Implicit prices and recursivity of agricultural households' decisions

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Abstract

This paper analyzes the recursivity of consumption and production decisions of agricultural households. The paper demonstrate that a necessary and sufficient condition of recursivity is that implicit prices of goods that are produced by a household or used as inputs are equal to market prices. This result emphasizes the household specific nature of the recursivity property. For any sample, recursivity could hold for only a fraction of the observations. An empirical illustration, focussing upon the equality of implicit and market prices of family labour, is undertaken using data from the Côte d'Ivoire. Results indicate that non recursivity is a common case in this sample.

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1. Introduction[1]

Most analyses of the effects of policies directed towards agricultural producers are based on models derived from the theory of production. As agricultural households are both producers and consumers, these analyses are well founded only if households' decisions are recursive (de Janvry, Fafchamps and Sadoulet, 1991), that is if they can be modeled as resulting from a decision program consisting of two stages. First, outputs and inputs of production are determined by profit maximisation. Then, decisions related to consumption and leisure are taken according to their market prices, to unearned income and to profit earned on the farm (Singh, Squire and Strauss, 1986). If decisions are not recursive, it is not only the effects of economic policies on production levels which can depart from the standard neoclassical view, but also their impact on household welfare. The recursivity of agricultural household decisions is therefore a question of major importance for policy assessment.

In this paper, we show that a necessary and sufficient condition of the recursivity of decisions is that implicit prices of goods that are produced (or used as inputs) are equal to the corresponding market prices. Although sometimes mentioned in the literature, this equivalence result has not yet been demonstrated in a general framework. De Janvry, Fafchamps and Sadoulet (1991) and Jacoby (1993) establish results in the limited setting of leisure and consumption models under the constraint of market participation. Skoufias (1994) also had the intuition of such a result but did not attempt to prove it formally. Our approach encompasses various causes of non-recursivity: markets imperfections, such as rationing or differing selling and buying prices; non participation of the household to some markets; or externalities related to sales or purchases. We argue in this paper that differences between implicit and market prices also indicate the likely origin of the non recursive situation when it

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prevails.

We emphasize the household-specific nature of the recursivity property. Recursivity is not a functional property of household decision making since it depends on the values of market prices. The local aspect of the recursivity of decisions is little recognized in the literature. We know of only one paper (de Janvry, Fafchamps and Sadoulet (1991)) which underlines it: in the case where transaction costs create a wedge between sale and purchase prices, the ensuing market failure is shown to be household specific. Thus, in any empirical analysis using household data, only some households would satisfy the requirements of recursivity. Consequently, relevant empirical models have to be consistent under any combination of recursive and non recursive behaviours for households within the sample under scrutiny.

The methodology developed here provides a simple way to assess the empirical relevance of the hypothesis of recursivity. It is based on the estimation of household specific implicit prices, and therefore, dispenses with any prior assumption on recursivity.

The empirical illustration of our methodology that we present in this paper shows the tractability of this approach. It could be used prior to the estimation of full households' models so as to decide what specification (recursive or not) should be chosen. Its implementation requires only production data, this being sufficient to recover the relevant implicit prices (Thijssen, 1988, Jacoby, 1993, Skoufias, 1994). The data used here come from the Côte d'Ivoire Living Standard Survey 1985-1986 conducted by the World Bank and the Côte d'Ivoire Statistical Office. We only focus on decisions related to family labour and compare estimated real marginal products of labour in the farm for different family members and wages paid in the local labour market. Results indicate that implicit wages of female labour are lower than market wages for nearly half of the sample. This is found to be the main cause of non-recursivity in this sample.

In section 2, we set up the model, demonstrate the equivalence result and discuss other characterizations of recursivity given in the literature. In section 3, we describe the results of the empirical application. Section 4 concludes.

2. Recursivity and implicit prices

The economic literature on the recursivity of production and consumption decisions of rural households (Nakajima (1969)) originated from questions about the effect that market failures and non participation to markets have on agricultural households' behaviour. The common view is that if markets are not competitive or if households are neither buyers nor sellers in some markets, there are interactions between consumption and production decisions and recursivity does not hold (Singh, Squire and Strauss (1986) and Benjamin (1992)). This argument may provide an explanation for the poor performance of the traditional neoclassical model of rural households in predicting behaviour (Junankar, 1988, de Janvry, Fafchamps and Sadoulet, 1991). Nevertheless, most of the applied literature on rural households' behaviour in LDCs, is based on the assumption that production and consumption decisions are recursive.

2.1. The theoretical set-up.

The model considered here is static and deterministic. This is a general framework if consumption and production plans can be made contingent to any state of the world in any period. Such a model allows the effect of various departures from the assumption of complete markets to be studied in a simple framework. It is essential to be able to study such departures since non recursivity can only stem from market failures. In fact, if markets are complete in the sense of Arrow-Debreu, households' decisions are recursive since in such an economy, the distribution of owners' rights on production units does not matter (*e.g.* Laffont, 1983). In other words, in the Arrow-Debreu world, the fact that some households own production units as this is the case with agricultural households, does not matter.

