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Estimation of the Contribution of Child Labour to the Formation of Rural Incomes:

An Application to Nepal

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Abstract

This paper estimates the contribution of child labour to the formation of household income in rural enterprises. The contribution to household income from the employment of children comes either from the employment on-farm at a shadow wage or off-farm in the agricultural or other sectors. The paper uses a cost function with household labour as a quasi-fixed factor in order to estimate the shadow wage for each component of the household labour force. The study also provides an estimate of contribution of child labour to household income in the rural sector, both at the household and national level. A set of simulation also highlight the role that child labour plays in insuring household subsistence and how it does affects income distribution.

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1. Introduction

Child labour is the result of a complex household decision. Such a decision reflects, inter alia, the intertemporal allocation of resources, the access to credit markets and the relative returns of education versus work. If schools are not available, or their quality is very poor, the decision to send a child to work might be due more to the lack of alternatives than to the additional income generated through work. On the other hand, if the household is very poor and lacks access to credit market, the income generated by the children might be essential to guarantee the survival of the household and of the child.

Information about the value of children's time outside of school is also very important for other aspects of policy design, such as incentive schemes, like contingent cash transfers, and more traditional transfer schemes. In general, policies aimed to incentivate child schooling need information of the likely contribution of children's to household income in order to be properly designed.

Knowledge of the value of children's output also helps to shed light on the issue of the relative productivity of child versus adult labour. In order to understand better the demand for child labour and the possible substitutability between child and adult labour, information on relative productivity is important.

The main difficulty encountered in this area is given by the fact that most of the children do not work for a wage, but with their family: typically a farm or petty business. Therefore it is difficult to measure their contribution to family income. Given the imperfection of the labour market, especially in agriculture, it is difficult to infer children's contribution to household income by using observed market wage. Moreover, even if it were possible, in the typical data sets available the number of observations on children's wage is too small to allow for any robust inference.

Up to now very few systematic attempts have been made to fill this gap in information. Researchers have mainly used extrapolation from children's wage equation, with the limitations discussed above, cell averages or direct estimation of production function in farm or business sector.

This paper tries to address the problem in a systematic and consistent way starting from the observation that the contribution of children to household income cannot be assessed, where it is most prevalent, by relying on market measures. It is necessary to model the whole production and consumption process of the household in order to obtain a consistent measure of the children's and other household members "shadow" wage rate. On this basis it is possible to "impute" the value of the children's contribution in terms of output of the family farm or

business and obtain an estimate of the relative importance of child labour for the current welfare of the household.

In particular we will focus on the contribution of child labour to the formation of household income in agricultural enterprises. Such a contribution from the employment of children may come from the self-employment on- the family farm where labour is evaluated as a shadow wage, or from off-farm employment in the agricultural or other sectors.

We estimate a cost function assuming household labour as a quasi-fixed factor in order to obtain a measure of the shadow wage for each component of the household labour force, of the relative distance of the value of children labour productivity from the competitive wage and of how this distance varies with productive circumstances, such as farm type, location, technologies, presence of irrigation, etc., and household organizational models.

The study also provides an estimate of the size of the children shadow economy compared to the adult contribution.

It is unrealistic to assume that agricultural labour markets are competitive in Nepal. About 40 per cent of the Nepalese farm economy is subsistence agriculture isolated from both output and factor markets. The basic economic unit of Nepalese agriculture is the farm-household. When the production and consumption decision variables are non-separable, then market goods and leisure are not priced at the market value. The evaluation of labour, therefore, is shadow and is revealed by the value of the marginal farm product. Non-separability is present by definition in subsistence farming which can be considered as closed micro-economy, as first described in Chayanov (1926) and Sen (1966). The shadow wage depends on the characteristics of the workers and their hedonic value (Brown 1983, Barten1964, Benjamin 1992). Accounting for the heterogeneity between adult and child work allows to estimate a different shadow wage for the adult and the child. This last assumed to be a fraction of adult wage rate as in Basu 1998, 1999,2000.

The estimation of the shadow wage can be performed either from the primal side, as traditionally done (Jacoby 1993, Skoufias 1994, Lambert and Magnac 1994) or from the dual side using either a cost, as in the present work, or a profit function. While we will focus here on estimations based on the dual side, we will also compare our results with those stemming from the direct estimation of a production function.

One of the main problems encountered in the estimation of the shadow wages for the Nepalese agricultural sector is the modelling of multiple-output production technologies and of zero realization due to the fact that not all farms produce all outputs and all inputs. We deal with this censoring problem by adopting an extension of the Heckman model to estimate a system of equations with multiple censored variables.

We make use of Nepal Living Standard Survey 1996 to estimate a system of equations that includes the cost function and the input demand shares, modified to allow for quasi-fixed factors and both worker and farm characteristics. As mentioned above we prefer to derive the shadow wages from the dual side as marginal costs, rather than from direct estimates of marginal productivities as done in other studies (Jacoby 1993 and Skoufias 1994). The dual approach permits to model household labour as a quasi-fixed factor. Shadow wages can then be modified to take into account differences in parents and children's characteristics. This structure permits deriving effective shadow wages with relevant policy implications.

The paper first discusses the importance of child labour for the Nepalese farm-household economy and describes the main features. The third section introduces the estimated farm-household model. The econometric methodology is described in the subsequent section. Section 5 presents a description of the data. In Section 6, we report the econometric technique adopted to deal with censoring in hired labour input. Then, in Section 7 we comment the results of our empirical evidence. The conclusions follow.

2. Child labour in Nepal: importance for the farm-household economy

The following section, as well as the rest of the empirical analysis, is based on the Nepal 1996 LSMS survey. The Nepal Living Standards has been designed and managed by the World Bank. Data collection has been planned over a full year to cover a complete cycle of agricultural activities and capture seasonal variation in variables such as water availability. Field work took place in four subsequent phases starting in June 1995 and finishing in May 1996. The actual dataset numbers 3,373 households. The Nepal Living Standards are being used by the Central Bureau of Statistics in preparation of findings. World Bank used the data in the preparation of a Poverty Assessment. For more details on sample design, survey questionnaires, and field work see Nepal Living Standards Survey – Survey Design and Implementation 1998, World Bank.

About 81 per cent of Nepalese labour force is employed in the agricultural sector which accounts for about 40 per cent of GDP. Because of low investments, the level of human development is also low, limiting people's choices and capabilities. Child labour is mainly employed in agriculture. In Nepal, child work is concentrated mainly in self employed agriculture and is more frequent in poor households. Basu and Van's (1998) luxury argument is not the only reason for employing a child in the farm or in the household (Deb and Rosati 2002). Lack of off-farm job or educational opportunities (Bahlotra and Heady 2002), food insecurity and health status also help explaining the high demand for farm work. Child labour is also a consumption-smoothening strategy for poor households operating in risky environments

and in regions where credit markets are missing or inefficient (Mealli, Guarcello, and Rosati 2003). As maintained by Skyt Nielsen and Dubey (2002), the lack of parental human capital may explain high fertility rates making less resources available to enroll children to school.

As it is reasonable to think, a precondition for child labour is that children can substitute adults' labour (Basu and Van 1998). In general, substitution between child and adult labour implies that a child can do the same type of job as an adult, but not necessarily equally well. In agriculture, children can substitute for adults, but they may produce a product of lower quality either because of differences in strengths or skills and/or because are employed in different agricultural activities. Farm child labour is seasonal when competing with schooling.

The Nepalese micro-data from the Living Standard Survey (NLSS) brings interesting evidence on the importance of child labour in the farm household economy, the trade-off between employing a child on the farm or sending the child to school, and the substitution between adult and child labour.

Table 1 reports the geographical distribution and some family characteristics for the whole Nepalese NLSS sample, for household without and with at least one working child 10-14 years old. The latter sub-sample is divided in children self-employed in agriculture and children employed in other paid jobs. In the sample about 50 per cent have children. Among those who have children, about 31 per cent of the households have children who do not work. In the remaining households with working children, amounting to 21 per cent of the sample, 81 per cent of the households self-employ their children in agricultural activities.

