Income Contributions of Child Work in Rural Ethiopia*

John Cockburn†

The contribution of child work to household income is undoubtedly a key factor influencing the decision to put children to work and a key factor to consider in designing policies to reduce child work and increase child schooling. While some studies examine children's labour "contribution" in terms of the number of hours they work, very few attempt to directly measure the income contribution of children. Furthermore, estimations of children's income contribution are practically inexistent where, as is the case for the vast majority of child workers, work is performed within the household, rather than for wages. In this study, we estimate a household income function with child labour included as an input. Results using a variety of functional forms (Cobb-Douglas, translog, Generalised Leontief, Generalised Cobb-Douglas and CES) and alternative child labour variables are compared. We conclude that children and adults are perfect labour substitutes and that the marginal productivity of children is roughly one-third to one-half that of male adults. The total income contribution of each working child is estimated to be equal to roughly 4-7% of household income, although there is substantial variation between households with values of this total contribution ranging up to 50%. These results underline the dependency of poor households on child work for survival.

3 October, 2001

Keywords: child labour, schooling, Ethiopia, household production

JEL: D13, J13, J22, O15, Q12

---

* I would like to acknowledge financial support from the SSHRC, the Commonwealth Scholarship Program, DFID, the ORS Awards Scheme and Nuffield College. I am very grateful to Marcel Fafchamps, Bernard Fortin, Pramila Krishnan, John Muellbauer and Francis Teal for their assistance and suggestions. All errors and omissions are my own responsibility.

† Centre for the Study of African Economies and Nuffield College (Oxford University) and CREFA, jcoc@ecn.ulaval.ca

1. Introduction

One of the principal factors in deciding to put children to work is presumably the amount of income this work generates directly or indirectly. Therefore, to understand and ultimately influence child work and schooling decisions, it is important to have an accurate evaluation of the magnitude of these child income contributions and their determinants. Knowledge of children's income contributions is also crucial to determine the level of compensation required in income-based policies to reduce child work and encourage school attendance. Finally, this information will provide us with an idea of the total short-term cost for the economy of reducing child work to be weighed against the long-term benefits of increased schooling. Yet there are few studies on this issue in the literature, particularly for work performed by children within the household, which is by far the most common form of child work[1].

Where children have the option of working in the labour market, we might assume that the child wage rate provides an accurate measure of children's income contribution and that this income contribution would vary little between children. However, smoothly functioning child labour markets rarely exist. In their absence, a child's income contribution depends on his labour productivity in household activities, which likely vary substantially according to the household's asset profile, demographic composition and other characteristics[2]. In the preceding chapter, household production characteristics (composition, assets, etc.) are shown to have strong impacts on child time use in rural Ethiopia, presumably through their effects on the returns to child work and on household income[3]. In this paper, we estimate the income contribution of children and analyse its determinants among rural Ethiopian households[4].

Ethiopia is a country of extremes and, as such, may bring out more clearly the ways in which children contribute to household income in poor countries in general. The second poorest nation in the World (GNP per capita = $US 100), it also has the third highest fertility rate (seven

---

[1] According to the World Bank (1999), "the typical child laborer works on family-owned farms or in family-owned stores – three-quarters of child laborers work in family owned enterprises" (p.3).

[2] Mueller (1984) concludes that in rural Botswana, "the more productive capital the household has, the more productive work its members perform, particularly its children" (abstract). Cain (1977) argues, in the context of a Bangladeshi village, that "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).

[3] Further evidence of the importance of household asset ownership in child work and schooling decisions is provided in Bhalotra and Heady (1998), Canagarajah and Coulombe (1997), De Tray (1983), Levison and Moe (1998), Mergos (1992), Mueller (1984) and Rosenzweig and Evenson (1977), among others.

[4] We do not address the question of children's income transfers to parents when they become adults. See De Vos (1985), Fure (1983), Hoddinott (1992) and Vlassoff and Vlassoff (1980), among others, for studies on this issue.

children per woman) and the lowest school enrolment rates (24% net primary school enrolment rate)[5]. Variations in rainfall can be dramatic, even within regions. Famines, a lengthy and ruinous civil war ending in 1991 and recent conflict with Eritrea further exacerbate the climate of uncertainty and vulnerability. Most of these problems are even more acute in rural areas. Although separating cause from effect is difficult, they are almost surely related to another remarkable characteristic of Ethiopia, particularly rural Ethiopia: the highest incidence of child work in the World (42% full-time productive labour participation)[6].

A survey of the literature on children's economic contributions is presented in section 2. The theory underlying our analysis is presented in section 3 and the estimation strategy is outlined in section 4. The results of the analysis are presented and discussed in section 5. Section 6 presents the conclusions and suggestions for further research.

2. Survey of the literature

The literature on children's economic contributions has emerged primarily in the context of fertility and child time use analysis. In his seminal study, Caldwell (1977) argues that high fertility may be an economically rational decision where the income contribution of children exceeds their costs. Rosenzweig (1978) concludes, "in geographical areas where child wage rates and earnings are high, parents appear to raise more children and to school them less" (p.344). Cain (1977) notes that the total income contribution of a child over his/her childhood depends on the age he/she begins working, the amount he/she works and the returns to his/her work (wages paid or labour productivity.) Most studies of children's contributions limit their analysis to the first two factors: starting age and amount worked[7].

Cain, in perhaps the most detailed description of the types of economic activities performed by children in rural households, discusses the age children begin different types of work. Although his analysis is based on a village in rural Bangladesh, the profile he portrays is similar to that reported elsewhere[8]. He finds that "children of both sexes begin their economically useful lives around age 6, performing such tasks as gathering fuel, fetching water, carrying messages, and caring for younger children" (p.212). He underlines the sexual division of labour even among children, with girls specialising in domestic activities and boys in herding and agricultural

---

[5] World Bank (1998).

[6] ILO (1995) and ILO (1996) provide overviews of child work in Ethiopia. As the ILO definition excludes domestic work, actual labour participation rates are much higher, particularly in rural areas. In our sample of 1477 rural Ethiopian households, 60% of all children, and up to 80% of 11-15 year old girls, have work as their main activity.

[7] See De Tray (1983).

[8] See Caldwell (1977), De Tray (1983).

production activities. He also notes that as children grow older they evolve into different activities requiring increasing physical and mental development. For example, "boys assume responsibility for the care of cattle around age 8 or 9… (and they) begin agricultural work at approximately age 11" (p.212). Girls "begin to participate in most rice processing and food preparation activities between ages 9 and 10" (p.213).

In terms of the amount children work, Cain finds that by age 13-15, children work as long hours (roughly nine hours per day) as adults. Even seven-to-nine year old children work an average of five hours per day and four-to-six year olds roughly two hours per day. He separates children's economic activities into "productive" and "enabling" labour. Productive labour includes activities such as agricultural work and herding that directly contribute to household income. Enabling labour includes activities such as domestic work, fuel and water collection, and child minding. Although it does not directly generate income, enabling labour frees up other household members to perform productive work. Cain finds that the majority of work is "productive" in the case of boys, whereas girls devote most of their working time to "enabling" labour.

The returns to child work are the most difficult, and least often assessed, component of children's economic contributions. This is easiest to do when children perform, or have the option of performing, wage work; that is, in the present of a smoothly-functioning market for child work. Under these conditions, optimisation dictates that the returns to child work should be equal to the market child wage rate. However, as De Tray (1983) points out, where child participation in the labour market is thin (as is generally the case), there are selectivity problems in extending these data, or a wage equation based on this data, to children who perform only non-market labour. Furthermore, when the child labour market is thin, it proves difficult to gather sufficient data for robust analysis.

In his analysis of child work in Peninsular Malaysia, De Tray (1983) finds that "almost no children under age 15 report wage earnings" (p.33). While he presents some data on wage rates (an average of US$ 0.25 per hour), he makes no attempt to compare child wage rates with those of adults. Cain (1977) finds that boys' wage rates for harvest labour are equal to 95% of male adult wage rates by the age of 12-13. Data for younger boys are too few to draw robust conclusions – four observations for 8-9 year olds – but they also suggest that children's marginal income contributions are substantial: wage rates equal to 67% and 79% of the male adult wage rate for 8-9 year old boys and 10-11 year old boys, respectively. In rural India, Rosenzweig (1981) finds that "given the relatively low participation rates of children, particularly girls, in the wage labour market, it was impossible to estimate separate male and female child wage rates" (p.234). He uses district-level child wage rates in his child time use analysis – assuming that the child labour market is smoothly functioning despite low participation rates – and finds that child wage rates are roughly 30% and 13%, respectively, of female and male adult wage rates. Higher relative child wage rates are reported in another of his studies of rural India (Rosenzweig and Evenson (1977)), with child daily field wage rates equal to 75% and 50% of female and male adult wage rates, respectively. In a separate study of the Philippines, Rosenzweig (1978) finds that the average wage of children performing wage work in his sample is 21.5 pesos, two-thirds of the male adult wage rate. Given the relative numbers of hours worked, "this suggests that, on average, the contribution of a 15-year-old to family income is almost 25 percent of that contributed by the head of the household" (p.338).

The measurement of children's economic contributions in the absence of a child labour market is more difficult and requires a direct estimate of their labour productivity. In assessing the relative productivity of girls, Cain (1977) can only make qualitative judgements based on his observation of their relative efficiency in performing a variety of tasks. Vlassoff (1979) uses a series of what he calls "indirect measures" such as work duration, school absenteeism, the level of work (idle, light or heavy), etc. In a later study (Vlassoff (1982)), he uses this qualitative information to construct a "work index", which he correlates to household fertility decisions.

The first to perform a direct estimation of child work productivity is Mueller (1984). She estimates a Cobb-Douglas household income function with household assets (cattle, smaller animals, land, education and age of head) and labour variables (hours of labour by children, male adults and female adults) as explanatory variables. As she points out "time use data based on a sample of only 5 days in the year do not have a high degree of precision". Unfortunately, she does not present the marginal productivities, only the coefficients of her regressions, which represent elasticities of output with respect to each input. The income elasticities with respect to children and males are similar (0.08 vs. 0.10) in households with cattle, but no significant income from children is found in households without cattle.

An interesting recent strain of literature also attempts to estimate the marginal product and shadow wages of individuals involved in household production activities via the estimation of household income functions and frontiers. This literature is primarily concerned with understanding whether rural labour markets are perfect (and household models are separable), that is whether the marginal product value of workers equals their market wage rate[9], and analysing

[9] See Barrett, Sherlund et al. (2000), Jacoby (1993), Lambert and Magnac (1992), Lambert and Magnac (1994), Lambert and Magnac (1998) and Skoufias (1994).

non-market labour supply decisions in the context of non-separable models[10]. Although primarily concerned with the analysis of adult labour decisions, several of these studies include child work among the explanatory variables[11].

Jacoby (1993) estimates a household production function using data from the Peruvian Sierra[12]. Although he is primarily interested in estimating shadow wages for adult males and females, he nonetheless includes teenage (ages 12-19) and child (ages 6-11) labour variables (in reported hours). Using the elasticities provided by the Cobb-Douglas coefficients and the mean values of the labour and income variables, it is possible to calculate the corresponding marginal products. We conclude from his analysis that children and teenagers are roughly one quarter to one third as productive as adult males and one half to two thirds as productive as adult females. Surprisingly, there is no significant difference between the marginal productivities of children and teenagers. Skoufias (1994) adopts the same approach using panel data from rural India. He finds that female household members are much more productive than their male counterparts but, even more surprisingly, children are found to be the most productive of all. However, the extent of child work is extremely limited in his sample and so these results are not necessarily reliable. Unfortunately, it is not possible to calculate the marginal product of children without the full database used by Barrett, Sherlund et al. (2000)[13].

Cain (1977) is the only researcher, to my knowledge, to have attempted to draw together information on children's starting age for work, amount of work and productivity in order to attempt to evaluate children's total economic contribution throughout their childhood. Making some heroic assumptions, he concludes that children make a net positive contribution at as early as ten years of age and that their cumulative economic contribution turns positive by age 16-21[14].

---

[10] See Barrett, Sherlund et al. (2000), Jacoby (1993) and Skoufias (1994).

[11] See Barrett, Sherlund et al. (2000), Jacoby (1993) and Skoufias (1994). Lambert and Magnac (1998) attempted to include a child work variable but were unsuccessful (p.18).