Consider one household whose preferences are described by a utility function, denoted $U(c_1,.,c_n)$, where $(c_1,.,c_n) = c$ are consumptions of goods 1 to n. Initial endowments, such as leisure time or initial stocks, are written as a vector $\omega = (\omega_1,.,\omega_n)$

and unearned income is denoted by M. On the production side, the farm technology is described by $G(q_1, ., q_n) \leq 0$ where $(q_1, ., q_n) = q$ are inputs and outputs of production, using the convention that input quantities are negative. The fact that some goods cannot be consumed, produced or used as inputs, can be described by positivity and/or negativity constraints that are written as a set of linear constraints $T_c c \leq 0$ and $T_q q \leq 0$ for consumption and production goods respectively. T_i are matrices with only one non zero element on each line which can be equal to 1 or -1.

Market prices that households face need not be unique: purchase prices can be different from sale prices, wholesale prices are different from retail prices. Nonetheless, consider a set of reference market prices, $p = (p_1, ., p_n)$ which is chosen by the analyst from the observation of prices that the household could use for trading. We define recursivity with respect to these prices. Guidance for the choice of such prices is presented after our main result in section 2.3.

Other elements of the economic environment are constraints restricting choices because of various market failures such as missing markets, rationing, multiplicity of market prices or liquidity constraints. To show more clearly how economic environment can be described by constraints in the model, we present four examples, each corresponding to a different market failure. These examples will be followed up in the sequel.

Example 2.1. *Family labour. The household can sell off-farm hours of work* (H_{of}) *or work on the farm* (H_{on})*. If these two goods are perfectly substitutable (see Lopez (1984) for an alternative assumption), one element of* c*, say* c_1*, is equal to leisure* $c_1 = T - (H_{of} + H_{on})$ *where* T *is available time. The reference market price is supposed to be the off-farm wage* w*, and* $q_1 = -H_{on}$ *is the family labour input. Constraints, such as* $c_1 \geq 0$ *and* $q_1 \leq 0$ *, are summed up in* $T_c c \leq 0$ *and* $T_q q \leq 0$*. If hired labour is not perfectly substitutable to family labour, there is no purchase market for family labour and this is certainly a market failure. In this case, there is a cross-constraint between consumption and production decisions:* $c_1 - q_1 - T \leq 0$*.*

Example 2.2. *Rationing constraints. Purchases of corn, for instance, cannot be greater than a rationing bound* s_1. *In this case,* $c_1 - q_1 \leq s_1$.

Example 2.3. *Price bands. The household can produce corn,* q_1, *using an input* q_2. *They also consume a quantity,* c_1. *They can sell corn at price* p^s *and buy it at a price* p^d. *There is a price band because of transaction costs, (de Janvry, Fafchamps and Sadoulet, 1991, and Sadoulet, de Janvry and Benjamin, 1996) and* $p^d > p^s$. *Choose the reference price to be* $p_1 = p^s$. *The budget constraint is written as:* $p_1(c_1 - q_1) \leq M + p_2q_2$. *As purchasing corn is more expensive, there is a constraint written as:* $p^d(c_1 - q_1) \leq M + p_2q_2$. *If* $c_1 < q_1$, *the budget constraint binds and the cross-constraint does not because* $p^d(c_1 - q_1) < p_1(c_1 - q_1)$. *In contrast if* $c_1 > q_1$, *the cross-constraint binds and the budget constraint does not. It is straightforward to adapt the example to the case where the purchase price is chosen as the reference.*

Example 2.4. *(de Janvry, Sadoulet, Fafchamps and Raki, 1992) Liquidity constraints. Households' borrowing depends on marketed surpluses because these quantities are the only observable household characteristics that a lender could condition on. Then:*

$$p'(c - q - \omega) \leq M + \sum_i \alpha_i \max(q_i - c_i, 0) \qquad \forall i, \alpha_i \geq 0, \exists i, \alpha_i > 0$$

We infer from these examples that most, if not all, of effective economic constraints due to market failures are functions of marketed surpluses and unearned income only. We assume that these constraints can be of two types[2]. First, non participation or rationing constraints are written as:

$$S.(c - q - \omega) \leq s$$

where s is a positive vector and S a matrix with only one non zero element in each line which can be 1 or -1.

[2] These constraints depend on prices or local characteristics. As those variables are assumed to be fixed in the sequel, we dispense with this dependence.