Inspection of Table 1 reveals that the average household is headed by a 44.6 years old breadwinner and is composed of 6 members, 3 adults and 3 children. The household composition does not differ significantly across classes with and without working children. The level of education of the head of the household with non-working children is, though low, about twice as much as the level of education of households with working children. About 39 per cent of the households live in Central Nepal and more than half of the households is located in the hillside. About 30.6 per cent of the whole NLSS has at least a child 10-14 years old. In 69 per cent of the cases, there are children either working in agriculture (80.53) or in other paid job (19.44). Among the households with children self-employed in agriculture and for households with children employed in other paid jobs the average age of the head does not vary significantly. The average size of the household with children self-employed in agriculture is 0.6 times bigger than the average size of households with children employed in other sectors. In the Tarai region there are more off-farm opportunities judging by the high proportion (0.482) of children not self-employed in agriculture.

Table 2 addresses the link between household income and child labour in Nepal. It

shows the distribution of children's working hours by expenditure quintile. Interestingly, the expenditure level of households with non working children is about 50 per cent higher than the level of total expenditure of households with working children. In general, children belonging to the first two quintiles work more than children belonging to households relatively more well-off. Working children self-employed in agriculture work less than children employed in other sectors. This is mainly due to the seasonality of the agricultural activities.

Table 3 illustrates the intra-household division of labour by component and occupation. In the households with working children, the wife supplies about the same working hours as the children. The child employed in non agricultural activities works more both with respect to a child self-employed in agriculture and to the mother. As the central panel of Table 3 shows, when the child is employed in the household farming activity, the adult component of the household is also employed for 86 per cent of its time in agriculture, mainly in their own farming activities. In the cases in which the child is not self-employed in agriculture, the adults are employed either in agriculture (30 per cent), in other sectors (10 per cent) or self employed outside the agricultural sector (25 per cent). Adults self-employed in non-agricultural activities are 25.2 per cent of the subsample of households with children non working in agriculture. The bottom panel of table 3 reports the distribution of the hours supplied by children across sectors. About 84 per cent is employed in the home agricultural activities and 9 per cent of the children is hired in other farms.

Table 4 describes the reasons for which children 10-14 years old never attended school. The absence or the distance of the school from home has a marginal importance (less than 5 per cent). School cannot be afforded by 25.4 per cent of the sampled Nepalese households. This constraint seems especially stringent in households with girls (16.1 per cent of the total). In 19.4 per cent of the cases help was needed at home especially from girls (69 per cent). Parents show a low propensity to invest in the education of their girls because, of the 26 per cent of the households where the parents are opposing school attendance, about 81 per cent of the cases involves girls. Boys and girls do not show a significantly different behaviour regarding their willingness to attend school.

In the Nepalese sample, 44.1 per cent of the farms produce for subsistence. This informal agricultural sector deserves special attention because these households are less connected to markets, enjoy lower off-farm job opportunities and have a more critical access to educational or other services. Table 5 compares the characteristics and the labour supply of the households engaged in subsistence agriculture with the other farming households. Subsistence farms are those farms that do not sell the product to the market and therefore self-consume what they produce. As expected, subsistence farm households on average have a total expenditure

lower that non-subsistence families. The household size is slightly lower and the numerosity within age classes is comparable. Subsistence farming is relatively more frequent in the Far-West and mountain regions of Nepal. Most importantly, children employed in subsistence farms work significantly more than children employed in non subsistence farms. The average level of education of the head of non subsistence farm-households is higher with respect to the level of education of the head of subsistence farms.

3. A Farm-Household Theoretical Model

We utilize a farm-household model to analyze the decisions concerning child labour based on the classical literature of subject (Singh, Squire and Strauss 1986, Huffman 2001). In order to specify a treatable model and taking into consideration the characteristics of child labour in Nepal, we find it reasonable to make the following assumptions.

Assumption 1. Until children reach maturity, the parents exert control upon children's choices over time and activities. For example, a child works and/or goes to school according to the parents' decision.

Assumption 2. Parents have the control of all the income that accrues to the household, both from adult and from child work. The parents distribute the income to the household members according to an undeclared sharing rule known to the household memebrs but not directly observable by the researcher. The model refers to a unitary household "glued together" and represented by the preferences of the adults.[1]

Assumption 3. A Nepalese child works in the household farm or off-farm mainly in agriculture; we therefore model the Nepalese household economy as an agricultural economy.

Assumption 4. Children consumption of leisure is invested in education. Hence, in our setting demand for leisure is equivalent to demand for schooling or human capital accumulation.

Assumption 5. The number of children is assumed to be exogenous to the family because typically Nepalese households have negligible control over their reproductive decisions and to affect both consumption and production decisions.

We further assume that the household maximizes a static utility function which is defined over a composite consumption good, leisure and demographic characteristics of both

[1] The unitary model is often empirically rejected when compared to collective models (Chiappori 1992, Donni 2001, Arias, Atella, Castagnini, and Perali 2003) based on individual behaviour. However, the main interest in this study is the derivation of shadow wages of child labour rather than learning something about the child participation decision and the intrahousehold distribution of resources.

parents and children. The single-output production technology adopts three quasi-fixed inputs, adult and child family labour and land, and two variable inputs, adult hired labour and capital. Let *W* be the welfare index of the household, then the maximization program is

$$\max_{C_i, l_i, L_i^O, L_i^H, L_i^I} W = U\left(C_p, C_s, l_p, l_s; d_p, d_s\right), \quad i = p, s,$$

$$s.t. C_p + C_s = \left[F(L, K, S; d_p, d_s) - wL^H\right] + w\sum_i L_i^O + y,$$

$$L_i^F = L_i^I + L_i^O,$$

$$L = \sum_i L_i^I + L^H, \quad i = p, s \tag{1}$$

$$T_i(d) = l_i + L_i^F = l_i + L_i^I + L_i^O, \quad i = p, s,$$

$$L_i^O \geq 0, \quad i = p, s$$

$$(C_i, l_i, L_i^I, L^H, L_i^O) \in \wp$$

where L is the sum of labour supplied by the parents p and children s employed on farm L_i^I and L^H is adult hired labour, L_i^O is labour supplied by parents and sons off-market either in agriculture or other sectors, though at a small extent in Nepal, at the market wage w. The term *C* refers consumption, *l* to leisure, and *d* is a set of demographic characteristics that influence the utility of the household such as parents and children age, gender and education. The notation S indicates land, K stands for capital. The off-farm wage is assumed to be the same for adults and children and for an employments either on other farms or in other sectors.[2] All off-farm time uses have the same price. The exogenous variable y measures non labour income. $\wp$ is the convex constraint set limiting the choices of $(C_i, l_i, L_i^O, L^H, L_i^F) \in \wp$. The set can include positivity constraints, or rationing because of particular market structures or other causes.

The utility function and the production function are twice continuously differentiable and strictly quasi concave. This structure guarantees that the cost function is properly defined and is regular. If we maintain the assumption of the existence of only one type of work remunerated at competitive conditions, then the set of constraints can be summarized in a single

[2] Assuming different values of the adults and children's market wage rate would just complicate the analysis without adding changing in any substantive way the results.

equation describing the household full income corresponding to the value of the endowment of consumption goods and household time

$$C_i + wl = p(.) + wT(d) + y = \left(F(L, K, S; d_p, d_s) - wL^H \right) + \sum_i w_i L_i^O + wT(d) + y = Y \tag{2}$$

where $p(.) = \left(F(L, K, S; d_p, d_s) - wL^H \right)$ is the non maximized "accounting" function of farm profits.

The maximization of the household welfare program presented above, after solving for the time constraint, leads to the Lagrangian function:

$$\begin{aligned} &= U\left(C_p, C_s, T_p - L_p^I - L_p^O, T_s - L_s^I - L_s^O; d_p, d_s \right) + \\ &+ l\left(F(_i L_i^I + L^H, K, S; d_p, d_s) - wL^H + \sum_i w_i L_i^O + y - C_p - C_s \right) + m_p L_p^O + m_s L_s^O, \end{aligned} \tag{3}$$

where l is the Lagrangian multiplier associated with the budget constraint, and m_p, m_s are the Lagrangian multiplier associated with the inequality constraints related to the off-farm market labour choices of adults and children.

Maximization of the Lagrangian with respect to C_i, L_i^I, L_i^O, L^H yields the following first order conditions

$$\begin{aligned} U_{C_i} &= l, \\ U_{L_i^I} &= l F_{L_i^I}, \\ U_{L_i^O} &= l w_i + m_i, \\ F_{L^H} &= \frac{w}{l}. \end{aligned} \tag{4}$$

The last equation states that hired labour will be employed up to the point where the marginal product of L^H is equal to the wage paid to hired labour. The first three equations represent the equilibrium conditions for the maximization of the household utility function.