[12] The same household production function is studied in more detail, including a breakdown into livestock and crop production functions, in Jacoby (1992).

[13] A rough calculation using the mean values of the relevant variables suggests that this marginal product value for children, as well as the number of hours worked, is almost the same as that of adult household members.

[14] He assumes that an adult male produces twice as much food as he consumes and that he consumes the minimum necessary calories for his age group. Children's production is then calculated by multiplying the resulting food calorie production of adult males by children's time inputs and wage rates as a proportion of adult males.

3. Theory

The main objective in this study is to measure the contribution of child work to household income. In particular, we would like to know the cost for households, in terms of foregone income, of withholding their children from labour activities, for example to send them to school. This impact can be measured at the margin or in total. As we restrict attention to the decision of individual households to put their children to work, market-level and general equilibrium effects are ignored. An analysis of regional or economy-wide shocks – such as a government-imposed ban on child labour – would need to integrate the latter effects, perhaps through the construction a computable general equilibrium (CGE) model[15].

At the margin, we obtain the cost to the household of reducing its child work input by one unit. In the case of market child work, this will simply be equal to the market wage rate, whereas the marginal income contribution of children working in household production is equal to the value of their marginal product. Under certain conditions – perfect child labour market, indifference between household and market labour, etc. – household profit maximisation will ensure that the marginal product is equal to the market wage rate.

The case of children who perform "enabling", as opposed to "productive", labour is trickier. Enabling labour frees up other household members to perform income-generating productive or market labour. Besides its indirect income contribution, enabling labour generates output of its own, what is called home goods in the jargon, such as meals, childcare, etc. As this output is not marketable, it cannot be measured in income terms and is thus ignored in this analysis. It is nonetheless important to bear in mind that the production of home goods can be significant in the types of labour activities commonly performed by children.

The above measures of children's marginal income contributions indicate the effect of reducing or increasing child work by one unit. This does not tell us how household income will be affected by larger variations in child work participation, such as those entailed in the choice to send a child to school or to withhold him/her entirely from work activities. In the case of market labour, we can assume that the decisions of an individual household will have no measurable effect on the market wage rate, such that marginal and average income contributions are the same. Consequently, the total income contribution of a child's market labour is equal to the wage rate multiplied by the number of hours of market labour performed.

---

[15] For example, Basu and Van (1998) argue that it is conceivable that a ban on child wage labour could lead to an increase in the adult wage rate such that the net effect on household income could actually be positive.

When we consider household child work, whether it is enabling or productive, the marginal product varies with the level of labour participation (law of diminishing returns). In the case of productive labour, we can evaluate the total income contribution by setting to zero the child work time in an estimated household production function and measuring the resulting change in predicted total income, assuming that all other variables are unchanged. Analysis of the total income contribution of enabling labour requires the specification and estimation of a full agricultural household model.

To structure the discussion, we construct a simple two-member (one adult and one child) agricultural household model with competitive adult and child labour markets:

(1) $U = U(C,h_A,h_C)$

(2) $Q = f(L_A,L_C;K)$

(3) $PC = PQ - w_A(L_A-L^H_A) - w_C(L_C-L^H_C) + E$

(4) $L^H_A + h_A = T_A$

(5) $L^H_C + h_C = T_C$

where subscript A (C) identifies the adult (child), C=consumption, h=non-work (school or leisure) time, Q=production, L=labour time in household production, K=household assets, P=the commodity price[16], w=the market wage rate, L^H=labour time of household member, E=non-labour income and T=time endowment. If the amount of adult or child work required for household production (L_A,L_C) exceeds the amount supplied by the household (L^H_A,L^H_C) for the child or adult household member, the household hires in labour. In the opposing case, excess household labour is hired out to earn market wages. The resolution of this model leads to the following first-order conditions:

(6) $Pf_{LA}=w_A$

(7) $Pf_{LC}=w_C$

Consequently, where a smoothly functioning child labour market exists, the marginal productivity of child work will be equal to the market real wage rate. In effect, a profit-maximising household will use household labour or hire in outside labour until its marginal product falls equal to the market wage rate[17]. It is therefore not necessary to estimate a household production function to calculate the marginal income contribution of a child performing household productive labour. This is a standard result of the separable household model. Furthermore, the

[16] By including only one common price for goods C and Q, we assume that they are the same good. This hypothesis could be relaxed without changing the essence of the results.
[17] Provided that it is profitable to produce at all.

total income contribution of a child is equal to this wage rate multiplied by the amount he/she works, as this is what it would cost the household to replace him/her.

In this simple model, we do not distinguish between "productive" and "enabling" child work as discussed in the preceding section. We now explicitly include enabling labour by including a non-marketable "home good" (Z), which is both consumed and produced by the household. This requires the addition of a second home good production function with only household labour as an input[18]:

(8) $U = U(C,Z,h_A,h_C)$

(9) $Q = f(L_A,L_C;K)$

(10) $Z = g({L^Z}_A,{L^Z}_C;K^Z)$

(11) $PC = PQ - w_A(L_A-{L^H}_A) - w_C(L_C-{L^H}_C) + E$

(12) ${L^H}_A + {L^Z}_A + h_A = T_A$

(13) ${L^H}_C + {L^Z}_C + h_C = T_C$

This does not change the first-order conditions above as profit maximisation still requires that the household equalise the marginal productivity value of labour in household production with the market wage rate. With regards to enabling child work, the first-order conditions can be expressed as follows:

(14) $Pg_{LC} = (U_C/U_Z)w_C = (U_C/U_Z)Pf_{LC}$

In effect, the absence of a market for the home good renders the home good production decisions of the model non-separable from the consumption decisions. In particular, the level of child work in home good production depends on the marginal rate of substitution between the market and home goods (U_C/U_Z). As we can see, the household determines child work participation in enabling labour such that its marginal utility is equal to the marginal utility of the income generated through child wage or productive labour:

(15) $Pg_{LC}U_Z = w_CU_C = Pf_{LC}U_C$

Household income is equal to the sum of the value of household profits, non-labour income and household labour earnings:

(16) $Y = \left(PQ - w_A L_A - w_C L_C\right) + E + w_A L_A^H + w_C L_C^H$

(17) $= PQ + E + w_A\left(L_A^H - L_A\right) + w_C\left(L_C^H - L_C\right)$

Thus, the marginal impact of child work used in home good production (that is, enabling labour) on household income is equal to:

[18] See Gronau (1986) and Gronau (1997) for overviews of the “home production” literature.

(18) $$\frac{\partial Y}{\partial L_C^Z} = Pf_{LA}\frac{\partial L_A}{\partial L_C^Z} + Pf_{LC}\frac{\partial L_C}{\partial L_C^Z} + w_A\frac{\partial L_A^H}{\partial L_C^Z} - w_A\frac{\partial L_A}{\partial L_C^Z} + w_C\frac{\partial L_C^H}{\partial L_C^Z} - w_C\frac{\partial L_C}{\partial L_C^Z}$$

(19) $$= w_A\frac{\partial L_A^H}{\partial L_C^Z} + w_C\frac{\partial L_C^H}{\partial L_C^Z}$$ using (6) and(7)

To the extent that enabling labour by children frees adult labour for productive use, the first term will be positive and may offset the second expression, which is presumably negative.

In the absence of a smoothly functioning market for child labour, there is no observable child wage rate and condition (15) becomes simply:

(20) $Pg_{LC}U_Z = Pf_{LC}U_C = U_{hc}$

Under these conditions, households will balance the marginal utilities of alternative uses of children's time with their marginal productivities. In the absence of the market labour alternative, a child's labour productivity will vary according to his/her household's production characteristics (e.g. asset ownership, household composition, etc.). As a result, in addition to factors such as household poverty and tastes, household production characteristics may contribute to the decision to send children to work or to school. To the extent that these characteristics are exogenous with respect to child time use decisions, it is interesting to explore which types of assets have the strongest impact on child work productivity. The most straightforward manner to examine these impacts is to compare, at the sample mean values for all inputs, the elasticity of child work productivity with respect to each household production input (X_i):

(21) $$\left(\frac{\delta f_{LC}}{\delta X_i}\right)\left(\frac{X_i}{f_{LC}}\right)$$

If child and adult labour are substitutes in household production, a reduction in child work will increase the marginal productivity, or shadow wage, of adult household labour. In the case of market labour, Basu and Van (1998) require an economy-wide ban on child labour – and a general equilibrium analytical framework – to obtain a similar result. In the case of household production, this result emanates directly from the nature of substitutability of adult and child work and depends solely on a given household's decision to reduce child work. This said, reducing child work would lead to an increase in total household production (and income) only if child work productivity is negative, which is unlikely. However, in the case of an economy-wide ban on child labour, we would expect that the supply of goods produced by households would fall and their prices would consequently increase, such that even if household production is reduced, household income may increase.

4. Estimation strategy

Data used in this study is from the Ethiopian rural household survey (ERHS), which consists of three rounds of detailed surveys of 1477 rural households from 15 villages throughout rural Ethiopia[19]. Children are defined as individuals between the ages of six and 15. From Table 1 below, we see that more than half of all children have work **as their main activity**. Only 18% of children attend school[20]. Education is not compulsory for children in Ethiopia. Finally, a large share of children, primarily younger children, does not attend school and does not have work as their main activity.

Table 1: Children's main activities in rural Ethiopia
(Percent 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)**

Table 2 provides a summary of the types of work activities they perform. Fetching wood or water and herding are the most common activities performed by these children. Boys are more heavily involved in herding and increasingly turn to farm activities as they get older. Girls migrate from fetching wood and water to herding as they get older.

Table 2: Primary work activities of children
(Percent of children performing each activity as his/her primary 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**

[19] 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. Descriptive statistics are provided in appendix Table A- 1. The database is available at: http://www.economics.ox.ac.uk/CSAEadmin/datasets/Ethiopia-ERHS/ERHS-main.html

[20] All children who attend school have school as their main activity and vice versa.

As discussed earlier, a child's total economic contribution depends in part on the age he/she begins working. As the following table illustrates, children in rural Ethiopia begin working at a very young age; on average, at the age of 6.

Table 3: Age at which children begin to work, by sex
(Percent of all children beginning work at the age indicated)

Age	<=4	5	6	7	8	9	10	11	12	13	14	15
boys	12.9	20.4	22.3	21.0	10.4	4.3	6.2	1.0	0.6	0.7	0.2	0.0
girls	16.3	19.0	21.5	21.0	11.7	4.0	4.2	0.9	0.7	0.2	0.2	0.2
Total	**14.5**	**19.7**	**21.9**	**21.0**	**11.1**	**4.2**	**5.2**	**1.0**	**0.6**	**0.5**	**0.2**	**0.1**
Cumulative	14.5	34.2	56.1	77.1	88.2	92.4	97.6	98.6	99.2	99.7	99.9	100

The importance of children's economic contribution is underscored by the fact that, within the sample of rural households, work was cited as the primary reason for non-attendance in 35% of all responses and over half the responses concerning children aged 11 to 15 (Table 4). If children considered too young to attend school are left out, work-related reasons are cited in over half of all responses.

Table 4: Primary reason for not attending school by age group and sex
(Percent of all primary reasons given for non-attending children by sex and age group)

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

4.1 Choice of variables

There are three principal methods that can be used to estimate children's marginal productivity. As discussed earlier, in the presence of a smoothly functioning labour market, the household will equalise the marginal product value of labour inputs with their respective market wage rates, obviating the need to estimate a production function at all. The fact that only 1% of children in rural Ethiopia do any work outside the household (for wages or in-kind payment) undermines the hypothesis of a smoothly functioning child labour market.

A second method is to estimate a household production function for a specific activity that produces a marketable product. The marginal productivity of child work in this activity can then be derived from the estimated production function. Profit maximisation dictates that the household will allocate all inputs among marketable activities until their marginal product values are equal[21]. Thus, the marginal product of children in any given activity provides an estimate of their marginal product in all marketable household production activities. The difficulty in estimating production functions for specific activities is the absence of reliable activity-specific input data. In particular, few household surveys collect activity-specific data on child work. Even when such data exist, they are generally unreliable due to the inherent difficulties of collecting time use data: seasonal fluctuations, observation bias, recall errors, high costs, etc. The theoretical problem of this approach is its neglect of child enabling labour, which is often the most important type of child work, particularly in areas such as rural Ethiopia. As we saw in equation (19), the impact of child "enabling" labour depends on intra-household labour substitution possibilities.