Second, the cases of price bands and liquidity constraints involve all goods and exogeneous income:

$$F(c - q - \omega, M) \leq 0$$

where F is a vector of functions $\{F_k\}_k$, such that $F(0, M) \leq 0, \frac{\partial F_k}{\partial d_i} \neq 0$ (if $d_i = c_i - q_i - \omega_i$) and as M is always disposable:

$$\frac{\partial F_k}{\partial M} < 0$$

Decisions of production and consumption are then derived by solving the following program ($\mathcal{P}$) where the price vector entering in the budget constraint is the vector of reference market prices[3]:

$$\max_{c,q} U(c)$$
$$\text{subject to} \quad \left| \begin{array}{l} p'(c - q - \omega) \leq M \\ G(q) \leq 0 \\ T_c c \leq 0; T_q q \leq 0 \\ S.(c - q - \omega) \leq s \\ F(c - q - \omega, M) \leq 0 \end{array} \right.$$

This decision program distinguishes constraints bearing on only one side (technological and positivity constraints) and cross-constraints bearing on both sides (the budget and other economic constraints). This distinction will turn out to be essential for our characterization of recursivity.

2.2. A formal definition of recursivity

The general characterization of recursivity is that the determination of production and consumption decisions is sequential (Nakajima, 1969, Singh, Squire and Strauss, 1986). First, the household considers that prices are p, the technology of production is given by $G(q) \leq 0$ and $T_q q \leq 0$, and takes its production decisions accordingly. Any other constraints in S or F are disregarded. It is in this sense that the predictions

[3] If there is to be a unique solution to utility maximization (Takayama, 1985) some technical assumptions are needed. Sufficient conditions are that the utility function is strictly quasi-concave, the production set is strictly convex and the set of other constraints is convex. We will also assume in the sequel that all derivatives exist. In order to accomodate the possibility that F could include minima and maxima of functions, derivatives of F denote the left-derivatives of F.

of the theory of production are correct under recursivity. Second, the household perceives all farm profits and takes decisions relative to consumption under constraints bearing on consumption, $T_c c \leq 0$, $S.(c - q^* - \omega) \leq s$, $F(c - q^* - \omega, M) \leq 0$[4].

This characterization can be interpreted as meaning that the household delegates all production decisions to a profit maximizer, retaining however all property rights over the production unit.

Definition 2.5. *Decisions are said to be recursive with respect to the reference price* p *if the solution to* ($\mathcal{P}$) *can be obtained as the recursive solution to two decision problems,* $\mathcal{P}_1$ *and* $\mathcal{P}_2$*:*

$\mathcal{P}_1$:

$$\max_q p'q \quad \text{subject to} \left| \begin{array}{l} G(q) \leq 0 \\ T_q q \leq 0 \end{array} \right.$$

$\mathcal{P}_2$:

$$\max_c U(c) \quad \text{subject to} \left| \begin{array}{l} p'(c-\omega) = M + \Pi \\ T_c c \leq 0 \\ S.(c - q^* - \omega) \leq s \\ F(c - q^* - \omega, M) \leq 0 \end{array} \right.$$

where q^* *denotes the argument of the maximum of the first decision problem* $\mathcal{P}_1$ *and optimal profit is* $\Pi = p'q^*$*.*

This definition rests on the decision programs. To make it a testable condition on observables, characterizations in terms of observed behaviour have to be derived. The main approach followed in the literature has been to analyze the restrictions implied by recursivity on demands and supplies (Singh, Squire and Strauss, 1986, Benjamin, 1992). We here follow a different route to characterize recursivity through the comparison of implicit and reference prices.

2.3. Restrictions on implicit prices.

We first show that if the only constraints involving both consumption and production goods is the budget constraint, recursivity holds.

[4] It is as if the household were buying agricultural products at price p through an internal market.

Lemma 2.6. *If there is no constraint of the type* $S.(c-q-\omega) \leq s$ *or* $F(c-q-\omega, M) \leq 0$*, then recursivity holds.*

Proof: Fix q such that $G(q) \leq 0$ and $T_q q \leq 0$ and denote $\Pi = pq$. Since decision programs $\mathcal{P}$ and $\mathcal{P}_2$ are identical when q is fixed, then $c(\Pi)$ solution of $\mathcal{P}$ when q is fixed and $c(\Pi)$ in $\mathcal{P}_2$ coincide for any Π. As utility is increasing in Π, the optimal solution q of $\mathcal{P}$ is the maximum Π and it is given by $\mathcal{P}_1$.□

This result substantiates the claim that if markets are complete then recursivity holds. It is a global result and it can readily be extended to the case where we look only at constraints binding at the optimum.

Lemma 2.7. *Let* c^* *and* q^* *denote the optimal solutions to* $\mathcal{P}$ *such that the cross constraints are not binding at the optimum:* $S.(c^*-q^*-\omega) < s, F(c^*-q^*-\omega, M) < 0$*. Then recursivity holds.*

Proof: As optimal solutions to $\mathcal{P}$ (resp. $\mathcal{P}_1, \mathcal{P}_2$) are also optimal solutions to decision problems $\mathcal{P}'$ (resp. $\mathcal{P}'_1, \mathcal{P}'_2$) where cross constraints S and F are neglected, we can apply lemma 2.6 to $\mathcal{P}'$.□

These results state that a sufficient condition for recursivity is that no cross-constraint holds at the optimum. Conversely, non recursivity can only occur because some cross-constraints hold. To have a more concrete understanding of these lemmas, consider their application to the four examples already presented.