When off-farm work and hired labour is zero, i.e. when such decisions are at a corner and family and hired labour are not perfect substitutes (Deolalikar and Vijveberg 1987, Jacoby 1992), then implicit shadow prices must be adopted because the model is non separable.[3] The labour market may be missing or binding hours constraints, both for adults and children, and lack of contractual flexibility in the off-farm labour market may lead to a failure of the market clearing possibilities. Low subjective expectations about the probability to find a job off-farm, especially for low-skilled workers such as children, may generate expected off-farm wages that

[3]The qualitative properties of the model do not change if we assume perfect substitutability between adult and child labour, nothing of importance would change in the results if we would allow for different levels of productivity among adults and children. However, this is an important aspect of the econometric

are lower than a return to labour employed with certainty on the own farm. This observation is especially appropriate in Nepal where off-farm opportunities are virtually lacking.

The production and consumption sides of the household economy illustrate the general equilibrium structure of the model. The exogenous characteristics *d* of the household and the enterprise affect both sides of the micro economy. Within the theory of the household enterprise this is an interesting feature since it permits testing the separability hypothesis between consumption and production decisions (Singh, Squire, and Strauss 1986, Benjamin 1992, Udry 1996). Under separability, the general equilibrium program of the household is recursive. Production decisions are not affected by the household's endowments, preferences, characteristics or decision processes. On the other hand, consumption decisions are affected by production choices since profits are part of the budget constraint.

The separation between production and consumption decisions is ensured by the household rational behavior in presence of complete markets. Recent empirical works (Benjamin 1992, Udry 1996, Pavoni and Perali 2000) show that production decisions do depend on farmers' preferences and endowments. The jointness in decision making is evident even in the absence of market failures when the same input, such as time, is shared across the household and home production processes, and in presence of home consumption of the household marketable product. Imperfections in the labour, credit and land markets are commonly observed in empirical work (Benjamin 1992, Udry 1996, Bhalotra and Heady 2001). Under these conditions, farm production and household consumption decisions are nonseparable and leisure/labour demand on the household is not independent from the on farm demand of family labour. As a consequence, shadow wages, rather than market wages, determine adults and children's labour/leisure choices. The case of a Chayanovian farm-household closed economy, which in Nepal is represented by subsistence farming, where the household members are not employed off-farm and no agricultural labourers are hired-in is non recursive by construction (Lambert and Magnac 1994).

In our set-up, the child consumption of leisure is invested in education at the cost corresponding to the return foregone from the employment in the farm. The empirical evidence for developing countries shows that, while a large number of children both go to school and work, many specialize in either of the two activities. A high level of future returns to schooling is one of the factors favouring specialization in educational activities. For a given level of schooling, a low cost of "quality" with respect to the cost of "quantity" tends to make specialization in schooling more likely. The net returns to education depend negatively on child labour productivity (Rosati and Tzannatos 2004). Households whose returns to child labour are

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execution that will be considered in the next section.

relatively high, are less likely to have children studying only, and more likely to have children working (full time or not). Higher costs of education reduces net returns from education and increases both costs of an additional child (reduces the "quality" to "quantity" price ratio).

4. The Econometric Specification

The production technology is described as a restricted short run cost function with three quasi-fixed factors: 1) adult labour, 2) child labour, and 3) land and capital. By specifying family labour as a quasi-fixed factor, it is not necessary to impute a market wage for family labour, but we can estimate it as the shadow wage corresponding to the value of the marginal product. By separating hired and family labour it means that we need to model a censoring process also on the input side.

The econometric specification pays special attention to the modelling of adult/children separability that is obtained when adults and children's work are not perfect substitutes. When the work of the child is not a perfect substitute for the work of an adult and/or children do not perform the same activities as the adults, then the marginal productivity is different both because adults and children have different skills and because they are allocated to different activities according to a natural division of labour, in Beckers' sense. In general, heavy activities such as ploughing are naturally undertaken by adults, while picking or other less demanding activities are parts of children's jobs. Children do not drive tractors. There are also other constraints known to the farm management and unknown to the researcher. Because of the questionnaire design, we do not know "who does what" in the field neither for the adults nor for the children. Since we do not know whether adults and children are employed in different activities in the farms, it is impossible to differentiate their corresponding marginal product. Further, in our framework, both adult and child labour is a quasi-fixed factor which is not allocable to different activities because these are not observed.

Given this informational constraint, we are bound to assume that adults and children produce the same product with different levels of quality/quantity per unit of time, which, in turn, are associated with age (adult/child) specific shadow wages. This relationship can be modelled with a la Barten (1964) specification relating differences in the quality/quantity of a product with the hedonic characteristics of the worker (Benjamin 1992). This is a reasonable assumption if the agricultural wage of interest is the implicit shadow wage paid to family labour, which, differently from the wage paid to hired labour, is not observable. Objective market wages and subjective shadow wages differ if markets are non competitive so that the agricultural household model is non separable. The case of child work is a case of non-

separability due to a labour market failure. If recursivity holds, the influence of demographic variables on production should not be significant.

In line with these conditions, the econometric execution takes into account the following assumptions:

Assumption 6. *The farm-household economy is non-separable.*

Assumption 7. *Adult and child family labour are quasi-fixed factors.*

Interestingly, only the dual representation of the technology can explicitly model quasi-fixed factors as translating terms. This is the reason why we estimate the dual rather than the primal representation of the technology.

Consider a general production technology $q = F(L^h; L_p, L_s)$ where L_p, L_s represent adult and child labour as quasi-fixed factors and L^h is the variable factor hired labour. If we do not account for quality differences of the product obtained from adult and child labour due to heterogeneity in their skills, the shadow wage w^*, corresponding to the value of the marginal product of both adult L_p and child labour L_s, is the same for both adults and children but differs from the market wage w prevailing in the agricultural sector:

$$\underbrace{w^* = \frac{\partial q}{\partial L_p} p = \frac{\partial q}{\partial L_s} p}_{\text{unobservable}} \neq w \tag{5}$$

In order to differentiate adult from child labour, effective labour is here modelled as a modified factor

$$L_i^* = L_i \left(q_i(d_i)\right) \tag{6}$$

for $i = p, s$, where d are individual specific characteristics affecting the Barten (1964) scaling modifying function $q_i(d_i)$.[4]The scaling transformation leads to the following definition of the effective wage:

$$w_i^* = \frac{\partial q}{\partial L_i} p = \left(\frac{\partial q}{\partial L_i} q_i(d_i) \right) p \neq w \quad for \;\; i = p, s. \tag{7}$$

The scaling function $q_i(d_i)$ is also the shadow wage to generate the shadow effective wage $w_i^{e^*}$

[4] See also Jorgenson, Lau, and Yotopoulos (1972), Benjamin (1992), Kuhmbakhar and Knox-Lovell (2000) in more recent production applications.

$$w_i^{e^*} = \frac{w_i^*}{q_i(d_i)} \tag{8}$$

The function attributes differences in shadow wages to "hedonic" differences in worker characteristics (Brown 1983). The scaling function can be interpreted as a quality correction factor reflecting the fact that children with different characteristics may perform their tasks with significantly different levels of quality.

The implementation of the dual side of the above program requires the definition of a modified (*a la* Barten in our case) total cost function which can be written as:

$$c(q, w; z, d) = \underset{x}{\text{Min}} \left\{ w'x + w^{*'}z \mid q = F(x, z, d) \right\} \quad (9)$$

where w is an n-vector of input prices, q is an m-vector of predetermined levels of outputs, z is a k-vector of quasi-fixed factors and d is an l-vector of exogenous characteristics of the farm-workers, x is an n-vector of inputs, F is a transformation function with the usual properties and $w^{*'}$ is defined by (7). The structure of the minimization problem implies that the cost function is homogeneous of degree one in input and output prices. Two additional properties of the cost function are of interest for estimation purposes. First, by Shephard's lemma we have that:

$$x_i(q, w; z, d) = \frac{\partial c(q, w; z, d)}{\partial w_i} \tag{10}$$

where, x_i is the i-th component of the input vector and w_i is the price of that input. These input demand functions are homogeneous of degree zero on input prices. Second, if entrepreneurs are minimizing costs, we obtain the fixed factor's shadow wage:

$$w_z^* = \frac{\partial q}{\partial z} p = \frac{\partial c(q, w; z, d)}{\partial z} = \left(\frac{\partial c}{\partial z} q(d) \right) p \tag{11}$$

by differentiating total costs with respect to the level of the quasi-fixed factor. As shown by Paris (1989), the dual shadow price approach is appropriate also in the case of multiple outputs with fixed allocable inputs. This is the behavioral basis of our modelling strategy. Therefore, we use a short run restricted cost function where farm assets and adult and child labour are quasi-fixed factors.