The third method is to measure children's income contribution directly by estimating a household income function. This is the approach we adopt. It has the advantage of integrating children's direct and indirect, or labour freeing, effects on household income.

In rural Ethiopia, households have several income sources. Table 5 presents the average shares of the different sources of household income in our sample. These averages disguise the fact that only a minority of household derive income from any given non-crop income source. Live animal sales are not included in our total income variable given their lumpy nature. The share of these sales in total income is indicated at the end of the table below. Own consumption and in-kind payments are valued using community-level prices.

Table 5: Sources of household income

Variable	Share	s.d.
Crop sales	57.4	33.5
Female business	8.8	18.0
Income earning activities	7.5	16.6
Wages	7.5	15.4
Animal products	5.4	13.0
Rent	2.7	11.3
Other (aid, remittances,...)	10.8	20.7
Animal sales	10.1	17.5

Let us now turn our attention to the choice of child work variable. Ideally, accurate information on the number of hours of child work would be used. However, we have already mentioned the problems of collecting time use data. Consequently, these data are rarely available in large-scale household surveys and when they are available, they are subject to significant

---

[21] Udry (1996) puts this conclusion into question in the context of a non-unitary household model.

measurement error. In the case of the ERHS, no such data are available. Households are asked to recall the average number of hours their **school-going** children works during school days and on weekends, but only 20% of all children attend school and they presumably work less than other children.

The ERHS does provide information on each child's main activity (work, school or "inactive"). We thus use the numbers of children with work as their main activity (working children hereafter) as our base child work variable. We argue that even if time use data were available, their reliability would be dubious and it may still be preferable to use numbers of working children instead. In recognition of the fact that school-going and "inactive" children may perform significant amounts of work and contribute to household income[22], we also experiment with alternative child work variables that include them separately or lumped together with working children[23]. As productivity can be expected to vary with the age and sex of the child, we attempt to disaggregate the child work variables.

All of these variables are likely to be endogenous with respect to household income, both due to simultaneity – household income affects the choice of children's main activity - and possible unobserved correlated variables such as management ability and effort levels[24]. Consequently, we also compare results when the child work variables are instrumented. As instruments, we try the total number of children in the household, the dependency share (total number of children, infants and elderly divided by household size), the average age of children in the household, the share of boys among children, the share of children in the household who are children of the household head and the numbers of infants and elderly.

The other explanatory variables included are standard household production/income variables including: household productive assets (land, livestock, tools, permanent crop plants), land fertility, material inputs (fertiliser, seeds, etc.), household composition (number of males and females), non-household labour and the age, sex and education of the household head[25]. Site dummies control for community fixed effects.

---

[22] According to the time use data collected for school-going children, they work an average of three hours per school day and ten hours per weekend.
[23] In particular, we use the following alternative child work variables: number of non school-going (that is, working and inactive) children; total number of kids (that is, working, school-going and inactive).
[24] Mueller (1984) concludes "this simultaneity bias may lead to some underestimation of the time input coefficients" that is, of marginal labour productivities.
[25] See Appendix for details and descriptive statistics.

4.2 Functional form

There are two principal considerations we take into account in selecting a suitable functional form for our estimations: parameter restrictions and the treatment of zero input values. It is well known that some of the most common functional forms have strong parameter restrictions. The Cobb-Douglas function assumes unitary elasticity of substitution between all inputs. The Constant Elasticity of Substitution (CES) function allows different values for this elasticity but, as its name suggests, this elasticity is constant and common to all inputs. The use of multi-level CES functions allows different elasticities of substitution between specific groups of inputs. The Generalised Leontief and translog functions are the most flexible functional forms we examine. We are particularly interested in the relationship between child work and other household production inputs.

The treatment of zero input values is also a concern for us. Many households do not use one or the other of these inputs (Table 6). This is largely a result of our broad definition of household income, which includes quite different types of production (agricultural crops, livestock, permanent crops, etc.) and the sex/age disaggregation of the child work inputs. It poses an important estimation problem in that most standard functional forms - in particular the Cobb-Douglas and trans-log forms - do not allow zero-valued inputs. More precisely, these functional forms dictate that production (or income) will be zero if any of the inputs is totally absent.

The simplest and most common remedy is to add an arbitrary constant to the values of the input in question[26]. Weninger (1998) criticises this approach as creating biased and inconsistent estimates, where the bias increases with the size of the constant relative to the input's mean values. Johnson and Rausser (1971) finds that the bias is less when the arbitrary amount is added only to zero-value observations rather than to all the observations for a given input. Jacoby (1992) finds that "when common constants of 10 and 0.1 (instead of 1) are used in the final version of the translog, coefficients on some of the inputs, such as livestock inputs and transportation, change noticeably" (p.284). In the case of the standard Cobb-Douglas (CD) functional form for example, we have:

(22) $$Q = A\prod_{i=1}^{I}(X_i + c)^{\alpha_i}$$

where Q=output, X_i=input i and c is an arbitrary constant. For the translog (TL), we have:

(23) $$\ln Q = A + \sum_{i=1}^{I}\beta_i \ln(X_i + c) + \frac{1}{2}\sum_{i=1}^{I}\sum_{j=1}^{J}\gamma_{ij}\ln(X_i + c)\ln(X_j + c)$$

Table 6: Number of households with zero values for each input (sample size=1354)

Child work variables	Uninstrumented			Instrumented		Other production inputs	
	All	Working	NSG	Working	NSG		
Kids	331	556	414	355	355	**Females**	37
Boys	603	853	717	619	619	**Males**	115
Girls	577	792	654	589	589	**Outside labour**	435
Young boys	826	1070	898	836	836	**Land owned**	70
Young girls	925	1062	1044	935	935	**Material inputs**	448
Older boys	806	1043	853	815	815	**Livestock value**	247
Older girls	896	989	972	900	900	**Productive assets**	101

Note: NSG=non school-going

Another common solution is to simply omit all observations for which one of the inputs has a value of zero. This reduces the sample size, often substantially. It is also difficult to defend on a theoretical basis. Similarly, the option of eliminating offending inputs from the regression is theoretically unjustified. Given that there are large numbers of zero values in our sample for each of the inputs, this solution is also not practical. A fourth solution is to suppose that some inputs are perfect substitutes and to aggregate them, eventually including a discount factor. While this hypothesis may be reasonable for labour inputs, it is harder to justify for other inputs and should be tested anyways.

A more satisfactory approach is to use non-linear techniques to estimate, rather than impose, the constants in equation (22), allowing them to differ between variables:

$$(24) \qquad Q = A\prod_{i=1}^{I}(X_i + \mu_i)^{\alpha_i}$$

where the μ_i are estimated. We call this the generalised Cobb-Douglas (GCD) approach.

There are also several functional forms that can handle zero values for inputs. In addition to relaxing the unitary elasticity of substitution hypothesis, the CES function allows zero input values if these elasticities of substitution (σ) are greater than one[27]:

$$(25) \qquad Q = A\left(\sum_{i=1}^{I}\alpha_i X_i^{-\rho}\right)^{-s/\rho} \quad \text{where } \sigma=1/(1+\rho)$$

The generalised Leontief (GL) function further relaxes the hypothesis of constant elasticity of substitution and also allows zero input values[28]:

---

[26] This approach is used in Jacoby (1992), Jacoby (1993), MaCurdy and Pencavel (1986) and Skoufias (1994)
[27] Udry (1996) uses the CES production function in a study of African agricultural households for this reason.
[28] See Diewert (1971) for the original development. Sadoulet and de Janvry (1995) discuss this functional form. Lambert and Magnac (1998) use it with limited success (low significance levels). Barrett, Sherlund et al. (2000) find that it failed specification tests and adopt a cubic alternative:

(26) $$Q = \sum_{i=1}^{I}\sum_{j=1}^{J} b_{ij}\sqrt{X_i X_j} \text{ where } b_{ij}=b_{ji}\geq 0$$

We experiment with all of these approaches and compared the results. Ordinary least squares are used to estimate the CD, TL and GL models and non-linear least squares are used for the GCD and CES formulations[29].

5. Results

We focus our attention first on the CES formulation, as it has a stronger theoretical foundation than the GCD formulation and provides far more robust results than the GL formulation. The GCD and GL formulations are considered subsequently. Finally, we turn our attention to the translog formulation with an added arbitrary constant. In each case, we present the regression coefficients, marginal products and the elasticities of these marginal products with respect to the other production inputs. Descriptive statistics for the variables used in the estimations are provided in Table A- 1.

5.1 Cobb-Douglas

The CES function encompasses the CD formulation, and so we use it to test the CD restriction of unitary elasticities of substitution between inputs. As this restriction was strongly rejected (1% confidence level), we do not present the CD results. However, as it is widely used in the literature, we did experiment quite extensively with the CD formulation and the various solutions used in the literature to handle zero-valued inputs[30]. We found that the results vary substantially according to the choice of added constant (we compared 0.01, 0.1 and 1), with the marginal product of children falling from two-thirds to one-quarter that of adult males as the constant was increased. We also found that restricting the sample to households with no zero-valued inputs drastically reduced the significance level of the results. Nonetheless, when the added constant was minimised (0.01), the estimated marginal products of children were roughly in the range of those found in the CES and GCD formulations below, providing further support to the latter.

$$\sqrt[3]{Y} = \beta_0 + \sum_{k=1}^{K} \beta_k \sqrt[3]{X_k} + \frac{1}{2}\sum_{k=1}^{K}\sum_{j=1}^{K} \gamma_{kj}\sqrt[3]{X_k X_j}$$

29 The GCD formulation was also estimated by maximum likelihood with similar results.

30 Results available on request.

5.2 Constant Elasticity of Substitution (CES)

The CES function is widely used and admits zero-valued inputs provided the elasticity of substitution is superior to unity. We adopt a two-level CES function where the different types of labour are treated as a CES sub-aggregate:

(27) $$Q = A\left(\alpha_1 \text{Land}^{-\rho} + \alpha_2 \text{Labor}^{-\rho} + \alpha_3 \text{Input}^{-\rho} + \alpha_4 \text{Asset}^{-\rho}\right)^{-s/\rho} e^{\sum_i \beta_i Z_i}$$, where:

(28) $$\text{Labor} = \left(\delta_{21} \text{kid}^{-\rho_2} + \delta_{22} \text{Females}^{-\rho_2} + \delta_{23} \text{Males}^{-\rho_2}\right)^{-1/\rho_2}$$

and Z_i are other household characteristics and site dummies. However, the substitution parameter in the labour aggregate (ρ_2) was not significantly different from -1, indicating perfect substitution[31]. We therefore imposed perfect substitution in the final regressions, maintaining separate discount factors for children and females relative to males

(29) $$\text{Labor} = \delta_1 \text{Kid} + \delta_2 \text{Females} + \text{Males}$$

For estimation purposes, we convert this to the following semi-logarithmic form

(30) $$\ln Q = \ln A - \frac{s}{\rho} \ln\left(\alpha_1 \text{Asset}^{-\rho} + \alpha_2 \text{Labor}^{-\rho} + \alpha_3 \text{Input}^{-\rho} + \alpha_4 \text{Livestock}^{-\rho} + \alpha_5 \text{Land}^{-\rho}\right) + \sum_i \beta_i Z_i$$

The marginal product of child work is given by the following expression:

(31) $$f_{LC} = s\alpha_2 \delta_1 \text{Labor}^{-(1+\rho)} \left(\sum_{i=1}^{I} \alpha_i X_i^{-\rho}\right)^{-1} Q \; ;$$

where X_i= productive assets, labour, material inputs, livestock and land. The elasticity of this productivity with respect to production input X_i is given by:

(32) $$\varepsilon_{LC,i} = \frac{-\alpha_i X_i^{-\rho}}{\sum_{j=1}^{J} \alpha_j X_j^{-\rho}} \rho$$

In the base regression the child work variable is the uninstrumented total number of children with work as their main activity (working kids; Table 7). Returns to scale are diminishing (s=0.635) and we strongly reject constant returns to scale (H_0: s=1; t=6.7***)[32]. The substitution parameter is significantly different from 0 indicating that the Cobb-Douglas hypothesis of a unitary elasticity of substitution between inputs is not supported by the data and that the CES for-

---

[31] ρ_2=-1.20228; standard.error.=0.42; t(H_0:ρ2=-1)=0.48. Results available on request.