Example 2.1(continued): *The constraint on off-farm hours of work* $c_1 - q_1 - T \leq 0$ *that links consumption and production decisions does not bind if off-farm work is positive. Conversely, if decisions are not recursive, off-farm hours are zero (they cannot be negative).*

Example 2.2(continued): *When there is rationing on purchases, if excess demand is (strictly) less than the rationing bound then decisions are recursive. If they are not recursive, then the rationing constraint binds and excess demand is equal to the bound.*

Example 2.3(continued): *If the reference market price is the supply price, the constraint on purchases of corn* $p^d(c_1 - q_1) \leq M + p_2 q_2$ *does not bind if there is no purchase:* $c_1 < q_1$. *Excess supply,* $q_1 - c_1$, *is sold at price* p_1. *Recursivity holds with respect to the supply price. Reciprocally, if decisions are not recursive with respect to this price, then the constraint binds and* $c_1 \geq q_1$. *On the other hand, if the reference market price is the purchase price, then recursivity holds if purchases are strictly positive.*

Example 2.4(continued): *The liquidity constraint does not bind, or more exactly is the same as the budget constraint if* $\forall i; q_i < c_i$. *Recursivity holds. Reciprocally, if decisions are not recursive then for at least one* i, $q_i \geq c_i$.

The results presented above cannot be used very easily in empirical analysis. There are two reasons why this is the case. First, these results specify conditions that bear on household specific constraints that are unlikely to be observed. Second, they provide sufficient condition only. Hence they cannot deal with border cases such as $c_1 = q_1$ in example 2.3 where decisions could be either recursive or non recursive. The rest of this section therefore goes beyond these first results and presents necessary and sufficient conditions bearing on easily observable variables. To proceed, we shall first assume that all goods are consumed and produced at the optimum. Therefore, we analyze decisions in the domain $T_c c < 0$ and $T_q q < 0$. We will tackle the general case later.

Let us first define implicit prices. In $\mathcal{P}$, denote $\lambda, \mu, \sigma, \delta$ the positive Lagrange multipliers associated to the budget constraint, the technological constraint, and the constraints S and F. Because the constraints ($T_c c \leq 0$ or $T_q q \leq 0$) are not binding, the Lagrangian is:

$$\mathcal{L} = \mathcal{U}(c) + \lambda(M - p'(c - q - \omega)) - \mu G(q) - \sigma' S(c - q - \omega) - \delta' F(c - q - \omega, M)$$

The first order conditions of $\mathcal{P}$ with respect to c and q are written in terms of marginal utilities U_i and derivatives of G, G_i as:

$$\begin{cases} U_i = & \lambda p_i + \sigma' S_i + \delta' \dfrac{\partial F}{\partial d_i} \\ \lambda p_i = & \mu G_i - \sigma' S_i - \delta' \dfrac{\partial F}{\partial d_i} \end{cases} \tag{2.1}$$

where excess demands $c - q - \omega$ are denoted d and S_i is the ith column of S. If $V(M)$ denotes the indirect utility function as a function of income, the marginal utility of money is written:

$$\frac{\partial \mathcal{L}}{\partial M} = V_M = \lambda - \delta' \frac{\partial F}{\partial M} > 0$$

It is strictly positive because $\lambda \geq 0, \delta \geq 0$ (the inequality being strict for one of them) and $\frac{\partial F_k}{\partial M} < 0$.

The implicit price of good i is equal to its marginal rate of substitution with money and is proportional to the derivative G_i using (2.1):

$$p_i^* = \frac{U_i}{V_M} = \mu \frac{G_i}{V_M} \tag{2.2}$$

The equivalence result of this paper can now be formalized as follows:

Proposition 2.8. *The following statements are equivalent:*

i). Household decisions are recursive with respect to p

ii). Implicit prices of all goods are equal to the reference prices, p*; the budget constraint is binding,* $p'(c - q - \omega) = M$*; and the technological constraint is binding* $G(q) = 0$.

iii). There is no effect on utility of removing all cross constraints S *and* F.

Proof: See appendix.

Note that by using (iii), recursivity implies that $(\mathcal{P}_2)$ can also be written as:

$$\begin{array}{ll} \max_c U(c) & \\ \text{subject to} & p'(c-\omega) = M + \Pi \end{array}$$

as no cross constraint is binding at the optimum. The proposition shows that this is an equivalent definition of recursivity to the one given above.

This result is better described by following up the examples.