We proceed then by estimating a system composed by a restricted translog cost function with four outputs, three inputs modified with a translating function to accommodate three-quasi fixed factors and its derivatives with respect to input prices and output quantities. Quasi-fixed inputs act as exogenous factors modifying the cost function via shifting. The translog total cost function modified via a translating transformation (Pollak and Wales 1981, Lewbel 1985) can

be written as:

$$\ln c(q,w;z,d) = a_0 + \sum_{i=1}^{4} a_i \ln q_i + \sum_{r=1}^{3} b_r \ln w_r + \sum_{g=1}^{2} g_g \ln\left(z_g\, q_g(d)\right) + g_3 \ln z_3 + \tag{12}$$

$$+0.5\sum_{i=1}^{4}\sum_{j=1}^{4} a_{ij} \ln q_i \ln q_j + 0.5\sum_{r=1}^{3}\sum_{s=1}^{3} b_{rs} \ln w_r \ln w_s + \sum_{r=1}^{3}\sum_{i=1}^{4} g_{ri} \ln w_r \ln q_i +$$

$$+\sum_{r=1}^{3}\sum_{g=1}^{2} t_{rg} \ln w_r \ln z_g + \sum_{k=1}^{5} V_k \ln d_k + \sum_{r=1}^{3}\sum_{k=1}^{5} V_{rk} \ln w_r \ln d_k,$$

where p_i denotes the price of output i produced, w_r is the price of input r. The demographic function $q_g(d) = \exp\left(\sum_{j=1}^{3} d_j d_j\right)$ is specified as linear in the logarithms function of the exogenous characteristics *d*. The set of demographic characteristics transforming adult work includes the age of the household head grouped in four classes (1= less than 30 years old, 2= 30-44 years old, 3 = 45-60 years olds, 4 = more than 60 years old), education of household's head, and the percentage of the adult component working on the farm. On the other hand, the set of children's characteristics is formed by are number of student 10-14 years old, a dummy equals to one if in the family there are girls 10-14 years old, and a dummy taking the value of one if household consumption is not adequate.

Using Shephard's lemma, the derivatives of the cost function with respect to the natural logarithm of input prices can be written as:

$$s_r = b_r + \sum_{k=1}^{5} V_{rk} \ln d_k + \sum_{g=1}^{2} t_{rg} \ln z_g + \sum_{s=1}^{3} b_{rs} \ln w_s + \sum_{i=1}^{3} g_{ri} \ln q_i \tag{13}$$

where $s_r = -w'x/c = -\partial \ln c/\partial \ln w$ is the share of the $r-th$ input in costs. Homogeneity of degree one in *p* and *w* of the cost function implies the following parametric restrictions

$$\sum_{r=1}^{3} b_r = 1, \sum_{i=1}^{4} g_{ri} = \sum_{r=1}^{3} b_{rs} = \sum_{k=1}^{5} t_g = \sum_{k=1}^{5} V_{rk} = 0, \tag{14}$$

and symmetry

$$a_{ij} = a_{ji}, b_{rs} = b_{sr}. \tag{15}$$

Homogeneity of degree zero of the demographic function $q_g(d)$ involves that

$$\sum_{j=1}^{3} d_j^a = \sum_{j=1}^{3} d_j^c = 0.$$

In general, the properties derived from the optimization structure of the model can be tested. In the present case, linear homogeneity in prices, symmetry, and homogeneity in $q_g(d)$ are

imposed as maintained hypothesis.

The shadow wage is derived as the marginal effect of a change in fixed factors on total costs, which, in the long run, corresponds to total revenues

$$w_{z_g}^{*} = \frac{\partial c(q,w;z,d)}{\partial z_g} = \frac{\partial \ln c(q,w;z,d)}{\partial \ln z_g}\frac{c}{z_g} = g_g \frac{c}{z_g}. \qquad (16)$$

where c and z_g are total costs and adult or child labour respectively. The effect of demographic characteristics on total costs, on the other hand, correspond to the following partial contribution

$$\frac{\partial c}{\partial d_j} = \frac{\partial \ln c(q,w;z,d)}{\partial d_j} c = \left(g_g \cdot d_j\right) c.$$

Finally, the effective shadow wage w_z^{*e} of adult and child labour is given by the sum of the effective shadow wage with the total contribution to the marginal productivity of labour provided by the characteristics of the worker[5]

$$w_z^{*e} = w_z^{*} + \frac{\partial c}{\partial d_j}. \qquad (17)$$

5. Data

The empirical analysis is based on the Nepal Living Standard Survey (NLSS) 1996. The aggregated data-set is made up of the following eleven sections reproducing most of the information contained in the household survey. 1) Information of head of the household, and wife such as age, education, paid working hours, and wages; 2) Family and children 10-14 years old paid working hours and family wages; 3) Health information at the household level of aggregation; 4) Farming and livestock; 5) Production, sales and prices of agricultural activities; 6) Expenditure on agricultural inputs; 7) Credit and savings; 8) Remittance and transfers, plus other income; 10) Household consumption and expenditure; and finally, 11) Geographic location of the household. For the purpose of estimating the shadow wage of child labour it is relevant to report that the data do not include information on who does what in the farm.

The estimation has been carried out on a sample of 2,380 farm households obtained excluding observations with singles (73 observations), landless households (780 observations), non-farming households (116 observations), those farming households without adults self-employed in agriculture (122 observations), and households with head younger than 17 years

old (5 observations).

Table 6 reports the descriptive statistics of the data used in the estimation along with standard errors, minimum and maximum values. The legend reports the definitions of the variables and the unit of measurement.

In presence of sharecropping contracts which are found in 18 per cent of the sample and subsistence farms representing 32 per cent of the cases, as shown in Table 6, output and input prices are not observed and have been imputed using *ad hoc* imputation techniques. This measurement aspect is crucial because without output prices the implicit valuation of labor corresponding to the value of the farm marginal product cannot be derived.

Total costs have been computed as the sum of variable and fixed costs including the use value of land and capital assets and adult and child labour. Family labour is evaluated as the accounting value left after having paid all other factors of production. Output prices of subsistence farms have been imputed with the prevailing average price in the observed location of the farm. Note that when fixed costs are included, then total costs equal total revenues (*TR*) by construction because the accounting value of fixed costs is computed assuming a long run perspective. Total fixed costs (*TFC*) are composed by the opportunity cost of the money invested in the fixed plant *R* and the fixed costs associated with fixed labour. The return to family labour (*RFL*) is defined as:

$$RFL = TR - TVC - R$$

where *TVC* are total variable costs. Given this accounting construction, profits are zero $p = TR - TVC - (R + RFL) = 0$ and total costs equal total revenues. We assume that when $RFL > 0$, then the returns to family labour are sufficient to keep a family farming in the long-run.

6. Econometric Estimation

In order to deal with the censoring in the input equation for hired labour, we adopt the generalized Heckman approach which is the Heckman two-step estimator extended to a system of censored equations. This method gives unbiased estimates as compared to the maximum simulated likelihood method (Hajivassiliou, McFadden, and Ruud 1996) that uses multiple integrals that are computed with a simulated algorithm to reproduce the statistical process that generated the zero realizations (Arias and Perali 2003).[6]

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[5] Note that given homogeneity of degree zero of the demographic function $q_g(d)$ the total effect of the demographic attributes is equal to zero.

[6] In the simulated maximum likelihood approach the variance covariance matrix of the parameters is a full matrix, while in the generalized Heckman estimator only the diagonal terms can be estimated.

Our methodological approach assumes that the zero realizations are the outcome of a rational economic choice or it is determined by physical, technological or normative constraints thus justifying a Tobit structure. The data generating process that we assume reproduces the unconstrained choice of not undertaking a certain activity if the output price is below a reservation price corresponding to a break-even point.

In a general representation of a system of equations with censored endogenous variables, each equation in the system can be written as:

$$y_i = f_i(x_i, b_i) + u_i \text{ if } f_i(x_i, b_i) + u_i > 0$$
$$y_i = 0 \qquad \text{if } f_i(x_i, b_i) + u_i < 0 \quad (18)$$

where, y_i is the endogenous variable corresponding to the i-th equation in the system, x_i is a vector of explanatory variables, b_i is a vector of parameters and u_i is a random variable. Precisely, u_i is the i-th component of a multivariate normal random vector u of mean zero and variance Σ. Therefore, $u_i \sim N(0, s_i^2)$ where, s_i^2 is the i-th diagonal term of the matrix Σ.