[32] Udry (1996) also finds decreasing returns to scale in his estimation of a CES household production function in Burkina Faso. Croppenstedt and Muller (2000) and Weir and Knight (2000) finds very similar scale parameter to ours (0.67 and 0.7, respectively) in CD estimations of cereal production functions with a sub-sample of households from the same Ethiopian survey we use.

mulation is preferable. Indeed, the elasticity of substitution is high (2.1=1/(1-0.527)), satisfying the condition for zero-value inputs (elasticity above 1).

Table 7: Base regression results (Constant Elasticity of Substitution (CES))

PRODUCTION INPUTS				OTHER CHARACTERISTICS			SITE DUMMIES		
	Coef.	t	(t)		Coef.	t		Coef.	t
Scale returns (s)	0.635	12.5***		**fertsh**	0.171	3.1***	**haresaw**	-0.772	-6.0***
Substitution (ρ)	-0.527	-6.2***		**chat**	0.556	5.5***	**geblen**	-0.901	-6.9***
				coffee	0.432	4.4***	**dinki**	-0.402	-3.2***
Distribution (α):				**enset**	-0.038	-0.3	**yetemen**	-0.252	-2.1**
productive assets	0.025	2.3**		**eucalyptus**	0.089	1.6	**shumsha**	0.101	1.0
household labour	0.535	8.4***		**femhead**	-0.029	-0.5	**sirbana**	0.182	1.6
material inputs	0.036	3.1***		**agehead**	-0.002	-1.5	**adele**	-0.241	-1.7*
livestock	0.218	3.7***		**headed**	0.024	2.9***	**korod**	-0.123	-1.2
land	0.187	N/A		**constant**	6.500	46.2***	**trirufe**	0.130	1.0
							imdibir	0.880	4.2***
Discount factors (δ):							**azedebo**	-0.803	-4.5***
males	1.000	N/A	N/A				**adado**	0.020	0.1
females	0.965	2.9***	0.1				**garagod**	-0.929	-5.5***
working kids	0.227	1.4	4.6***				**doma**	0.275	2.1**

Notes: Dependent variable=total household income. t=t-statistic. Number of observations=1354. Adjusted R^2=0.55. t-statistics are not calculated for the land distribution parameter as it is equal to one minus the sum of the other distribution parameters. The male discount factor is normalised. (t)=t-statistic for the test H_o:**δ=1**. Significant at 10% (*), 5% (**) and 1% levels (***). Definitions in Table A- 1.

The distribution parameters on all production inputs are strongly significant. Among the other household characteristics, the share of fertile land and the cultivation of chat and coffee contribute positively to household income. The age and sex of the household head is not significantly related to income. However, his/her education is a significant positive determinant[33]. Finally, many of the site dummies are strongly significant, indicating that there are community characteristics that affect household income, which is unsurprising given the social and agro-economic diversity of the sites. The small number of sites (15) in the sample prevents exploration of community characteristics.

With a discount factor of 0.227, children are less than one-quarter as productive as adult males. However, our estimate of the working kids discount factor is not very precise as evidenced by the low value for the t-statistic. Indeed, we cannot reject the hypothesis that the marginal product of child work is zero, although we do strongly reject the hypothesis that it is equal to that of male adults (H_0: δ_1=1). Female adults, on the other hand, are found not to be significantly less productive than male adults.

While the discount factor for child work is supposed fixed in this formulation, the marginal product of children depends on the level of all other inputs (see equation (31)). Indeed, marginal products of child work (and all other inputs) vary substantially within the sample of households (Table 8), suggesting that the incentives to put children to work strongly depend on household characteristics[34].

Table 8: Marginal products for base regression (CES)

Variable	Mean	s.d.	Min	Max
productive assets	**4.7**	9.1	0.0	140.5
household labour	**306.1**	757.8	9.5	15312.3
material inputs	**6.1**	20.2	0.1	276.7
livestock	**210.5**	525.6	5.3	10697.6
land	**332.1**	1222.0	2.1	25258.2
males	**306.1**	757.8	9.5	15312.3
females	**295.2**	730.9	9.2	14768.7
working kids	**69.5**	172.1	2.2	3477.0

To take account of the fact that even children who do not have work as their main activity perform significant amounts of work, we experiment with wider definitions of child work. We first add inactive children to obtain the total number of non school-going (NSG kids) children in the household. We then add school-going children, thus obtaining the total number of children in the household (All kids). As the coefficients and marginal products of the other variables change little with these alternative definitions of child work, we present only the results for the child work variables (Table 9). The lines in these tables thus separate results from different regressions according to the child work variable used. Results from the base regression – Uninstrumented working kids – are reproduced in bold characters for reference. Also for reference, we include the results for females obtained with the aggregate version of each child work variable[35].

Regardless of the choice of uninstrumented child work variable (working, non school-going or all kids), children are less than one-quarter as productive as male adults and their discount factor has little statistical significance. Working children are somewhat more productive than their school-going and inactive counterparts, as we would expect. The low statistical significance of the child work variable is not altogether surprising given the fact that we are using numbers of children by status, rather than actual hours of child work. Note that these discount factors are significantly superior to zero at the 20% confidence level. Our results do strongly show that the child discount factor is inferior to one, indicating that children are less productive than male adults

---

[33] See Weir and Knight (2000) for an analysis of the impact of education on farm productivity.
[34] Marginal products are expressed in Ethiopian birrs. At the time of this survey (1994), five birrs were worth roughly one US dollar. Average household income in 1994 for our sample was 3156 birrs (roughly $US 600).
[35] These results change very little when child work variables are disaggregated by sex/age.

Table 9: Discount factors with alternative child work variables (CES)

	Uninstrumented								
	Working kids			NSG kids			All kids		
Labour aggregate	Coef.	t	(t)	Coef.	t	(t)	Coef.	t	(t)
females	0.965	2.9***	0.1	0.956	2.9***	0.1	0.960	3.0***	0.1
kids	**0.227**	**1.4**	**4.6*****	0.196	1.4	5.8***	0.182	1.6	7.1***
boys	0.207	0.9	3.3***	0.280	1.3	3.5***	0.191	1.2	5.1***
girls	0.245	1.0	3.2***	0.128	0.7	4.9***	0.176	1.1	5.0***

	Instrumented					
	Working kids			NSG kids		
Labour aggregate	Coef.	t	(t)	Coef.	t	(t)
females	0.973	3.0***	0.1	0.942	3.0***	0.2
kids	0.353	1.7*	3.1***	0.252	1.7*	5.1***
boys	0.503	1.5	1.5	0.318	1.5	3.1***
girls	0.323	1.2	2.5**	0.215	1.1	4.1***

(t) represents the t-statistic for the test H_o: δ=1. Significant at 10% (*), 5% (**) and 1% levels (***)

When we instrument the child work variables using the total number of children, their average age and the share of boys as instruments (bottom half of Table 9), the marginal productivity of child work increases somewhat and become significantly different from zero at the 10% confidence level[36]. In fact, working children are found to be more than one-third as productive as male adults. Our regression does not satisfy the condition for applying the Hausman test for exogeneity[37]. However, using the Sargan test of overidentifying restrictions, we cannot reject the hypothesis that the model is correctly specified and the instruments are valid, even at the 10% confidence level[38]:

$$\chi_3^2 = 2.4 < \chi_3^2(10\%) = 6.25$$

Furthermore, the fit of the instrumenting equation is very good (R^2=0.51) and the explanatory power of the excluded instruments is high (partial R^2=0.42 and F=265.7 (p=0))[39].

---

[36] We also tried and rejected the following excluded instruments: share of dependents in household, share of direct children of head among all household children, number of infants (aged 4 and younger) and number of elderly (aged 60 and over) household members.

[37] The Hausman test is often difficult to compute as the difference of the estimated covariance matrices is not always a positive definite matrix as required for standard matrix inversion.

[38] This involves regressing the residuals from the IV regression on the excluded instruments, where the number of observations multiplied by the R^2 of this regression follows a chi^2 with the degrees of freedom equal to the number of excluded instruments. Note also that none of coefficients on the excluded instruments are significant.

[39] The instrumenting regression for working children is presented in Table A- 2 with excluded instruments in bold. Instrumenting regressions for non school-going children and working and non school-going boys and girls are similar and available on request. Bound, Jaeger et al. (1993) underline the importance of the explanatory power of excluded instruments and suggest that their partial R^2 and F-statistic in the first-stage regression be presented.

When child work variables are disaggregated by sex, the estimated discount factors have low significance value, but suggest that boys are somewhat more productive than girls, perhaps due to greater specialisation of boys in directly income-producing activities. Age-disaggregated results are not presented, as they are statistically insignificant.

Without instrumentation, the marginal productivity of child work is found to be on average roughly one-fifth that of male and female adults, although there is a huge variation between households (Table 10)[40]. Once the child work variables are properly instrumented, marginal productivity increases markedly, particularly that of working children, which attains more than one-third the productivity of an adult male or female.

Table 10: Marginal products with alternative child work variables (CES)

	Uninstrumented											
	Working kids				Non school-going kids				All kids			
Variable	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**
males	**306.1**	757.8	9.5	15312.3	**303.8**	757.3	9.2	15296.7	**317.0**	798.7	9.5	16323.3
females	**295.2**	730.9	9.2	14768.7	**290.3**	723.8	8.8	14618.8	**298.6**	752.4	9.0	15378.4
kids	**69.5**	**172.1**	**2.2**	**3477.0**	**59.6**	148.5	1.8	2999.4	**57.4**	142.3	1.8	2953.9
boys	**63.5**	157.1	2.0	3178.3	**84.9**	212.7	2.6	4278.6	**60.1**	149.2	1.9	3095.5
girls	**75.0**	185.6	2.3	3754.9	**38.8**	97.3	1.2	1956.6	**55.2**	137.1	1.7	2843.7

	Instrumented							
	Working kids				Non school-going kids			
Variable	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**
males	**314.3**	792.9	9.6	16144.2	**317.0**	798.7	9.5	16323.3
females	**305.8**	771.6	9.4	15710.6	**298.6**	752.4	9.0	15378.4
kids	**110.9**	279.9	3.4	5698.5	**79.8**	201.0	2.4	4108.9
boys	**158.5**	400.2	5.0	8243.0	**100.2**	252.0	3.1	5189.4
girls	**101.7**	256.8	3.2	5290.0	**67.8**	170.4	2.1	3510.0

The total contribution of child work, as opposed to its marginal contribution, can be measured by using the estimated equations to predict household income with ($\hat{Y}_{CL}$) and without child work ($\hat{Y}_{noCL}$), assuming that all the other inputs remain constant. We then divide the resulting difference by predicted household income with child work and by the number of child workers (n) in the household in order to obtain the average percentage income contribution of each child (Table 11): $(\hat{Y}_{CL}-\hat{Y}_{noCL})/n\hat{Y}_{CL}$. This procedure is followed for each child work variable.

[40] Similar results were obtained when marginal products were evaluated at the vector of mean values of inputs.

Table 11: Average percentage income contribution (CES)

	Uninstrumented											
	Working kids				Non school-going kids				All kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
adults	**17.0**	11.6	2.7	90.1	**15.8**	9.8	2.6	90.1	**15.8**	9.1	2.7	70.3
kids	**2.6**	**1.5**	**0.4**	**12.2**	**2.3**	1.4	0.4	10.8	**2.3**	1.6	0.3	28.4
boys	**1.3**	1.4	0.0	8.3	**2.4**	2.0	0.0	12.7	**2.2**	1.6	0.4	28.8
girls	**1.8**	1.8	0.0	13.0	**1.3**	1.0	0.0	7.4	**2.2**	1.3	0.3	10.0
	Instrumented											
	Working kids				Non school-going kids							
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max				
adults	**15.2**	8.6	2.7	69.0	**15.4**	8.7	2.7	69.8				
kids	**4.4**	3.1	0.7	52.3	**3.1**	2.2	0.5	39.8				
boys	**3.1**	2.2	-0.8	31.8	**2.9**	2.0	-0.1	30.1				
girls	**2.5**	1.6	-0.3	14.7	**2.3**	1.5	0.0	10.9				

The average percentage income contribution per child appears to be modest (2.3 to 4.4%), although for some households it can be quite substantial. Working children make a larger average contribution than their school-going and "inactive" counterparts. Average contributions estimated with the instrumented child work variables are higher. Boys appear to make larger average income contributions than girls.

