**2.0**	**4.9**	**-4.8**	**-3.4**	**-5.0**
Land fertility	**-4.2**	**-1.1**	**-8.7**	**4.8**	**1.6**	**9.0**	**-3.4**	**-1.4**	**-5.1**	**3.8**	**2.2**	**5.2**
Land slope	**0.9**	**0.4**	**-1.7**	**-1.6**	**-2.8**	**1.6**	**3.0**	**2.6**	**3.3**	**-2.7**	**-1.7**	**-3.2**
# Small animals	**0.2**	**-13.1**	**7.1**	**-12.1**	**-10.5**	**-10.4**	**3.5**	**4.4**	**3.2**	**-2.5**	**-1.4**	**-3.0**
# Bull/oxen	**11.2**	**12.6**	**9.8**	**-8.7**	**-5.5**	**-9.1**	**-2.0**	**-7.6**	**1.3**	**-2.6**	**-2.4**	**-2.5**
# Cows/calves	**-26.9**	**-16.8**	**-31.5**	**29.4**	**21.3**	**32.2**	**0.6**	**4.3**	**-1.4**	**1.4**	**1.3**	**1.8**
# Hoes	**2.4**	**4.9**	**-1.4**	**-1.1**	**-1.7**	**1.7**	**2.0**	**2.9**	**1.3**	**-1.0**	**-0.6**	**-1.1**
# Ploughs	**-2.0**	**-1.1**	**-5.5**	**1.0**	**-1.5**	**5.3**	**2.1**	**1.9**	**2.3**	**-1.7**	**-1.0**	**-2.2**
# Sickles	**2.6**	**5.3**	**-1.2**	**-1.0**	**-1.5**	**1.7**	**2.2**	**1.0**	**2.9**	**-2.4**	**-1.6**	**-3.0**
Minutes to water	**6.1**	**5.8**	**3.7**	**-5.8**	**-5.0**	**-3.6**	**3.0**	**-0.2**	**4.9**	**-4.3**	**-2.9**	**-5.2**
Dummies (percentage variation in predicted probabilities when the dummy goes from 0 to 1)												
Child of head	-12.7	-5.4	-17.6	14.4	8.8	18.2	-2.9	2.0	-6.0	5.2	3.5	6.6
Female head	-12.1	-5.6	-14.9	13.9	9.8	15.4	-11.2	-11.3	-12.2	8.8	4.5	11.7
Permanent crop	**12.4**	**14.2**	**12.4**	**-8.9**	**-3.6**	**-11.8**	**9.3**	**4.7**	**12.5**	**-10.1**	**-6.5**	**-12.7**

The worrying exceptions, where the income opportunities provided by asset ownership appear to dominate, concern hoes (boys only), small animals and permanent crops, which increase the relative probability of children working rather than attending school. Also, results obtained without site variables suggest that land ownership may increase child work and reduce schooling due to the specialisation of children in land-intensive herding activities. Generally speaking, access to assets that are used in child work activities (complements to child work) is more likely to increase child work and less likely to increase child schooling. Income is found to have a clear positive impact on child schooling and, when it is instrumented, a negative effect on child work.

We also find a tight relationship between child work and school participation with respect to physical assets. For practically all of the explanatory variables, the sign of the labour and

schooling effects are opposite and often of similar magnitude. Thus, it appears that policies aimed at combating child work will simultaneously encourage schooling and vice versa[35].

Our results suggest that poverty alleviation efforts should aim to improve access to physical assets - such as bulls, oxen, ploughs, nearby sources of water and land fertility - that increase household income without encouraging child work.

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[35] See Ravallion and Wodon (2000) for a study arguing the contrary.

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