The Generalized Heckman procedure transforms the system of censored equations in (8) into a system of uncensored equations by using the appropriate correction. We start by considering the expected value of the endogenous variable conditional on a positive observation.

$$E[(y_i \mid y_i > 0] = f_i(x_i, b_i) + s_i \frac{f(f_i(x_i, b_i)s_i)}{\Phi(f_i(x_i, b_i)s_i)} \quad (19)$$

where, f and Φ are respectively the probability density function and the cumulative density function of a standard normal distribution. Then, the unconditional mean (conditional only on explanatory variables) can be written as:

$$E[(y_i \mid x_{it}] = f_i(x_i, b_i)\Phi\left(\frac{f_i(x_i, b_i)}{s_i}\right) + s_i f\left(\frac{f_i(x_i, b_i)}{s_i}\right) \quad (20)$$

Using the expression for the unconditional expected value of each endogenous variable we consider the following system of uncensored equations:

$$y_i = f_i(x_i, b_i)\Phi\left(\frac{f_i(x_i, b_i)}{s_i}\right) + s_i f\left(\frac{f_i(x_i, b_i)}{s_i}\right) + x_i \quad (21)$$

where $x_{it} = y_{it} - E[y_i \mid x_{it}]$. The system in (11) can be estimated by maximum likelihood

assuming that $x \sim MVN(0, \Omega)$ where, x is a random vector which i-th element is x_i. Note that the random variables x_i are different from the random variables of the censored system u_i.

7. Results

The estimates of the cost function obtained using a maximum likelihood procedure are presented in table 7. The proportion of significance of the parameters is homogenous across the group of price, outputs (cereals and vegetables, fruit, milk, livestock) and demographic characteristics. The farm characteristics included in the analysis are the regional dummies which distinguish the Eastern and Central regions from the other regions of Nepal and the Tarai planes. The dummy for sharecropping and subsistence farming are intended to capture some crucial structural and institutional characteristics of the Nepalese farming mode.

Table 8 reports the Allen elasticities of substitution for the three variable inputs considered that is hired labour, chemicals and materials show the correct sign along the diagonal. This evidence says that at the data means the curvature of the cost function is regular. The own impact of hired labour is highly elastic. The inputs are all substitutes.

The marginal effects of characteristics and fixed factors on total farm costs are presented in Table 9. In the Eastern and Central regions of Nepal costs are relatively higher. Costs are lower where sharecropping is the mode of agricultural production. Subsistence farming, where the agricultural product is not sold on the market, presents a lower cost structure. In the case of sharecropping the marginal evaluation of labour is based on the value of total production farmed not just on the proportion of production sold on the market after having paid the rent to the landlord. Similarly, the shadow wage of workers producing in subsistence farms is evaluated at an imputed price. The regression includes these two variables to control for structural differences across farms, and, ultimately, shadow wages. The coefficients associated with the fixed factors are the marginal effect on total costs. Given the definition of returns to family labour described in the data section and the long run perspective taken in our study, the effect on total costs equates the impact on total revenues. The coefficient then provides a direct evaluation of the shadow wage as illustrated in equation (8). As expected, the effect of adult and child labour is positive and significantly different from zero.

The estimated adult and children shadow wages are presented in Table 10. The shadow wages are evaluated 1) at the unconditional mean of all the variables, $E(w_i^*)$, 2) conditional on positive levels of child labour, $E(w_i^* \mid z_2>0)$, and 3) conditional on absence of child labour but in presence of children 10-14, $E(w_i^* \mid z_2=0, nc>0)$.

Observe that the shadow wage rate of the adults is lower in households that employ

children in agricultural production. This seems to indicate that farms characterized by a low productivity of labour are those more in need to employ children in order to guarantee the subsistence of the household. However, we should also consider the possibility that households employ children because of lack of alternatives in the use of their time (school not present, school costs to high, low return to education, etc.) which may generate a situation of "over-employment" that reduces productivity. In households with school aged children in non-working condition, the adult shadow wage is higher.

The adult and child wage differential is about 0.53 rupees per hour

$$w_p^* - w_s^* = 1.456 - 0.927 = 0.529$$

corresponding to an adult/child wage ratio of $w_s^*/w_p^* = 0.637$. The shadow value of the child productivity is more than a half of the adult at the data mean. This result shows that adult and child labour are not perfect substitutes (Basu 1999 and 2000).

In the main body of the paper we have developed a method to derive the shadow wages by means of the dual approach, that is by the estimation of a cost function. In the appendix, we present the primal approach based on the estimation of a production function as in Jacobi (1993) and Skoufias (1994) for the sake both of comparison and of establishing a reciprocal form of control of the experiment's main outcomes, that is the adult and child shadow wages.

The shadow wages obtained from the primal estimation are twice as large as those estimated using the dual approach. Inspection of Table A.2 reveals that, in presence of children self-employed in the farm, the adult shadow wage is 3.30 rupees per hour, while the total household income, given adding adult and child shadow wages up, is about 5.79 rupees per hour. This figure increases at 9.54 rupees per hour when children are not working. In both cases, the adult shadow wage appears to be overestimated if compared with the market wage of a hired worker, 1.863 rupees per hour.[7] On the basis of the same comparison, the child shadow wage is overestimated as well. Indeed, it is unrealistic that the productivity of a child 10-14 years old is higher than the productivity of an hired worker.

Moreover, assuming that an adult household member works on average 2304 hours in a year, this value is obtained assuming that in a year an employee works on average 8 daily hours per 288 days, his own contribution to household income is about 7,603 rupees, when there are working children, and 21,989 rupees, otherwise. For the present exercise, the per capita poverty

[7] In the Nepalese sample used for carrying out the estimation only 2.6 per cent of farms hire permanent workers. On average, these farms hire less than two full-time workers (1.45) and the cost for each worker is about 4,292 rupees per year. Note that a hired worker earns an amount of money slightly lower than the estimated poverty line, 4,404 rupees. Assuming that each employee annually works about 2304 hours, the wage for hired labour results to be 1.863 rupees per hour.

line in Nepal was estimated by the World Bank (Prennushi 1999) to be NRs. 4,404 on the basis of a daily per capita calorie requirement of 2,124 calories. The poverty line was evaluated at the average price level prevailing in 1995/96 for this food basket, adjusted for a factor accounting for the proportion of non-food expenditures. Because 42 per cent of the population is classified as poor, it is reasonable to think that adult and children shadow wages obtained using the production function are overestimated.

Conversely, adult and child shadow wages estimated using the dual approach represent the Nepalese shadow economy more closely. Indeed, if there are working children the adult shadow wage is 1.46 rupees per hour. This figure is lower than the market wage. Families with such a low income experience severe poverty and may feel strongly pressured to send children to work. With the contribution of child labour, the total household wage sums to 2.38 rupees per hour (Table 10). When children are not working, the value of the adult productivity is 4.5 rupees per hour. The annual contribution to household income of an adult is 10,375 rupees, more than twice the per capita poverty line. The shadow labour income estimated using the primal approach is about four times the level of the per capita poverty line, which does not seem to reflect accurately the depressed living conditions of rural Nepal. On the basis of these evidences, we may conclude that the primal approach overestimates the productivity of agents self-employed in agriculture in Nepal.

It is important to remark that the degree of adult/child substitutability is affected by differences in characteristics. For example, an educated child going to school may be a better substitute for the labour performed by an adult with a low level of education. Therefore, a proper comparison between shadow wages should take into consideration differences in the effectiveness in performing the work, as it can be deduced from the different characteristics of adult and child labour employed in the farm. Table 11 shows that the proportion of adults' on-farm working hours does not have a significant impact on the productivity of the adults. An adult with higher education is likely to have a lower effective shadow wage. Therefore, efforts or abilities in Nepalese farming are associated with higher experience as captured by the average age of the adult component, but not by the importance of farming relative to other off-farm activities. The effective shadow wage of farmers with a head relatively older, with lower education and a lower level of employment on the farm is significantly larger, especially because of the contribution of the relative importance of the age.

Effective shadow wages for children are positively influenced by the presence of a girl 10-14 years old, but are negatively influenced by the number of working students. This is in line with the finding presented for the adult component. Children's productivity is lower when consumption levels are inadequate and the health conditions are more precarious.