Which household characteristics drive the differences in the marginal product of child work? To answer this question, we measure the elasticity of child work productivity with respect to the other inputs (Table 12). As these elasticities change little when alternative child work variables are used, we present only the results obtained with uninstrumented working kids. Adult labour clearly influences child work productivity most, although household assets and material inputs also increase child productivity.

Table 12: Elasticity of marginal child work productivity to inputs (CES)

Variable	Mean	s.d.	Min	Max
productive assets	**0.05**	0.03	0.00	0.34
material inputs	**0.08**	0.07	0.00	0.35
livestock	**0.06**	0.04	0.00	0.28
land	**0.06**	0.04	0.00	0.30
males	**0.28**	0.08	0.00	0.53
females	**0.27**	0.08	0.00	0.51

5.3 Generalised Cobb-Douglas

As discussed in section 4.2, to handle the problem of zero values in the CD formulation, we could estimate the constant to be added to all input values, rather than impose an arbitrary value. Note that, given its unusual form, the GCD does not impose unitary elasticity of substitution between inputs and so the earlier rejection of the CD formulation does not apply to the GCD[41].

Both maximum likelihood and non-linear least squares programs had difficulties converging when number of females and males and child work variables were entered separately that is, treated as imperfect substitutes:

(33) $$Q = A\left[\prod_{i=1}^{I}(X_i + \mu_i)^{\alpha_i}\right]e^{\sum_i \beta_j Z_j}$$

where the X_i represent production inputs (kids, females, males, outside labour, land, material inputs, livestock and productive assets) and the Z_i represent other household characteristics and site dummies. However, results are much better when we aggregate males, females and children as perfect substitutes, as suggested by the CES results, with a productivity discount factor for children and females:

(34) $$\text{Labor} = \delta_1 \text{Kid} + \delta_2 \text{Females} + \text{Males}$$

For estimation purposes, we transform (33) into semi-logarithmic form:

(35) $$\ln Q = \ln A + \alpha_i \ln\left[\prod_{i=1}^{I}(X_i + \mu_i)\right] + \sum_i \beta_i Z_i$$

The marginal product of child work is given by the following formula:

(36) $$f_{LC} = \left(\frac{\alpha_{\text{Labour}}\delta_1}{\text{Labour} + \mu_{\text{Labour}}}\right)Q$$

The elasticity of this marginal product with respect to other inputs is simply:

(37) $$\varepsilon_{LC,i} = \frac{X_i}{(X_i + \mu_i)}\alpha_i$$

Note that, as this elasticity does not depend on any child work variables, it also represents the elasticity of the marginal productivity of all production inputs with respect to changes in any given input i.

As before, we first present full results using uninstrumented total number of working kids as the child work variable, before considering the alternative child work variables (Table 13). The GCD formulation has roughly the same fit as the CES (R^2=0.56). It is also noteworthy that, while sometimes large, none of the estimated added constants (μ) is statistically significant. The effects of other household characteristics and the site dummies change little between the two

[41] In the added-constant GCD formulation, the elasticity of substitution between inputs i and j

formulations. The parameters for the other production inputs cannot be compared between the GCD and CES formulations. However, marginal products are similar (Table 14), if somewhat higher (with the exception of female adults).

Compared to the CES formulation, children are more productive and female adults less productive, relative to male adults (Table 13 and Table 14). In the base regression, children are found to be more than half as productive as female adults and close to one-third as productive as male adults. We again note a wide variation in the marginal product of child work between households, as measured by its standard deviation (Table 14).

Table 13: Base regression results (Generalised Cobb-Douglas (GCD))

PRODUCTION INPUTS	α	t	μ	t
productive assets	0.074	2.1**	3.579	0.5
household labour	0.318	5.4***	0.024	0.4
outside labour	0.094	2.1**	10.063	0.7
material inputs	0.136	3.0***	13.772	0.9
livestock	0.345	1.8*	2.784	1.0
land	0.103	1.8*	0.231	0.6

Discount factors	**δ**	**t**	**(t)**
males	1.000	N/A	N/A
females	0.522	2.3**	2.1**
working kids	0.310	1.9*	4.3***

OTHER CHARACTERISTICS	Coef.	t
fertsh	0.178	3.3***
chat	0.554	5.5***
coffee	0.431	4.4***
enset	-0.046	-0.4
eucalyptus	0.071	1.3
femhead	-0.013	-0.2
agehead	-0.003	-1.7*
headed	0.021	2.5**
constant	5.261	9.1***

SITE DUMMIES	Coef.	t
haresaw	-0.668	-4.8***
geblen	-0.756	-5.4***
dinki	-0.378	-2.9***
yetemen	-0.182	-1.5
shumsha	0.153	1.4
sirbana	0.138	1.1
adele	-0.199	-1.3
korod	-0.127	-1.2
trirufe	0.254	1.8*
imdibir	0.892	4.1***
azedebo	-0.665	-3.6***
adado	0.089	0.5
garagod	-0.780	-4.4***
doma	0.322	2.4*

Notes: Dependent variable=log of total household income. α=estimated GCD exponents; μ=estimated constants to be added to production inputs in GCD; t=t-statistic. Number of observations=1354. Adjusted R^2=0.56. (t) represents the t-statistic for the test H_o: **δ**=1. Significant at 10% (*), 5% (**) and 1% levels (***)

Table 14: Marginal products for base regression (GCD)

Variable	Mean	s.d.	Min	Max
productive assets	**7.5**	15.6	0.0	252.8
household labour	**396.7**	1031.9	7.7	19711.2
outside labour	**15.4**	77.1	0.1	2639.8
material inputs	**9.9**	30.7	0.1	561.4
livestock	**238.7**	660.4	10.8	11859.4
land	**456.4**	2051.7	0.7	44046.5
males	**396.7**	1031.9	7.7	19711.2
females	**207.0**	538.5	4.0	10287.0
working kids	**123.1**	320.1	2.4	6114.7

We now turn our attention to the alternative and disaggregate child work variables (Table 15). Results for female labour change somewhat according to the definition, although not the

---

is: $\frac{X_i/(X_i+\mu_i)}{X_j/(X_j+\mu_j)}$. As the constants are input-specific and can be large, this can be far from 1.

disaggregation, of the child work variable, so we present them along with the results for the child work variables themselves. Generally speaking, the marginal products of child work are somewhat higher and more significant than those obtained with the CES formulation. The marginal product of working children is greater than those of school-going and inactive children. Instrumenting the child work variables increases the estimated marginal products, such that working children are actually shown to be more productive than female adults and almost half as productive as male adults.

Table 15: Discount factors for alternative child work variables (GCD)

UNINSTRUMENTED CHILD WORK VARIABLES						
	Working kids		Non school-going kids		All kids	
	Coef.	**t**	**Coef.**	**t**	**Coef.**	**t**
females	0.522	2.3**	0.573	2.3**	0.586	2.1**
kids	**0.310**	**1.9***	0.213	1.7*	0.239	2.0*
boys	0.233	1.1	0.258	1.4	0.304	1.7*
girls	0.386	1.7*	0.179	1.1	0.190	1.1
INSTRUMENTED CHILD WORK VARIABLES						
	Working kids		**Non school-going kids**			
	Coef.	**t**	**Coef.**	**t**		
females	0.458	1.9*	0.486	1.9*		
kids	0.482	2.3**	0.341	2.2**		
boys	0.586	1.9*	0.483	2.0*		
girls	0.413	1.6	0.244	1.3		

Notes: Dependent variable=log household income; Coef.=regression coefficient; t=t-statistic

When we disaggregate by sex, significance levels decline somewhat. With the exception of uninstrumented working kids, boys are found to be more productive than girls. This again mirrors results obtained with the CES formulation. Results disaggregated by age group are not significant enough to merit presentation.

Marginal products of all inputs, including child work, are shown once again to vary substantially between households (Table 16). They are systematically higher than those estimated with the CES formulation, but the same profile emerges: working children have a higher marginal product than school-going and inactive children. When the child work variable is instrumented, estimated marginal products are much higher, even surpassing that of female adults in the case of instrumented working children. Boys are generally shown to have a higher marginal productivity than girls. In the instrumented working kids version, the marginal productivity of boys even surpasses that of female adults and is more than half that of male adults.

Table 16: Marginal products for alternative child work variables (GCD)

	Uninstrumented											
	Working kids				Non school-going kids				All kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
males	**396.7**	1031.9	7.7	19711.2	**391.3**	1032.2	7.7	19446.5	**389.3**	1080.1	10.8	23124.7
females	**207.0**	538.5	4.0	10287.0	**224.4**	591.8	4.4	11149.8	**228.2**	633.0	6.3	13551.6
kids	**123.1**	**320.1**	**2.4**	**6114.7**	**83.5**	220.3	1.6	4149.7	**93.2**	258.6	2.6	5536.1
boys	**92.1**	237.5	1.8	4586.4	**100.9**	267.5	2.0	5013.8	**117.0**	330.2	3.4	7295.0
girls	**152.5**	393.5	3.0	7598.5	**70.2**	186.0	1.4	3485.7	**73.0**	206.1	2.1	4554.0

	Instrumented							
	Working kids				Non school-going kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
males	**407.3**	1121.2	9.8	20443.4	**397.5**	1110.1	10.6	23108.4
females	**186.6**	513.7	4.5	9365.6	**193.1**	539.1	5.2	11222.7
kids	**196.2**	540.2	4.7	9849.9	**135.6**	378.6	3.6	7882.4
boys	**237.8**	659.5	5.9	12280.0	**189.2**	540.2	5.4	11809.0
girls	**167.4**	464.5	4.1	8647.8	**95.7**	273.2	2.7	5972.3

Average, as opposed to marginal, income contributions of children are also higher than those obtained with the CES formulation (Table 17). While modest – from 3 to 8% for boys and 2.4 to 5.6% for girls depending on the child work variable used – these income contributions can be as high as 19% in specific households.

Table 17: Average percentage income contribution (GCD)

	Uninstrumented											
	Working kids				Non school-going kids				All kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
males	**10.4**	10.7	2.0	63.2	**10.8**	9.5	2.2	61.2	**8.2**	1.8	3.3	13.3
females	**18.3**	9.3	4.7	69.9	**17.8**	8.8	4.6	67.4	**13.9**	2.7	5.9	20.4
kids	**4.3**	**2.2**	**1.1**	**13.3**	**3.0**	1.6	0.7	9.4	**3.2**	0.7	1.3	5.6
boys	**3.1**	1.6	0.8	10.7	**3.4**	1.7	0.9	10.9	**3.8**	0.7	1.8	6.2
girls	**4.9**	2.4	1.3	15.7	**2.4**	1.2	0.6	8.1	**2.4**	0.5	1.1	3.7

	Instrumented							
	Working kids				Non school-going kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
males	**7.2**	2.8	2.3	18.1	**8.1**	2.3	3.1	15.0
females	**16.0**	4.8	5.6	30.3	**14.2**	3.3	5.8	23.1
kids	**6.8**	2.4	2.3	17.0	**4.5**	1.1	1.8	8.1
boys	**7.8**	2.5	2.9	19.1	**6.0**	1.3	2.8	10.1
girls	**5.6**	1.8	2.0	13.2	**3.1**	0.7	1.4	5.3

To better understand the causes of variations in children's income contributions across households, we examine the elasticity of child work productivity with respect to the other production inputs. As these elasticities vary little with the definition and disaggregation of the child work variable, we present only the results for the base regression (uninstrumented working children; Table 18). As in the case of the CES formulation, child work productivity is most sensitive to male and female labour inputs, although household assets also increase child work productivity substantially.