Example 2.1 (continued): *We have seen that if decisions are not recursive, off-farm hours are equal to zero. This is therefore a case where households are self-employed ("autarkic") and where the implicit price of family labour is greater than the market wage. A border case of recursivity is when the implicit wage is equal to the market wage and the household is autarkic.*

Example 2.2 (continued): *Decisions are recursive if* $c_1 - q_1 \leq s_1$ *and* $p_1^* = p_1$. *In contrast, if* $p_1^* > p_1$, *the household is rationed and decisions are not recursive*

Example 2.3 (continued): *If the reference market price is the supply price and decisions are not recursive, excess supply is zero. The implicit price either falls into the price band between the selling and purchase price if* $c_1 = q_1$ *or is equal to the purchase price if* $c_1 > q_1$. *In the latter case, decisions are recursive with respect to the purchase price.*

Example 2.4 (continued): *If decisions are not recursive, for at least one good,* $q_i \geq c_i$. *Its implicit price is either equal to* $p_i + \alpha_i$ *if* $q_i > c_i$ *or falls into the price band* $]p_i, p_i + \alpha_i[$ *if* $q_i = c_i$.

To complete the characterization of recursivity, it is necessary to show that situations where goods are not consumed or not produced may be treated.

Proposition 2.9. *Assuming that at least one good is consumed and produced, household decisions are recursive with respect to* p *if and only if the following conditions hold: implicit prices of all goods that are produced or used as inputs are equal to the reference prices,* p; *the budget constraint is binding,* $p'(c - q - \omega) = M$; *and the technological constraint is binding* $G(q) = 0$.

Proof. The proof that recursivity implies these conditions follows similar lines that the proof used in proposition 2.8. To prove the converse, assume these conditions are verified and fix the quantities of goods that are not consumed or not produced to their optimum values. If there is one good that is produced and consumed, apply proposition 2.8 which shows that no cross constraints bind at the optimum and that they can be removed. Therefore $(\mathcal{P})$ can be written as:

$$\max_{c,q} U(c)$$
$$\text{subject to} \quad \left| \begin{array}{l} p'(c-q-\omega) = M \\ G(q) = 0 \\ T_c c \leq 0; T_q q \leq 0 \\ S_I.(c_I - \omega) \leq s_I \\ S_J.(q_J - \omega) \leq s_J \end{array} \right.$$

where c_I is the subvector of goods that they are consumed and not produced and q_J is the subvector of goods that are produced and not consumed. As constraints are separated for these goods, production decisions q are given by $(\mathcal{P}_1')$:

$$\max_q p'q$$
$$\text{subject to} \quad \left| \begin{array}{l} G(q) \leq 0 \\ T_q q \leq 0 \\ S.(q_J - \omega) \leq s_J \end{array} \right.$$

If implicit prices of goods q_J are equal to their market prices, the constraints $S.(q_J - \omega) \leq s_J$ are not binding and decisions are recursive. ■

The last part of the proof can also be used to formulate other definitions of recursivity of agricultural households' decisions. For instance, it could be defined as being the equivalence between $(\mathcal{P})$ and $(\mathcal{P}_1')$ and $(\mathcal{P}_2)$. In this case, a necessary and sufficient condition would be that implicit prices of goods that are both consumed and produced are equal to the reference prices and that the budget constraint and the technological constraint are binding.

We now return to the choice of the reference market prices. As a binding budget constraint is a necessary condition for recursivity, a natural candidate for the reference market prices is the set of prices at which the household trades positive quantities. If there is excess supply (resp. demand), the candidate is the supply (resp. demand) price. In other cases, supply equals demand and either the supply or the demand price could be chosen as reference.

Finally, we shall emphasize two important aspects that stem from this characterization of recursivity. First, recursivity is an idiosyncratic property for households. Of two households, differing for example by some family characteristics or facing different market prices, one may have a recursive behaviour while the other does not. Secondly, recursivity is neither a property of preferences nor of technology and that is why the terminology "recursivity" is to be preferred over "separability", a term which is also used in the literature. In other words, for any preferences and technology, there are prices such that the household would make recursive choices. Such prices are chosen so as to equalize implicit prices of goods which are produced. If decisions are not recursive, the structure of relative prices used by the household is different from the structure of relative market prices.

2.4. Extensions

When implicit prices and market prices are not equal, the difference between them embodies some information related to the cause of non recursivity. Suppose for example that the implicit price is greater than the reference market price. The household would like to purchase more of this good at the reference price but does not do it. It is due either to the fact that excess demand is rationed at this price (examples 2.1, 2.3) or to some negative externality of purchases (example 2.4). If the household is in fact a net supplier for this good, there is some positive externality of supply. In contrast, the household would like to sell more at the market price if it is greater than the implicit price. Nevertheless, given that the household does not increase its supply, this signals either that excess supply is rationed (example 2.1) or that the household has a positive excess demand for the good because of some positive externality of purchase.