From this evidence, we may conclude that the child marginal contribution to the shadow farm economy is about three fifth of the contribution of the adult. Considering that children provide 17.6 per cent of rural labour (in terms of annual working hours) in Nepal, we may attribute to children a contribution of 17.6*(0.637)=11.21 per cent of the value of Nepalese agricultural production.

This represents a substantial contribution to agricultural production and clearly illustrates the important role that child labour plays in the Nepalese economy. It is also very important to assess whether and to what extent child labour does help poor households to meet their subsistence needs. If the role of child labour in guaranteeing the subsistence of the household were negligible, than policy actions should be focused on reducing the direct and indirect costs of accessing education, on improving returns to education, on raising awareness of the importance of education etc. Less attention should be paid to the returns to child labour and to the need to compensate the household for the forgone income.

It is very difficult to measure subsistence; we adopt here the standard approach to use poverty and the depth of poverty as proxy to the subsistence level of consumption necessary to the household.

The presence of a working child is an important contribution to household income and has a significant impact both on the level of inequality and poverty. Table 12 reports the headcount, poverty gap, the Foster, Greer and Thorbecke indexes and the Sen index when children contribute to household income. We compare these figures with the measures presented in Table 13 for the case in which children do not contribute to household income. Table 12 describes the actual situation; while table 13 presents the results based on household income data generated assuming that children would not work.

Farming households with working children have higher levels of poverty both in terms of number of households below the poverty line and in terms of depth and severity of poverty. These were substantially more marked if children would not work. The difference in the impact on inequality for the reference and comparison situation, as described by standard measures of dispersion and the Gini coefficient, is negligible. However, the presence of children not contributing to household income produces higher inequality.

In particular, if children would not work, there would be an increase of 7 percentage points in the number of household below the poverty line: the headcount ratio would increase from 52 to 59 per cent. This indicates that poor farmers are the one more likely to use the work of their own children in agricultural production and that child labour helps quite a few of them to be above or at subsistence (as measured by the poverty lines). The fact that the poverty gap ratio also increases significantly if children stop working indicates that child labour is important

for very poor households and that the absence of this additional source of revenues would push those households well below subsistence. This is also confirmed by the increase in the Sen index and in the FTG index that we would observe if children would stop working. Finally, the lack of revenues from child labour, by affecting the relatively poorer household also tends to increase inequality, but this effect is not particularly relevant.

8. Conclusions

This work has estimated the shadow and effective wages of adult and children in Nepal. The technique differs from the previous one because it adopts a dual approach. This avenue has been pursued because the primal representation of the technology does not allow to treat fixed and variable factors differently. Because of this indeterminacy, in the traditional dual representation fixed factors would be evaluated implicitly at their market value rather than the implicit shadow evaluation. "Shadow" prices are appropriate when farm and household decisions are non separable, which we assume to be the case in Nepal where agricultural labour and other factor markets often fail or are missing. The presence of child labour is also an intrinsic cause of nonseparability.

The estimation is carried-out using a cost function rather than a production function as previously done in the literature. This dual approach evades the problem of treating fixed-factors, such as family labour, as variable factors as traditionally done in a primal context. This problem implicitly assumes that family labour can be evaluated at the market wage and that rural labour markets clear. This is an hypothesis which is in sharp contrast with the Nepalese rural economy. In this regard, we deem that this asymmetry can be properly solved only if a joint primal-dual estimation is undertaken. This operational aspect is left for future research.

The results show that adult and child labour employed in Nepalese farms are substitutes. The child shadow wage is at the mean about 60 per cent of the adult shadow contribution. This conclusion may not be generalized. For example, in terms of the effective shadow wage obtained by a child with inadequate consumption, the degree of substitutability is significantly lower. According to these estimates, children contribute about 11.21 per cent of the value of total agricultural production in Nepal. Considering that agriculture is responsible for 81 per cent of Nepalese GDP, 9.08 per cent of Nepalese GDP is produced by children. The simulation about the impact on poverty and inequality associated with the children pooling or not their income contributions show that children significantly contribute to lower poverty at the household level and, at a lesser extent, to reduce inequality.

Under a policy point of view, it is important to ask how much of the value of the output

produced by children remains under their control. When children are employed on-farm, the value of the child product is managed by the adults, who are the final claimants and responsible for the redistribution of income within the household. When children offer their time outside the household enterprise, then they may maintain full, partial or no ownership of their incomes. This question can find an answer at the household level if we can measure how the resources produced by the children from their work on their farm, but traditionally managed by the adults, are redistributed within the household.

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Table 1. Demographic Characteristics of NLSS and Sub-samples of Interest

Sample	All	With Non Working Children	With Working Children	With Working Children	
				Self-employed in agriculture	Not self-employed in agriculture
No. of households	*3,373*	*1,032*	*714*	*575*	*139*
Eastern	0.213	0.234	0.181	0.183	0.173
Central	0.391	0.370	0.353	0.346	0.381
Western	0.185	0.231	0.125	0.106	0.201
Mid-West	0.107	0.090	0.171	0.179	0.137
Far-West	0.104	0.076	0.171	0.186	0.108
Mountains	0.121	0.074	0.174	0.188	0.115
Hills	0.516	0.571	0.385	0.381	0.403
Tarai	0.363	0.356	0.441	0.431	0.482
Age of head	44.698	45.470	44.885	45.344	42.986
Head education (years)	2.556	3.102	1.527	1.395	2.072
No. of adults	3.220	3.354	3.303	3.383	2.971
No. of children	2.757	3.505	4.003	4.033	3.878
No. of children 10-14	0.753	1.408	1.524	1.494	1.647
Family size	5.977	6.859	7.305	7.416	6.849

Table 2. Children Working Hours by Expenditure Quintile

Sample		All	With Non Working Children	With Working Children	With Working Children	
					Self-employed in agriculture	Not self-employed in agriculture
No. of Households		*3,373*	*1,032*	*714*	*575*	*139*
Total Expenditure		49,053	61,789	39,062	37,998	43,460
I	Avg exp. 12,817	242		1297	1238	1593
II	Avg exp. 22,385	403		1404	1322	1763
III	Avg exp. 32,488	284		1181	1128	1387
IV	Avg exp. 49,633	239		1113	1026	1475
V	Avg exp. 128,034	112		870	780	1154

Table 3. Intra-household Division of Labour by Component and Occupation

Sample	All	With Non Working Children	With Working Children	With Working Children	
				Self-employed in agriculture	Not self-employed in agriculture
No. of households	*3,373*	*1,032*	*714*	*575*	*139*
			Total working hours by gender		
Husband	0.242	0.251	0.198	0.196	0.205
Wife	0.135	0.141	0.127	0.128	0.122
Adults	0.591	0.608	0.550	0.557	0.521
Children	0.034	0.000	0.125	0.119	0.152
Total working hours	**7,548**	**7,231**	**9,666**	**9,617**	**9,870**
			Adults' working hours by occupation		
Employed in agr.	0.126	0.108	0.150	0.114	0.301
Employed in nonagr.	0.167	0.193	0.093	0.091	0.099
Self-employed agr.	0.571	0.517	0.677	0.753	0.347
Self-employed nonagr.	0.136	0.181	0.081	0.041	0.252
Total working hours	**4,460**	**4,400**	**5,314**	**5,354**	**5,145**
			Children's working hours by occupation		
Employed in agr.	0.090	0	0.091	0	0.377
Employed in nonagr.	0.023	0	0.024	0	0.101
Self-employed agr.	0.844	0	0.842	1.00	0.344
Self-employed nonagr.	0.043	0	0.043	0	0.178
Total working hours	**256**		**1,210**	**1,210**	**1,498**

Table 4. Causes for which Children 9-15 Years Old Never Attended School

Causes	All	Boys	Girls
	Obs: 865	*Obs: 273*	*Obs: 592*
	%	*%*	*%*
School not present	0.014	0.003	0.010
Too expensive	0.254	0.094	0.161
Too far way	0.032	0.009	0.023
Helped at home	0.194	0.060	0.134
Farm work	0.020	0.006	0.014
Family business	0.006	0.002	0.003
School not good	0.001		0.001
Teacher absent	0.001		0.001
All male teachers	0.001		0.001
Not useful	0.007	0.002	0.005
Parents did not want	0.260	0.049	0.212
Not willing to attend	0.114	0.052	0.062
Other reasons	0.095	0.038	0.057

Table 5. Annual Working Hours by Component –Subsistence and Non-Subsistence Farm-Households