Table 18: Elasticity of marginal child work productivity to inputs (GCD)

Variable	Mean	s.d.	Min	Max
productive assets	0.06	0.02	0.00	0.07
material inputs	0.08	0.06	0.00	0.14
livestock	0.10	0.08	0.00	0.34
land	0.07	0.03	0.00	0.10
outside labour	0.04	0.03	0.00	0.09
males	0.31	0.01	0.00	0.32
females	0.16	0.00	0.00	0.17

5.4 Translog

The translog function is the most flexible functional form we examine. It is a second-order approximation of *any* function. For this reason, and the simplicity of its application, it is used widely. However, it shares with the Cobb-Douglas function the inability to handle zero-valued inputs. As in the case of the CD function, one common solution is to add a small arbitrary constant to all zero-valued inputs. We obtain:

(38) $$\ln Q = A + \sum_{i=1}^{I} \beta_i \ln(X_i + c) + \frac{1}{2}\sum_{i=1}^{I}\sum_{j=1}^{J} \gamma_{ij} \ln(X_i + c)\ln(X_j + c)$$

We could estimate this added constant as we did for the CD function (GCD), but this would be far more difficult given the introduction of interaction terms in the translog function. The marginal product of child work is given by the following formula:

(39) $$f_{LC} = \left(\beta_i + 2\gamma_{ii} \ln(X_i + c) + \sum_{j \neq i} \gamma_{ij} \ln(X_j + c)\right)\frac{Q}{(X_i + c)}$$

The elasticity of this marginal product with respect to other inputs is:

(40) $$\varepsilon_{LC,i} = \frac{f_{LC}^2}{Q} - \frac{f_{LC}}{(X_i + c)} + \frac{2\gamma_{ii} Q}{(X_i + c)^2}$$

Once again, we begin by presenting full results with uninstrumented total number of working kids as the child work variable, before considering the alternative child work variables (Table 19). We use 0.01 as the arbitrary added constant and later compare the results obtained when we use 0.1 and 1 as added constants.

Table 19: Base regression results (Translog (TL))

PRODUCTION INPUTS			PRODUCTION INPUTS (cont.)			SITE DUMMIES		
	Coef.	**t**		**Coef.**	**t**		**Coef.**	**t**
kids	0.038	0.8	**inputs X land**	-0.005	-1.7 *	**haresaw**	-0.636	-4.5 ***
material inputs	0.024	1.7	**inputs X adults**	-0.009	-0.8	**geblen**	-0.713	-4.8 ***
productive assets	-0.009	-0.4	**assets X livestock**	-0.014	-2.9 ***	**dinki**	-0.324	-2.5 **
livestock	0.169	4.1 ***	**assets X land**	-0.001	-0.2	**yetemen**	-0.193	-1.6
land	0.108	2.3 **	**assets X adults**	-0.002	-0.1	**shumsha**	0.169	1.6
adults	0.211	2.3 **	**livestock X land**	0.005	0.8	**sirbana**	0.261	2.2 **
kids^2	-0.021	-1.4	**livestock X adults**	0.025	1.0	**adele**	-0.138	-0.9
material inputs^2	0.009	3.3 ***	**land X adults**	-0.012	-0.4	**korod**	-0.073	-0.7
productive assets^2	0.009	2.9 ***	**OTHER CHARACTERISTICS**			**trirufe**	0.257	1.8 *
livestock^2	0.025	3.9 ***	**fertsh**	0.174	3.2 ***	**imdibir**	1.066	4.9 ***
land^2	0.012	1.8 *	**chat**	0.546	5.4 ***	**azedebo**	-0.677	-3.6 ***
adults^2	0.045	1.6	**coffee**	0.434	4.4 ***	**adado**	0.139	0.7
inputs X kids	-0.002	-0.7	**enset**	-0.061	-0.5	**garagod**	-0.708	-4.0 ***
assets X kids	-0.003	-0.6	**eucalyptus**	0.097	1.8 *	**doma**	0.353	2.6 ***
livestock X kids	0.015	2.4 **	**femhead**	-0.040	-0.7			
land X kids	-0.011	-1.5	**agehead**	-0.003	-1.7 *			
adults X kids	-0.045	-1.7 *	**headed**	0.025	2.9 ***			
inputs X assets	0.005	2.1 **	**outlabour**	0.105	2.2 **			
inputs X livestock	-0.002	-0.8	**Constant**	6.494	40.4 ***			

Notes: Dependent variable=log of total household income. All production inputs are logs. t=t-statistic. Number of observations=1354. Adjusted R^2=0.54. Significant at 10% (*), 5% (**) and 1% levels (***)

The TL formulation has an R^2 (=0.56) that is practically identical to those obtained with the CES and GCD. The coefficients on the other household characteristics and site dummies are also fairly similar. We reject, at the 5% significance level, the Cobb-Douglas hypothesis that the coefficients on all the interactive terms are nul ($F(21, 1303)=3.79 > F_{0.05}(21,1303)=1.56$) Given the interactive terms, the TL results are difficult to interpret directly. Instead, we look at the marginal products.

With the notable exceptions of working kids and land, the marginal products of production inputs resemble those obtained with the CES and GCD formulations (Table 20)[42]. The surprising result here is the negative average marginal product of working kids. Once again, we note a wide variation in marginal products between households, with strongly positive marginal products of children in many cases.

Table 20: Marginal products for base regression (TL)

Variable	Mean	s.d.	Min	Max
productive assets	**6.0**	10.2	-11.3	117.6
adults	**275.9**	907.3	7.4	17685.0
material inputs	**9.4**	53.9	0.1	765.3
livestock	**295.0**	898.2	-7747.2	13573.9
land	**62.5**	2916.3	-49604.1	34213.6
working kids	**-80.1**	474.3	-10582.5	4122.2

[42] The marginal product of adults is an average of the marginal products of males and females.

Given this unusual result for working kids, we now turn our attention to the alternative and disaggregate child work variables to see if they give the same results. When we use broader and/or instrumented child work variables, we obtain positive average marginal products for children, whether they are disaggregated by sex or not[43]. Furthermore, these marginal products quite closely resemble those obtained with the preceding CES and GCD formulations (Table 21). They are generally higher than those estimated with the CES formulation, but systematically lower than those obtained with the GCD formulation. When instruments are used, working children have a higher marginal product than school-going children. Relative to adults, children are one-fifth to one-half as productive depending on the child work variable used. The evidence on the relative productivity of boys and girls is ambiguous as boys are less productive in the OLS regression but more productive in the IV regression.

Table 21: Marginal products for alternative child work variables (TL): Constant=.01

	Uninstrumented											
	Working kids				Non school-going kids				All kids			
Variable	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**
adults	**275.9**	907.3	7.4	17685.0	**289.2**	892.3	8.5	17941.5	**347.4**	975.3	9.4	19965.1
kids	**-80.1**	474.3	-10582.5	4122.2	**55.8**	251.3	-619.2	6655.2	**115.2**	394.3	-12.9	9801.3
boys	**-40.0**	128.4	-1448.8	348.8	**69.0**	125.4	1.8	2317.9	**77.2**	258.2	-62.1	5655.1
girls	**-8.2**	492.1	-3156.2	7901.1	**119.6**	578.7	-540.7	12737.1	**100.6**	383.3	-369.5	8907.9

	Instrumented							
	Working kids				Non school-going kids			
Variable	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**
adults	**294.6**	655.6	9.0	15632.7	**329.0**	800.7	9.7	19801.4
kids	**153.4**	744.2	-440.8	20202.5	**82.8**	898.3	-966.0	25446.5
boys	**364.3**	2557.7	-10936.8	50321.4	**169.0**	437.9	-1182.0	9787.3
girls	**72.5**	281.4	-3216.7	3808.2	**86.0**	210.1	-377.8	3070.9

We re-run the regressions with alternative values for the added constant: 0.1 (Table 22) and 1 (Table 23) and find that the results are extremely sensitive to the choice of added constant. Given this sensitivity, we prefer the CES and GCD formulations and do not pursue the analysis with the translog any further.

[43] We use the same instrumenting equations as in the CES regressions. Once again, we do not satisfy the condition for applying the Hausman test for exogeneity but, using tests of overidentifying restrictions, we cannot reject the hypothesis that the model is correctly specified and the instruments are valid, even at the 10% confidence level: $\chi_3^2 = 1.4 < \chi_3^2(10\%) = 6.25$

Table 22: Marginal products for alternative child work variables (TL): Constant=0.1

	Working kids				Non school-going kids				All kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
	Uninstrumented											
adults	**296.6**	1142.0	-75.9	22731.1	**305.0**	1102.4	-16.0	22814.9	**361.4**	1151.8	-22.2	24073.2
kids	**-43.2**	397.1	-6475.1	6290.5	**25.8**	238.5	-3471.2	3872.4	**78.6**	253.4	-169.0	5803.2
boys	**-364.1**	5249.6	-142411.5	3455.5	**-263.6**	4597.1	-136625.1	1798.4	**101.8**	973.0	-25973.2	9928.0
girls	**262.8**	1402.6	-5692.5	27608.5	**-29.4**	766.0	-6648.2	13565.0	**27.9**	501.8	-5881.3	7026.2
	Instrumented											
adults	**307.8**	848.6	-15.3	22079.8	**323.5**	887.8	-17.3	22454.7				
kids	**119.9**	343.6	-1171.6	7771.1	**88.8**	372.6	-1326.5	8713.0				
boys	**-1090.3**	26241.2	-737119.1	3690.8	**-984.6**	27260.6	-833528.6	5787.8				
girls	**104.1**	1515.9	-13588.1	37475.1	**15.1**	642.5	-13915.7	3459.3				

Table 23: Marginal products for alternative child work variables (TL): Constant=1

	Working kids				Non school-going kids				All kids			
Variable	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
	Uninstrumented											
adults	**318.2**	1438.3	-161.2	33207.6	**320.1**	1354.3	-172.8	33265.6	**362.5**	1350.3	-199.1	31382.9
kids	**-0.6**	518.1	-7078.0	8302.5	**-9.6**	420.8	-9767.0	1294.4	**29.8**	238.3	-3797.6	3133.0
boys	**-296.6**	3635.2	-98429.4	1081.7	**-87.4**	1995.7	-59785.0	967.5	**37.5**	720.7	-18603.8	3521.3
girls	**168.0**	2232.9	-9203.8	60589.3	**6.8**	659.3	-12086.7	14017.6	**19.9**	360.0	-5973.5	5676.1
	Instrumented											
adults	**303.6**	870.0	-165.3	21564.8	**312.5**	880.4	-168.2	20673.3				
kids	**3.6**	423.3	-7016.0	2174.4	**29.5**	219.7	-2954.7	2663.1				
boys	**-67.7**	2980.8	-80682.7	6839.5	**3.6**	1674.2	-49416.8	4577.9				
girls	**4.4**	786.0	-12504.9	13840.5	**-5.6**	410.5	-8908.4	1860.9				

5.5 Generalised Leontief

Results obtained with the Generalised Leontief formulation, using uninstrumented working children as the child work variables, are presented in the table below (Table 24).

The fit of the base regression is less satisfying than in the preceding formulations (R^2-0.44). We also note that the child work variable is only significant in the interactive term with livestock. Similar results are obtained with the alternative child work variables (Table 25), although it is sometimes the interactive term with assets that is significant.