The case where there is uninsurable risk in market prices is now briefly developed in order to show that decisions are then generically not recursive except if the household is risk neutral. Consider that there is some uninsurable risk in the market price of one commodity which is produced and consumed. All other things being deterministic, we assume that there are two states of nature, H and L, such that the price of the commodity is respectively equal to p^H and p^L with $p^H > p^L$. All production decisions are taken prior to the resolution of uncertainty. Consumption decisions are taken afterwards. Using our framework, it is easy to demonstrate that the implicit price of the produced commodity is equal to the market price in both states of nature if and only if there is full insurance, i.e. marginal utilities are equalized across states. If there is no insurance market, equality between implicit and market prices can only happen if the household is neutral to risk. Decisions are recursive in this case only.

2.5. Related results and the design of empirical tests

The main route to test for recursivity in the literature is to consider restrictions on demands and supplies (Lopez, 1984, 1986, Benjamin, 1992). Using the theory of demand under rationing as developed in Deaton and Muellbauer (1980), demand and supply functions can always be written as functions of implicit prices under recursivity or non recursivity:

$$\begin{cases} q = & q(p_q^*) \\ c = & c(p_c^*, M) \end{cases}$$

where p_q^* and p_c^* are implicit prices of production and consumption goods. Under the assumption of recursivity, we have shown that, for the set of goods that are produced or used as inputs (noted I):

$$\forall i \in I, p_i^* = p_i$$

Assuming that prices of goods $i \notin I$ are known, the above result implies testable restrictions: on the production side, all decision variables are independant of exogenous income M or more generally of variables affecting only preferences (demographics for example). On the consumption side, all decision variables are independant of output or input prices if profit is held constant. The former restrictions are, for example, used by Benjamin (1992) who tries to assess the influence of household's demographic variables on the demand for farm labour. If recursivity holds, this influence should not be significant and that is indeed what he finds in the case of rural Java.

There are two drawbacks with the method outlined above. First, the null hypothesis is that decisions of all households are recursive, which is a very strong hypothesis indeed as we underlined that recursivity is household specific. The second drawback is that all goods need to be considered and that markets for goods which are not produced are perfect. An alternative method, that does not suffer from these drawbacks, would be to estimate the system of demands and supplies under non recursivity but this is certainly a very difficult task. A simpler method is to estimate implicit prices in a first stage and then estimate demands and supplies, as demonstrated by Thijssen, 1988, Jacoby, 1993, and Skoufias, 1994.

The recursivity diagnostic we develop in this paper consists in estimating implicit prices under no hypothesis, following in this the method just mentioned, and then compare those prices with market prices in order to see whether requirements for recursivity are fulfilled.

An empirical test based on our methodology uses the fact that if there exists a significant difference between the implicit and market prices for any good which is produced or used as an input, recursivity does not hold. It is therefore possible to focus on one good and test whether recursivity conditions are fullfilled for this particular good. This test of recursivity is conservative in the sense that only the rejection of the null hypothesis is informative: if, for this good, implicit price and market price are not equal, then recursivity does not hold. No rejection could mean that non recursivity arises because of another good. This is the approach we adopt in the following section to illustrate our characterization of recursivity.

3. An empirical illustration using Côte d'Ivoire data

We focus our analysis on family labour of agricultural households in Côte d'Ivoire. Family labour is our main variable of interest because it is the most widely used input of production for agricultural households. We only look at this necessary condition for recursivity.

3.1. The data

The data is drawn from the Living Standard Surveys conducted in Côte d'Ivoire by the World Bank and the Côte d'Ivoire Statistical Office (CILSS)[5]. As the survey is a rolling panel over two years, our working sample is composed by households present in 1985 and 1986. The survey gives detailed information on crop productions, inputs and characteristics of households and local labour markets. Only the main aspects of the data construction are presented here.

The survey registers agricultural production by asking households the annual detailed crop productions, net of home-consumption, and their selling market prices. Values of inputs, fertilizers, insecticides, transport and other inputs as well as hired labour costs are reported either for each crop or for the production as a whole. The latter is very common and precludes analysis of individual crops. To construct a production variable, we make two assumptions:

First, as the units of measurement of quantities produced are often non standard, we assume that "normalized" prices and quantities can be used. These are obtained by infering a scale of correspondance for non standard units (e.g. buckets, tins etc) on the basis of the relation between their mean prices and the mean price of the most commonly used unit of measurement in 1985, 1986 and 1987. We systematically corrected prices by setting observations outside the 25-75% interval at the values of the first and third quartiles by clusters.

Second, we aggregated prices in five groups using a standard Divisia index. These five groups of crops are: Coffee and cocoa; Other trees; Tobacco, cotton, sugarcane, yam and groundnut; Mil, corn and rice; Vegetables, manioc, taro, sweet potatoes. Quantities of output in each group are computed using these indices. Then aggregation is repeated over the five groups to obtain an index of aggregate production

[5] General information about agricultural markets and the setting of agricultural prices in Côte d'Ivoire can be found in Berthélémy and Bourguignon (1996) for example. References for the survey are Ainsworth and Muñoz (1986) and Grootaert (1986).