Sample	**Non-subsistence**	**Subsistence**
No. of households	*399*	*176*
	Demographic profile	
Eastern	0.183	0.182
Central	0.381	0.267
Western	0.095	0.131
Mid-West	0.190	0.153
Far-West	0.150	0.267
Mountains	0.158	0.256
Hills	0.376	0.392
Tarai	0.466	0.352
Age of head	45.667	44.614
Head education (years)	2.262	1.552
No. of adults	3.459	3.210
No. of children	4.138	3.795
No. of children 10-14	1.521	1.432
Family size	7.596	7.006
Total expenditure	40.539	32.240
	Total working hours by component	
Husband	1.838	1.997
Wife	1.239	1.224
Adult	5.436	5.170
Children	1.082	1.274

Table 6. Summary Statistics of a Sample of NLSS, No. Of farm Households 2,380

Variable	Truncation	Mean	Std. Dev.	Min.	Max.
LO1	0.995	3.980	1.5744	0	12.631
LO2	0.260	1.020	1.9759	0	10.602
LO3	0.231	1.026	2.0865	0	11.590
LO4	0.466	0.666	1.4636	−1.386	10.491
PO1		5.259	1.3929	1.353	8.069
PO2		2.918	2.0667	−1.386	8.869
PO3		3.336	1.0668	−4.423	4.665
PO4		6.383	2.1240	0	9.908
P1I		5.190	1.0786	0	9.114
P2I		2.110	0.4731	−2.571	7.438
P3I		6.670	1.3567	1.099	12.082
LNTC		9.574	1.0782	5.897	14.638
z1		7.763	1.0178	2.303	10.543
z2	0.247	1.623	2.8877	0	9.072
z3		−0.963	1.2870	−5.942	4.118
w_hired	0.370	0.138	0.2305	0	0.985
w_chem		0.304	0.2633	0.002	0.996
w_mater		0.558	0.3236	0.002	0.997
Head_age		2.424	0.9500	1	4
Head_edu		1.539	0.8291	1	3
Adult_on		0.629	0.3077	0	1
Child_school		0.506	0.7045	0	2
Child_female		0.333		0	1
Food_we		0.440		0	1
Tarai		0.355		0	1
Eastern		0.216		0	1
Central		0.316		0	1
Sharecropping		0.181		0	1
Subsistence farms		0.328		0	1

Note: All variables refer to the twelve-month period foregoing the date of interview.

Legend	
Output quantities, prices, log of total cost, and quasi-fixed factors	
LO1	Cereals and vegetables.
LO2	Fruit.
LO3	Milk.
LO4	Livestock.
PO1	Log of cereals and vegetable price.
PO2	Lof of fruit price.
PO3	Log of milk price.
PO4	Log of livestock price.
LNTC	Log of total costs.
z1	Log of adults' on-farm working hours.
z2	Log of children's on-farm working hours.
z3	Log of average of capital cost: 1 per cent of capital value.
Input shares and prices	
w_hired	Hired labour.
w_chem	Chemicals.
w_mater	Materials and other inputs.
P1I	Log of wage of hired labour.
P2I	Log of chemicals price.
P3I	Log of materials and other inputs price.
Demographic variables	
Head_age	Age class of household's head: 1 if head is younger than 30 years old, 2 if head is between 31 and 45 years old, 3 if head is between 46 and 60 years old, 4 if head is older than 60 years old.
Head_edu	Household head education: 1 = never attended school, 2 = less than five years of school, 3 = more than five years of school.
Adult_on	Proportion of adults' on-farm working hours.
Child_female	Dummy = 1 if there is at least a daughter 10-14 years old.
Child_school	Number of students 10-14 years old: 0 = zero students 10-14 years old, 1 = a student, 2 = more than one student.
Food_we	Dummy = 1 if no adequacy in consumption, 0 otherwise.
Tarai	Dummy = 1 if Tarai, 0 otherwise.
Eastern	Dummy = 1 if eastern, 0 otherwise.
Central	Dummy = 1 if central, 0 otherwise.
Sharecropping	Dummy = 1 if sharecropping, 0 otherwise.
Subsist.	Dummy = 1 if subsistence agriculture, 0 otherwise

Table 7. Parameters and Standard Errors of a Modified Translog Total Cost Function with Three Inputs and Three Quasi-Fixed Factors, No. of Farming Households 2,380

	Coefficient	**Std. err.**		**Coefficient**	**Std. err.**
a_0	2.792	0.1839	d_1^c	–1.471	2.8494
a_1	0.463	0.0409	d_2^c	7.232	6.3071
a_2	0.273	0.0298	d_3^c	–5.761	4.8509
a_3	0.167	0.0347	V_1	0.104	0.0625
a_4	0.118	0.0425	V_2	0.605	0.0751
a_{11}	–0.018	0.0084	V_3	1.075	0.0693
a_{12}	–0.023	0.0050	V_4	–0.976	0.0928
a_{13}	–0.011	0.0050	V_5	–0.649	0.0632
a_{14}	–0.005	0.0075	g_{g_1}	0.126	0.0167
a_{22}	–0.015	0.0077	g_{g_2}	0.008	0.0054
a_{23}	–0.004	0.0036	g_{g_3}	0.195	0.0142
a_{24}	–0.009	0.0051	V_{11}	–0.012	0.0151
a_{33}	–0.019	0.0087	V_{12}	0.120	0.0200
a_{34}	0.005	0.0052	V_{13}	–0.008	0.0159
a_{44}	–0.038	0.0081	V_{14}	–0.111	0.0175
b_1	0.308	0.0296	V_{15}	–0.058	0.0153
b_2	0.556	0.0248	V_{21}	0.096	0.0106
b_{11}	0.022	0.0057	V_{22}	–0.013	0.0118
b_{12}	–0.010	0.0040	V_{23}	0.121	0.0112
b_{22}	0.093	0.0054	V_{24}	–0.032	0.0126
g_{11}	–0.002	0.0048	V_{25}	–0.060	0.0100
g_{12}	0.008	0.0035			
g_{13}	–0.001	0.0033	s_1	–0.039	0.0174
g_{14}	–0.011	0.0050			
g_{21}	0.032	0.0031			
g_{22}	0.004	0.0024	Mean log-lik.		–8.2609
g_{23}	0.005	0.0024			
g_{24}	–0.005	0.0032			
d_1^a	0.134	0.1163			
d_2^a	–0.105	0.1539			
d_3^a	–0.029	0.2086			

Table 8. Allen Elasticity of Substitution

Hired labour	**Chemicals**	**Materials**
–2.162	0.889	0.893
0.889	–1.220	0.331
0.893	0.331	–0.940

Table 9. Marginal Effects of Characteristics and Fixed Factors

Farm Characteristics	
Tarai	–0.318
Eastern	0.488
Central	0.533
Sharecropping	–0.665
Subsistence Farming	–0.288
Fixed Factors	
z1 - Adult labour	0.126
z2 - Child labour	0.008
z3 - Land and Capital	0.195

Table 10. Shadow Wages of Adults and Children - Rupees per Hour

Shadow wage	$E(w_i^*)$	$E(w_i^* \mid z_2>0)$	$E(w_i^* \mid z_2=0, nc>0)$
Adult labour	2.688	1.456	4.503
Child labour		0.927	
Child/Adult Ratio		0.637	

Table 11 Contribution of Demographic Attributes to the Marginal Cost of Labour by Household Members

	Adults' Attributes
	%
Head_age	1.683
Head_edu	–1.324
Adult_on farm	–0.359
	Children's Attributes
Child_school	–1.250
Child_female	6.147
Food_we	–4.897

Table 12. Poverty and Inequality when children contribute to household income

Poverty	**All sample**	**Farming Hh**	**Farming Hh w/o working children**	**Farming Hh with working children**
Poverty line is set at 4,404 Rh	*Obs. 3,373*	*Obs. 2,380*	*Obs 1,805*	*Obs 575*
Headcount ratio per cent	34.450	39.665	35.563	52.115
Poverty gap ratio per cent	9.763	11.167	9.712	15.585
Index FGT(0.5) per cent	17.168	19.678	17.372	26.676
Index FGT(1.5) per cent	6.009	6.873	5.903	9.819
Index FGT(2.0) per cent	3.904	4.472	3.801	6.509
Sen index per cent	13.321	15.285	13.322	21.180
Inequality				
	Obs. 3,373	*Obs. 2,380*	*Obs 1,805*	*Obs 575*
Relative mean deviation	0.345	0.252	0.253	0.232
Coefficient of variation	1.223	0.834	0.840	0.726
Standard deviation of logs	0.772	0.607	0.611	0.559
Gini coefficient	0.466	0.351	0.353	0.323