Table 24: Base regression coefficients (Generalised Leontief (GL))

Variable	Coef.	t	Variable	Coef.	t	Variable	Coef.	t
Child work variables			inputs$^{1/2}$*adults$^{1/2}$	147.5	3.7***	haresaw	-979.0	-0.7
kids	-38.1	-0.1	assets$^{1/2}$*livestock$^{1/2}$	871.7	15.1***	geblen	304.5	0.2
inputs$^{1/2}$*kids$^{1/2}$	-33.6	-0.9	assets$^{1/2}$*land$^{1/2}$	-637.6	-7.6***	dinki	-805.5	-0.6
assets$^{1/2}$*kids$^{1/2}$	60.4	0.8	assets$^{1/2}$*adults$^{1/2}$	-66.8	-0.9	yetemen	-1577.9	-1.2
livestock$^{1/2}$*kids$^{1/2}$	1633.9	3.0***	livestock$^{1/2}$*land$^{1/2}$	589.6	1.4	shumsha	1982.4	1.7*
land$^{1/2}$*kid$^{1/2}$	-717.0	-1.3	livestock$^{1/2}$*adults$^{1/2}$	-3678.6	-8.1***	sirbana	-83.5	-0.1
adults$^{1/2}$*kid$^{1/2}$	-447.2	-0.8	land$^{1/2}$*adults$^{1/2}$	2755.7	5.2***	adele	-2410.3	-1.5
Other variables			lemsh	-502.8	-0.9	korod	469.2	0.4
material inputs	-0.4	-0.4	dothl1	241.4	0.5	trirufe	-2185.3	-1.4
productive assets	13.5	4.4***	chat	3722.9	3.4***	imdibir	5844.7	2.5**
livestock	-633.8	-5.0***	coffee	2732.5	2.6**	azedebo	-4610.8	-2.3**
land	-215.6	-1.6	enset	1581.0	1.3	adado	-3331.6	-1.7*
adults	469.5	1.4	eucalyptus	-401.6	-0.7	garagod	-5557.0	-2.9***
inputs$^{1/2}$*assets$^{1/2}$	-23.8	-5.6***	femhead	-529.2	-0.9	doma	1485.4	1.0
inputs$^{1/2}$*livestock$^{1/2}$	32.0	0.9	agehead	-9.8	-0.6	constant	221.6	0.2
inputs$^{1/2}$*land$^{1/2}$	-36.2	-0.9	headed	14.5	0.2			

Note: Dependent variable is income. Coef.=regression coefficient; t=t-statistic. Adjusted R^2=0.44

Table 25: Coefficients with alternative child work variables (GL)

	Uninstrumented						Instrumented			
	Working kids		NSG kids		All kids		Working kids		NSG kids	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
kids	-38.1	-0.1	249.2	0.5	357.0	0.8	853.9	1.2	790.7	1.1
inputs$^{1/2}$*kids$^{1/2}$	-33.6	-0.9	-16.9	-0.5	-17.0	-0.5	-11.9	-0.2	-53.9	-1.2
assets$^{1/2}$*kids$^{1/2}$	60.4	0.8	21.6	0.3	-311.4	-4.2***	-380.6	-3.8***	76.3	0.8
livestock$^{1/2}$*kids$^{1/2}$	1633.9	3.0***	873.4	1.7*	669.2	1.3	801.2	1.2	918.5	1.6
land$^{1/2}$*kids$^{1/2}$	-717.0	-1.3	138.0	0.3	416.4	0.8	415.5	0.6	-438.8	-0.8
adults$^{1/2}$*kids$^{1/2}$	-447.2	-0.8	-831.7	-1.4	0.4	0.0	-295.6	-0.4	-925.4	-1.4
boys	575.7	0.7	442.6	0.6	-20.1	0.0	7.4	0.0	-29.5	-0.1
girls	7.7	0.0	381.3	0.6	512.9	0.8	895.4	1.0	525.3	0.9
inputs$^{1/2}$*boys$^{1/2}$	-3.7	-0.1	-12.7	-0.3	23.2	0.6	40.3	0.8	23.5	0.6
inputs$^{1/2}$*girls$^{1/2}$	-22.5	-0.5	0.8	0.0	-59.5	-1.5	-60.0	-1.2	-59.7	-1.5
assets$^{1/2}$*boys$^{1/2}$	-768.1	-8.9***	-642.5	-7.9***	-421.1	-4.8***	-508.9	-4.1***	-422.7	-4.8***
assets$^{1/2}$*girls$^{1/2}$	715.9	8.3***	668.0	7.8***	-20.9	-0.2	-88.8	-0.8	-19.8	-0.2
livestock$^{1/2}$*boys$^{1/2}$	1215.4	2.0*	437.0	0.8	-25.0	0.0	100.5	0.1	-36.0	-0.1
livestock$^{1/2}$*girls$^{1/2}$	1555.9	2.8***	587.9	1.1	990.4	1.8*	1168.7	1.7*	989.3	1.8*
land$^{1/2}$*boys$^{1/2}$	1528.1	2.7***	1652.3	3.1***	1204.8	2.3**	1548.6	2.3**	1225.8	2.3**
land$^{1/2}$*girls$^{1/2}$	-2222.2	-3.9***	-1452.4	-2.7***	-585.1	-1.1	-742.0	-1.1	-585.3	-1.0
adults$^{1/2}$*boys$^{1/2}$	375.4	0.5	481.3	0.8	507.6	0.8	121.0	0.1	515.6	0.8
adults$^{1/2}$*girls$^{1/2}$	-1545.1	-2.2**	-1846.9	-2.9***	-387.3	-0.6	-526.6	-0.7	-391.9	-0.6
boys$^{1/2}$*girls$^{1/2}$	-302.9	-0.5	-9.0	0.0	152.7	0.3	739.6	0.8	139.6	0.3

Notes: The dependent variable is household income; inputs=material inputs; assets=productive assets; Coef.=regression coefficient; t=t-statistic; NSG=non school-going.

The coefficients in the preceding tables are difficult to interpret given the presence of numerous interactive terms. To better understand these results, we use the estimating equation to calculate the marginal product of child work for each household and present the resulting distribution of marginal products below (Table 26).

Table 26: Marginal products with alternative child work variables (GL)

	Working kids				Non school-going kids				All kids			
Variable	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**	**Mean**	**s.d.**	**Min**	**Max**
	Uninstrumented											
adults	303.4	983.9	-9697.8	7641.1	249.1	929.9	-9950.7	6997.9	363.1	848.4	-9616.0	6222.7
kids	**121.5**	**570.0**	**-3164.0**	**3892.2**	**149.1**	**324.4**	**-907.2**	**1928.8**	**17.6**	**542.7**	**-4784.6**	**1788.9**
boys	**102.4**	**1605.4**	**-19080.0**	**3548.9**	**35.7**	**1359.2**	**-16383.8**	**4400.6**	**-140.5**	**1015.9**	**-10248.0**	**3196.1**
girls	**282.8**	**1907.7**	**-9289.7**	**20165.0**	**394.8**	**1508.2**	**-6378.1**	**17420.9**	**155.7**	**393.4**	**-2207.7**	**2641.8**
inputs	2.7	8.2	-57.6	76.0	3.7	10.5	-56.3	131.5	2.9	9.0	-45.7	107.3
assets	-2.4	137.9	-2410.9	419.5	-5.7	132.3	-2451.7	413.7	-19.2	124.2	-2270.9	387.1
livestock	248.1	2388.4	-15254.6	22920.0	-55.6	2439.8	-20289.8	19656.6	-22.6	2562.2	-22020.7	18695.9
land	-114.6	2104.9	-16949.7	11101.1	305.3	2241.4	-14039.6	19464.2	340.4	2402.0	-23603.0	20977.8
	Instrumented											
adults	352.2	828.9	-9519.0	6035.8	246.8	972.7	-9848.9	7064.5				
kids	**-75.3**	**1328.6**	**-13060.1**	**2160.2**	**282.5**	**502.5**	**-1871.6**	**3147.0**				
boys	**-565.9**	**2893.0**	**-35024.0**	**4509.4**	**-153.0**	**1131.0**	**-10308.9**	**3250.4**				
girls	**195.1**	**722.4**	**-3945.3**	**3831.6**	**158.9**	**394.7**	**-2200.9**	**2644.3**				
inputs	2.8	9.5	-64.9	114.1	2.2	10.5	-64.0	135.1				
assets	-17.0	124.1	-2226.9	387.1	-3.1	138.4	-2441.7	414.3				
livestock	-28.8	2551.2	-20547.2	19118.7	46.1	2273.5	-21491.6	13323.2				
land	228.3	2292.1	-23448.6	18988.8	-116.0	2644.0	-27633.7	15228.9				

Note: MP=marginal product (evaluated at vector of mean values for the explanatory variables). t=t-stat. inputs=material inputs and assets=productive assets. NSG=non school-going.

While the results generally conform with those in the preceding formulations, they are much more sensitive to the choice of child work variable. Also, the dispersion of the marginal products, as measured by their standard deviation and the difference between the minimum and maximum values, is enormous. Under these conditions, we do not pursue the analysis of the total income contribution of children and the elasticities of children's marginal productivity with respect to the other production inputs.

These somewhat disappointing results with the GL formulation are not altogether surprising. In their studies using the Generalised Leontief production function, Lambert and Magnac (1992) also encounter this problem of low precision. Barrett, Sherlund et al. (2000) end up rejecting the Generalised Leontief function in favour of a cubic alternative as it failed specification tests.

6. Conclusion

We estimate a household income function derived from an agricultural household model with child work inputs. The presence of zero values for numerous inputs creates methodological problems that we attempt to solve in a variety of ways: adding an arbitrary constant to input values, use of a sub-sample of household with no zero inputs, alternative functional forms. Several alternative functional forms are tested: CES, Cobb-Douglas (CD), Generalised Cobb-Douglas (GCD), translog and Generalised Leontief (GL).

Results from the CES formulation indicate that child, male adult and female adult household members are perfect labour substitutes. They also suggest that the elasticity of substitution between aggregate household labour and the other production inputs is not unitary as postulated in the CD formulation. Results obtained with the Generalised Leontief and translog functions are shown to be sensitive to the choice of child work variable and added constant, respectively. The CES and GCD formulations emerge as our favourites as they generate sensible and statistically significant results without requiring the imposition of arbitrary added constants to zero input values.

In the absence of data on the hours worked by children, we use numbers of children who have work (as opposed to school or neither work nor school) as their stated main activity as the core child work variable. In recognition of the fact that school-going and "inactive" children also perform work, we experiment with alternative child labor variables that include these children. We also instrument this variable to control for the downward endogeneity bias; numbers of working children may decrease with income.

The results indicate that the average value for the marginal product of working children varies between 110.9 and 196.2 Birrs (roughly $US22 to 39[44]) in households where average income is 3156 Birrs (roughly $US 600). These values are roughly equal to one-third to one-half the marginal product of male adults. Somewhat lower values are obtained when inactive children are included (79.8 to 135.6 Birrs), as could be expected. OLS estimates also tend to be somewhat lower than these instrumental variables (IV) results (69.5 to 123.1 Birrs for working children). Marginal products of children vary between 20% and 50% those of male adults. Boys are found to have a marginal productivity that is roughly 50% higher than girls, perhaps due to their greater specialisation in directly income-producing activities. Age disaggregate results were statistically insignificant.

The average **total** income contribution of working children, per child worker, is estimated between 4.4 and 6.8% of total household income, once again with lower values for inactive children and OLS estimates. These results suggest that child work makes a significant income contribution. This is a striking result as the income contribution of children's labour is often

[44] The higher (lower) value corresponds to the GCD (CES) formulation.

considered to be of little importance. Furthermore, our analysis neglects non-income contributions, which may be particularly important in the case of girls.

There is significant inter-household variation in the marginal and average productivity of children. The total income contribution per child worker ranges up to a maximum of 52.3% of household income. We explore the determinants of child work productivity by estimating its elasticity with respect to other household production inputs. The results of this analysis suggest that child work productivity is especially strongly and positively associated with the number of adults in the household, although household assets and material inputs also have strong positive effects.

In the future, research using databases containing a larger sample of households and data on hours worked by children may provide more precise estimates of children's income contributions. It is also important to repeat this analysis in other countries to see how children's income contributions vary. It would also be interesting to examine children's income contribution in a specific activity, such as crop production or livestock, if data on household inputs could be allocated between household activities. Not only would this be a more conventional production function, but it would also reduce or eliminate the zero-valued input problem, allowing the use of the flexible translog function. In particular, the translog function could be used for a deeper analysis of the substituability/complementary of different inputs with respect to child work. This would provide us with a better understanding of the causes of inter-household variations in children's income contributions and the determinants of child work and schooling decisions.

7. References

Barrett, C. B., S. M. Sherlund, et al. (2000). Shadow Wages, Allocative Inefficiency and Labor Supply in Smallholder Agriculture. mimeo, Ithaca (New York), Dept. of Agricultural, Resource and Managerial Economics (Cornell University)**:** 35.

Basu, K. and H. P. Van (1998). “The Economics of Child Labor.” American Economic Review **88**(3): 412-427.

Bhalotra, S. and C. Heady (1998). Child Labour in Rural Pakistan and Ghana. mimeo, Bath and Bristol, University of Bristol and University of Bath.

Bound, J., D. A. Jaeger, et al. (1993). The Cure Can Be Worse than the Disease: A Cautionary Tale Regarding Instrumental Variables. Technical Paper, Cambridge (MA), NBER**:** 23.

Cain, M. T. (1977). “The Economic Activities of Children in a Village in Bangladesh.” Population and Development Review **3**(3): 201-227.