(YVNET). This two-step procedure allows us to use group-prices as instruments in the empirical analysis that follows.

We consider four variable inputs: fertilizers and insecticides (CHIM), hired labour (LAB), male and female family labour. Quantities of the first input is available in the survey. Hired labour is constructed by using the information on in-kind payments for each crop, correcting for double-counting in the case of sharecropping (Deaton and Benjamin (1987)). Annual monetary payments to hired labour are then added. To construct the number of hours of male family labour (HMAL) and female family labour (HFEM), questions about work last week and during the last year are used. Attempts to use finer decompositions (or children's hours of work) were unsuccessful. We also considered two fixed factors, land (LAND) and capital (CAP) which is a raw measure of available equipment. Finally, the information in the survey on wages earned by family members in outside activities is of very poor quality. We therefore use local wages that are constructed using the community questionnaire. Hence, we assume that all female and male labour in a given village have the same opportunities. More precise measure of wages is not permitted by the data and we cannot condition wages to individual characteristics. The list of variables used and descriptive statistics appear in table 1. The sample is composed of 373 households.

3.2. Econometric specification and methods

Implicit prices for labour are recovered from the estimation of a production function. These implicit prices could also be compared to those obtained from the estimation of input demands functions, and this was done in an empirical paper (Lambert and Magnac 1994). The reason for using a production function for the present illustration is twofold. First, the number of observations available to perform the estimation of a production function is not affected by the many zeros found in the observed quantities of inputs (chemicals). Second, estimating a production function also involve making fewer assumptions regarding optimization behaviour than estimating a cost function (Chambers, 1988). Two considerations have lead us to use a generalized Leontief specification for the production function. It is second order flexible (Diewert (1971)) and it easily allows inputs to be zero, in contrast with the translog specification for example.

As there are four variable inputs (hired labour, chemicals, male and female family labour), and two quasi fixed factors (land and capital), the following specification is used:

$$y = a_0 + \sum_{i=1}^{6} b_i \sqrt{x_i} + \sum_{i=1}^{6} c_{ij} \sqrt{x_i x_j}$$

where x_i is the quantity of input i and y is the production in volume.

Non constant returns to scale are then allowed if a_0 and $\sum b_i$ are different from zero. Implicit wages can then be computed by multiplying the marginal products of labour by the output price.

The estimation of the production function is carried out in levels for the year 1986. Since inputs are likely to be endogenous in the production function, we instrument them by exploiting the panel dimension of the survey. We consider a set of instrumental variables which consists in variables dated $t-1$ which are related to prices and family characteristics as well as variables such as production outputs and inputs dated $t-1$. The two-years dimension of the sample is only used to construct instruments because first-differencing the equations would imply correlation between instruments dated $t-1$ and residuals of the first-difference equation. We retain all instruments in their linear form and added interactions between them since inputs are interacted in the production function. Several specifications were tested using the Sargan criterion for overidentifying restrictions. We settled here for the most complete set of instruments not rejected by tests of overidentifying restrictions. Notes to table 2 provide a list of these instruments.

The results of the estimations of the production function equation are presented in table 2. We did not keep all the interactions that should have appeared according to the specification above. Those interactions that did not have a significant effect (at a 20% level) were excluded. Nevertheless, we did not look for parsimony, since our objective is not to have precisely determined coefficients but rather a good fit for implicit wages. Therefore, the specification we finally chose retains as many regressors as was reasonably possible, given the number of observations. Although the quality of the determination of the model seems low, the estimates of the elasticities are quite satisfying, even if they are very small (Lambert and Magnac, 1994). The own price elasticities conform in the majority of cases to the restrictions of economic theory. This is generally verified both at the mean point and if quartiles of their distributions are considered.

3.3. The comparison between implicit and market wages

In table 3, we present descriptive statistics respectively on market wages, computed from the sample, and implicit wages (or shadow wages) that are computed by multiplying the marginal productivities of labour by the output price. Comparing the implicit price for labour (w^*) and the market wage (w) allows to conclude whether recursivity holds ($w^* = w$) or not ($w^* \neq w$). Implicit wages for the three categories of labour (hired labour and male and female family labour) are computed observation by observation using the estimates of the production function. We assumed away any unobserved heterogeneity in marginal productivities of inputs and we computed heteroskedastic-consistent standard errors of implicit wages by using the variability of the estimates by the delta method (Amemiya, 1985). The computed standard errors are lower bounds for the true standard errors of implicit wages if there is unobserved heterogeneity. An informative statistic is the correlation between the market and the implicit wages appearing in table 3.B. It is significantly positive for hired labour, but it is very small for family hours of work, and even negative for female family labour. As these estimates are direct measures of real marginal productivities, it indicates that the relationship between market wages and implicit wages is stronger for hired labour than for family labour, which would conform with the idea that market wages are equal to the implicit wages of hired labour and not to the implicit wages of family labour.