Table 13. Poverty and Inequality when children do not contribute to household income

Poverty	**All sample**	**Farming Hh**	**Farming Hh w/o working children**	**Farming Hh with working children**
Poverty line is set at 4,404 Rh	*Obs. 3,373*	*Obs. 2,380*	*Obs 1,805*	*Obs 575*
Headcount ratio per cent	35.695	41.426	35.563	59.22
Poverty gap ratio per cent	10.485	12.189	9.712	19.707
Index FGT(0.5) per cent	18.169	21.093	17.372	32.39
Index FGT(1.5) per cent	6.532	7.613	5.903	12.81
Index FGT(2.0) per cent	4.292	5.021	3.801	8.72
Sen index per cent	14.223	16.564	13.322	26.16
Inequality				
	Obs. 3,373	*Obs. 2,380*	*Obs 1,805*	*Obs 575*
Relative mean deviation	0.349	0.256	0.253	0.236
Coefficient of variation	1.236	0.847	0.839	0.737
Standard deviation of logs	0.783	0.619	0.611	0.574
Gini coefficient	0.470	0.356	0.353	0.327

Appendix: Estimation of Shadow Wages from the Primal Side

One of the main contribution of this work is the specification of a modified cost function modelling the quality differences between adult and child labour. This approach has been explained in Section 3 and implemented in Section 4. As a means to control the experiment developed in Section 4, this appendix measures the marginal product of family labour from the estimation of the primal side production. The empirical exercise consists in estimating a production function in order to derive shadow wages of adult and children directly from the marginal agricultural productivity. Note that the production estimation does not allow for an explicit distinction of fixed and variable factors. By considering fixed factors as if they were variable, we implicitly assume that there is not a shadow wage, but a market wage, in the dual side. We now explore whether this inconsistency has important practical consequence.

For convenience, the production function is assumed to have a Cobb-Douglas functional form "demographically modified" *a la* Barten (1964):

$$\ln y = \alpha + \sum_{i=1}^{5} V_i d_i + \beta_a \ln\left(z_a^*\right) + \beta_c \ln\left(z_c^*\right) + \sum_{i=1}^{4} \gamma_i \ln x_i + \varepsilon,$$

where ln$y$ is the log of the value of total production and ε is a spherical error term. $z_a^* = z_a q_a(d)$ and $z_c^* = z_c q_c(d)$ are linear function in the logarithms, where the set of adult demographic variables $q_a(d) = \exp\left(\sum_i \delta_i d_i^a\right)$ comprises age classes and education of the head and the percentage of the adult component working on the farm; the set of demographic characteristics of children, $q_c(d) = \exp\left(\sum_i \delta_i d_i^c\right)$ is formed by the number of children 10-14 going to school, a dummy equals to one if there is a female child 10-14 years old, and a dummy of adequacy of consumption equal to one if consumption is not adequate. The notation x_i denotes the quasi-fixed factor land and capital and the three variable inputs: hired labour, materials, and chemicals. The shadow wages associated with the Cobb-Douglas specification of the production function is

$$w_i^* = \hat{\beta}_i \frac{y}{z_i},$$

where $\hat{\beta}_i$ is the coefficient associated with z_i, y and z_i are the values of total production and adult or child labour, respectively, evaluated at the mean.

Table A.1 presents the nonlinear estimates of the production function. The marginal effects on ln$y$ of the three variable factors, family labour and land, are positive and significantly different from zero at the 1 per cent level in the case of adult labour and land. However,. magnitude of the parameter associated with child labour is smaller.

Table A.1 Parameter Estimates of Nonlinear Production Function

Variables	**Coefficients**	**Standard Errors**
Constant	6.711	0.1719
Tarai	0.071	0.0420
Eastern	0.211	0.0496
Central	–0.118	0.0416
Sharecropping	0.185	0.0436
Subsist.	–0.541	0.0403
Z1 – Adult Labour	0.287	0.0184
Head_age	0.223	0.0590
Head_education	0.235	0.0689
Adult_on farm	–0.458	0.3576
Z2 – Child Labour	0.023	0.0064
Child_school	–0.042	0.0145
Child_female	5.870	2.2763
Food adequacy	–5.829	1.5135
Z3 – Fixed Asstes	0.226	0.0166
Hired Labour	0.029	0.0113
Chemicals	0.123	0.0138
Materials	0.058	0.0109

As a consequence, the contribution of children is relatively modest. The input factors, hired labour, chemicals and materials, exhibit statistically significant coefficients. The coefficients of the variables affecting the effort supplied by family workers and, in turn, the effective shadow wage, such as household head's age and education, are positive and statistically significant. On the other hand, the proportion of wife and husband on-farm hours is negative but is statistically significant at the 10 per cent level of confidence. If we concentrate our attention on the effect of the demographic characteristics of children, we can observe that none of them is statistically significant.

Table A.2 Adults and Children Shadow Wages

	Shadow Wage		
	$E(w_i^*)$	$E(w_i^* \mid z_2>0)$	$E(w_i^* \mid z_2=0, nc>0)$
Adult labour	5.773	3.300	9.544
Child labour		2.486	
Child/Adult Ratio		0.753	

Among the three dummies for geographical characteristics only Eastern and Central regions are significantly different from zero at the 1 per cent significance level. However, the location of

the farm in the Central area of Nepal has a negative effect on production. Sharecropping is also not significantly different from zero at any conventional level of confidence. The farm characteristic related to the presence of subsistence agriculture has a statistically significant negative effect.

Although the functional forms adopted for the estimation of production and cost function are not directly comparable because the cost function is a translog, the sign of the parameters associated with adult labour, child labour, and fixed assets are the same when comparing the two approaches (Table 7 for the cost function results). In both cases, the estimates associated with these input factors have a positive effect on the dependent variable. The magnitude of the related parameters differs among the production and cost function estimates. This is especially evident for child labour that from a value of 0.023 in the production estimate decreases to 0.008 in the cost function. However, the significance levels are generally comparable among the two estimations.

In Table A.2 we report the shadow wages of adults and children calculated under three different conditions: 1) at the unconditional mean of all the variables, $E(w_i^*)$, 2) conditional on positive levels of child labour, $E(w_i^* \mid z_2>0)$, and 3) conditional on absence of child labour but in presence of children 10-14, $E(w_i^* \mid z_2=0, nc>0)$. The shadow wage of adults is always higher than the shadow wage calculated for children. In particular, in presence of child labour, the adults' shadow wage is lower than the other two conditions, indeed it is equal to 3.300 rupees per hour. This outcome seems to bear the initial assumptions that child labour is a consequence of lower family income. If children are not employed in agricultural activities the adult shadow wage increases to 9.544. Controlling then for positive value of child labour, the shadow wage of children is 2.486 rupees per hour. (One US $ corresponds to 63 Nepali rupees in 1997). In the NLSS the average of hourly market wage paid at hired workers is about 1.863 rupees and is a support of our computed shadow wages. Finally, the shadow wages estimated from the production side are generally twice as much as the shadow wages estimated from the dual side (Table 10).

Table A.3 reports the contribution to the marginal productivity of household labour of the characteristics of interest of adults and children. These effects are expressed in proportion of mean of the total production. The adults' demographic characteristics are head age grouped in four classes (1= less than 30 years old, 2= 30-45 years old, 3 = 46-60 years olds, 4 = more than 60 years old), education of household's head, and the proportion of adults' on-farm working hours. The children characteristics, on the other hand, are number of student 10-14 years old, a dummy equals to one if in the family there are girls 10-14 years old, and a dummy measuring

the adequacy in household consumption. The marginal effect of each of the adults characteristics on total production are all positive. Younger adults with a lower level of education are relatively less productive. On the other hand, the productivity of child labour is in fact positively correlated with the presence of daughters 10-14 years old. However, as it is reasonable to expect, a child also attending school or that is not adequately fed is less productive. Interestingly, the effects of the characteristics on wages are larger when measured from the primal side.

Table A.3 Contribution of Demographic Attributes to the Marginal Productivity of Labour by Household Members

	Adults' Attributes
	%
Head_age	6.382
Head_edu	6.743
Adult_on farm	–13.125
	Children's Attributes
Child_school	–0.095
Child_female	13.443
Food_we	–13.348