Caldwell, J. C. (1977). “The Economic Rationality of High Fertility: An Investigation Illustrated with Nigerian Data.” Population Studies **31**(1): 193-213.

Canagarajah, S. and H. Coulombe (1997). Child Labor and Schooling in Ghana. Policy Research Working Paper, Washington, World Bank.

Croppenstedt, A. and C. Muller (2000). “The Impact of Farmers' Health and Nutritional Status on their Productivity and Efficiency: Evidence from Ethiopia.” Economic Development and Cultural Change **48**(3): 475-502.

De Tray, D. (1983). “Children Work Activities in Malaysia.” Population and Development **9**(3).
De Tray, D. (1983). Children's Economic Contributions in Peninsular Malaysia. A Rand Note, Santa Monica (CA), RAND**:** 49.
De Vos, S. (1985). “An Old-Age Security Incentive for Children in the Philippines and Taiwan.” Economic Development and Cultural Change **33**(4): 793-814.
Diewert, W. E. (1971). “An Application of the Shephard Duality Theorem: A Generalized Leontief Production Function.” Journal of Political Economy **79**(3): 481-507.
Fure, E. (1983). “Are Children Poor Men's Riches?” Scandinavian Economic History Review **31**(3): 161-77.
Gronau, R. (1986). Home Production - A Survey. Handbook of Labor Economics. O. Ashenfelter and R. Layard. Amsterdam, Elsevier. **I:** 273-304.
Gronau, R. (1997). “The Theory of Home Production: The Past Ten Years.” Journal of Labor Economics **15**(2): 197-205.
Hoddinott, J. (1992). “Rotten Kids or Manipulative Parents: Are Children Old Age Security in Western Kenya.” Economic Development and Cultural Change: 545-565.
ILO (1995). Report of the National Workshop on Child Labour in Ethiopia, Nazareth, Ethiopia, Eastern Africa Multidisciplinary Advisory Team (EAMAT, ILO).
ILO (1996). Report on the National Workshop on Child Labour Policy and Action Programme for Ethiopia, Debre Zeit, Ethiopia, Eastern Africa Multidisciplinary Advisory Team (EAMAT, ILO).
Jacoby, H. G. (1992). “Productivity of Men and Women and the Sexual Division of Labor in Peasant Agriculture of the Peruvian Sierra.” Journal of Development Economics **37**: 265-287.
Jacoby, H. G. (1993). “Shadow Wages and Peasant Family Labour Supply: An Econometrics Application to the Peruvian Sierra.” Review of Economic Studies **60**: 903-921.
Johnson, S. R. and G. C. Rausser (1971). “Effects of misspecifications of log-linear functions when sample values are zero or negative.” American Journal of Agricultural Economics **53**: 120-124.
Lambert, S. and T. Magnac (1992). Recursive or Non Recursive Agricultural Household Decision Making: An Application to Cote d'Ivoire. Document, Paris, DELTA.
Lambert, S. and T. Magnac (1994). Measurement of Implicit Prices of Family Labour in Agriculture: An Application to Côte d'Ivoire. Agricultural Houshold Modelling and Family Economics. F. Caillavet, H. Guyomar and R. Lifran. Amsterdam, Elsevier**:** 9-24.
Lambert, S. and T. Magnac (1998). Implict Prices and Recursivity of Agricultural Households' Decisions. mimeo, Paris, INRA (ENS)**:** 33.
Levison, D. and K. S. Moe (1998). “Household Work as a Deterrent to Schooling: An Analysis of Adolescent Girls in Peru.” Journal of Developing Areas **32**(3): 339-356.
MaCurdy, T. E. and J. H. Pencavel (1986). “Testing between competing models of wage and employment determination in unionised markets.” Journal of Political Economy **94**: S3-S39.
Mergos, G. J. (1992). “The Economic Contribution of Children in Peasant Agriculture and the Effect of Education: Evidence from the Philippines.” Pakistan Development Review **31**(2): 189-201.
Mueller, E. (1984). “The Value and Allocation of Time in Rural Botswana.” Journal of Development Economics **15**: 329-360.
Rosenzweig, M. R. (1978). The Value of Children's Time, Family Size and Nonhousehold Child Activities in a Developing Country: Evidence from Household Data. Research in Population Economics. J. C. Simon. Connecticut, JAI Press. **1:** 331-347.
Rosenzweig, M. R. (1981). Household and Non-household Activities of Youths: Issues of Modelling, Data and Estimation Strategies. Child Work, Poverty and Underdevelopment. ILO. Geneva, ILO**:** 215-243.

Rosenzweig, M. R. and R. Evenson (1977). “Fertility, Schooling, and the Economic Contribution of Children in Rural India: an Econometric Analysis.” Econometrica **45**(5): 1065-1079.
Sadoulet, E. and A. de Janvry (1995). Quantitative Development Policy Analysis. Baltimore (Maryland), Johns Hopkins University Press.
Skoufias, E. (1994). “Using Shadow Wages to Estimate Labor Supply of Agricultural Households.” American Journal of Agricultural Economics **76**: 215-227.
Udry, C. (1996). “Gender, Agricultural Production, and the Theory of the Household.” Journal of Political Economy **104**(5): 1010-1040.
Vlassoff, M. (1979). “Labour Demand and Economic Utility of Children: A Case Study of Rural India.” Population Studies **33**(3): 415-428.
Vlassoff, M. (1982). “Economic Utility of Children and Fertility in Rural India.” Population Studies **36**(1): 45-59.
Vlassoff, M. and C. Vlassoff (1980). “Old Age Security and the Utility of Children in Rural India.” Population Studies **34**(3): 487-499.
Weir, S. and J. Knight (2000). Education Externalities in Rural Ethiopia: Evidence from Average and Stochastic Frontier Production Functions. Working Paper, Oxford (UK), CSAE**:** 27.
Weninger, Q. (1998). . Working paper, , Utah State University.
World Bank (1998). World Development Indicators. Washington (D.C.).
World Bank (1999). The Child Labor Program, Washington D.C., Social Protection (Human Development Network, World Bank)**:** 15.

8. Appendix

Table A- 1: Definition and mean values of regression variables

VARIABLE	DEFINITION	MEAN VALUES				
	Kids (aged 6 to 15) in household	Uninstrumented			Instrumented	
		All	Working	NSG	Working	NSG
kids	Children	1.81	1.07	1.49	1.07	1.49
boys	Boys	0.90	0.49	0.70	0.49	0.69
girls	Girls	0.92	0.58	0.79	0.58	0.79

VARIABLE	DEFINITION	MEAN
income	Total household income	3156.25
	Production inputs	
females	Female household members (aged 16 to 59)	1.53
males	Male household members (aged 16 to 59)	1.50
adults	Adults household members (aged 16 to 59)	3.03
household labour	Aggregate of male, female and child household members	See note
outside labour	Hours of labour by non household members (hired or labour sharing)	62.78
land	Land owned by household (hectares)	1.89
material inputs	Value of inputs (fertiliser, seeds, etc.) used by household	186.99
livestock	Value of livestock owned by the household	1.97
productive assets	Value of productive assets (hoes, ploughs, etc.) owned by household	66.35
	Other characteristics	
fertsh	Share of land that is fertile (lem)	0.45
chat	Dummy:=1 if household owns a chat plant; 0 if not	0.13
coffee	Dummy:=1 if household owns a coffee plant; 0 if not	0.28
enset	Dummy:=1 if household owns an enset plant; 0 if not	0.30
eucalyptus	Dummy:=1 if household owns an eucalyptus; 0 if not	0.37
femhead	Dummy:=1 if household head is female; 0 if not	0.19
agehead	Age of head (in years)	46.48
headed	Years of education of household head	1.54
outlabour	Dummy:=1 if household used outside labour	0.679
	Site dummies	
haresaw	Dummy:=1 if household in Haresaw site; 0 if not	0.04
geblen	Dummy:=1 if household in Geblen site; 0 if not	0.05
dinki	Dummy:=1 if household in Dinki site; 0 if not	0.05
yetemen	Dummy:=1 if household in Yetemen site; 0 if not	0.04
shumsha	Dummy:=1 if household in Shumsha site; 0 if not	0.09
sirbana	Dummy:=1 if household in Sirbana site; 0 if not	0.06
adele	Dummy:=1 if household in Adele Keke site; 0 if not	0.07
korod	Dummy:=1 if household in Korodegaga site; 0 if not	0.08
trirufe	Dummy:=1 if household in Trirufe site; 0 if not	0.07
imdibir	Dummy:=1 if household in Imdibir site; 0 if not	0.05
azedebo	Dummy:=1 if household in Aze Deboa site; 0 if not	0.05
adado	Dummy:=1 if household in Adado site; 0 if not	0.09
garagod	Dummy:=1 if household in Garagodo site; 0 if not	0.07
doma	Dummy:=1 if household in Doma site; 0 if not	0.05
	Additional variables used in instrumenting equations	
agekid1	Average age of children in the household	10.25
sexr	share of boys among children	0.49

Notes: Mean value for labour variable depends on child work variable. NSG=non school-going

Table A- 2: Instrumenting equation for working children

Source	SS	df	MS
Model	733.929628	31	23.6751493
Residual	656.281911	1008	.651073324
Total	1390.21154	1039	1.33802843

Number of obs	=	1040
F(31, 1008)	=	36.36
Prob > F	=	0.0000
R-squared	=	0.5279
Adj R-squared	=	0.5134
Root MSE	=	.80689

kidwrk	Coef.	Std. Err.	t	P>|t|	(95% Conf.	Interval)
kid	**.5597317**	**.0203508**	**27.50**	**0.000**	**.519797**	**.5996664**
agekid1	**.0736122**	**.0122597**	**6.00**	**0.000**	**.0495548**	**.0976697**
sexr	**-.1354948**	**.0681673**	**-1.99**	**0.047**	**-.269261**	**-.0017287**
passval	-.0002721	.0001521	-1.79	0.074	-.0005706	.0000264
amale	.0307274	.0297872	1.03	0.303	-.0277248	.0891795
afemale	.0126948	.0306113	0.41	0.678	-.0473744	.0727639
input	-.000127	.0000657	-1.93	0.054	-.000256	1.96e-06
lvvalo1	.0062295	.0057887	1.08	0.282	-.0051297	.0175887
landown	.002617	.0072631	0.36	0.719	-.0116354	.0168695
lemsh	.0121422	.0693342	0.18	0.861	-.1239137	.1481982
femhead	-.062882	.0713532	-0.88	0.378	-.2028999	.0771359
agehead	-.0018787	.002053	-0.92	0.360	-.0059073	.0021499
headed	-.0461821	.0113838	-4.06	0.000	-.0685207	-.0238435
chat	.2232945	.1263057	1.77	0.077	-.0245578	.4711467
coffee	-.2689183	.1306977	-2.06	0.040	-.5253891	-.0124476
enset	-.0244236	.1574446	-0.16	0.877	-.3333804	.2845331
eucalyptus	.1672157	.0695597	2.40	0.016	.0307173	.303714
haresaw	-.8300696	.1451456	-5.72	0.000	-1.114892	-.5452474
geblen	-.3340099	.1524599	-2.19	0.029	-.633185	-.0348348
dinki	-.1423878	.1622234	-0.88	0.380	-.4607222	.1759465
yetemen	-.2224701	.1667337	-1.33	0.182	-.549655	.1047148
shumsha	-.0795363	.1278817	-0.62	0.534	-.3304811	.1714085
sirbana	-.3051934	.1360967	-2.24	0.025	-.5722587	-.0381281
adele	-.1753307	.171966	-1.02	0.308	-.5127831	.1621218
korod	.0991001	.1266412	0.78	0.434	-.1494105	.3476107
trirufe	-.7162278	.180433	-3.97	0.000	-1.070295	-.3621605
imdibir	-.8666384	.2682809	-3.23	0.001	-1.393091	-.3401854
azedebo	.0731314	.2319195	0.32	0.753	-.3819688	.5282317
adado	-.3255329	.2416675	-1.35	0.178	-.799762	.1486961
garagod	.0769884	.2141557	0.36	0.719	-.3432535	.4972304
doma	-.3153717	.1537676	-2.05	0.041	-.617113	-.0136303
_cons	-.2880603	.188032	-1.53	0.126	-.6570392	.0809186

Note: Instruments that are excluded from the production function are indicated in bold.