Results regarding recursivity are given in table 3.C. We computed the frequencies of observations for which the market wage is above, below or within the confidence interval of the estimated implicit wage. This indicator could be very sensitive to any measurement error in market wages and we acknowledge that our procedure is not robust in such a situation. Therefore, we also provide a description of the characteristics of households which fall outside the bounds to see if they conform with the prior ideas that we have about recursivity.

The strongest result in table 3.C is that the market wage for female labour is higher than the implicit wage for nearly half of the sample. Therefore recursivity between consumption and production decisions does not seem to hold. For hired labour and for male family labour, results are less striking: 89% of the observations are such that the market wage belongs to the 90% confidence interval of the corresponding implicit wage and about 10% of the sample has an implicit wage that is lower than the market wage. Furthermore, the standard deviation of the estimator of male family labour implicit wage is very high. In fact, although the median of male implicit wage is 0.44 while the mean of the market wage is 5.85, the latter still fall in the 90% confidence interval of the implicit wage in 89% of the cases. We are therefore more confident on the reliability of the female implicit wages estimates and our test would lead us to conclude that female family labour is an important source of non-recursivity.

The difference between implicit wages and market wages could arise from a misspecification of the production function. In fact, if there were only one agricultural output, the specification of the production function would not depend on the recursivity of households' decisions because it is a technological relationship. There are many outputs though and as explained in section 3.1, we aggregated them using market prices. If decisions were not recursive because of some market failures, relative to some outputs, the aggregate output index that we derived could be incorrect and the production function misspecified. Marginal productivity of family labour would not be consistently estimated and might be different from market price because of this misspecification. This would also be indicative however that recursivity does not hold although in an indirect way.

To try to have a better idea about the empirical relevance of the non-recursivity result, we examined in more details the household characteristics according to the level of their implicit wages for female family labour relative to the market wages. According to the above estimates, we distinguish two groups of households: those whose market wage fell above the 90% confidence interval of the implicit wage and the others[6]. The groups of households whose implicit wage for female family labour is less than the corresponding market wage consist in 49% of the population.

Theoretical arguments tell us that if implicit wage lies below the market wage, corresponding households should face rationing or negative externalities of participation in the labour market. We observe (table 4) that households for which the market price for female labour is above the 90% confidence interval of the implicit wage are households facing a lower price for their agricultural output (P) than other households. This could be due to measurement errors in output prices since we use them when computing the implicit wages. Nevertheless, it should then be true also for the implicit prices of the two other types of labour where in fact only 10% of the sample is such that the market wage is above the implicit wage. The households whose implicit wage is lower than the market wage also have a relatively higher market wage (WH). This, in turn, could be due to measurement errors in market wages. Nonetheless, the level of production they achieve is much higher, whether measured in absolute terms (YVNET) or per head (YVNET/ADT). These households use more of their own work force on the farm (HMAL, HFEM) and more seeds (SEMV) than the others. Conversely, they use less capital (CAP) than others. Furthermore, these households are observed with a (non significantly) lower ratio of off-farm employment to family size (HOFF/FS) or to on-farm work (HOFF/HON). These findings are all consistent with the idea that these households might face a constraint on their supply

[6] As this procedure is purely descriptive, we prefer to look directly at the differences in means across the two groups in the population. Running regressions with the shadow wage as dependent variable would not allow any behavioural interpretation since all variables on the right-hand side are potentially endogenous because they are determined by the same household unobserved effects than the shadow wages.

of off-farm work. Because rationing deprives them of an alternative income generating activity, they put more effort into their agricultural production than others, even though their output price is lower. This effort translates in a wider use of inputs that do not necessarily need to be purchased on the market (family labour, seeds) and conversely, in a lesser use of market purchased input such as capital.

Finally, a lower implicit price is correlated with a larger number of members of the household whether male (NM) or female (NF). These results are consistent with the usual hypotheses of decreasing marginal products of labour. The education of the household head or of household members and the quantity of hired labour (not reported in the tables) are not different in the two groups.

The descriptive analysis appears to confirm the argument that the characteristics of households whose implicit wages are lower than market wages differ from those of households for which the equality between the two can not be rejected. It also provides support for the idea that this difference is likely to be due to constraints on labour supply.

There are however other explanations for low implicit wages. For example, if there is a positive externality in the activity performed at home, such as child rearing, the marginal productivity of on farm work should include the valuation of this activity[7]. This underlines that the comparison between implicit and market wages is only a reduced form exercise and they are many competing explanations for the results obtained.

Altogether, our results seem to reject recursivity for a large part of the sample, although this is conditional to the correct measurement of market and implicit wages. In fact, according to the above estimates, half of the households in the sample (168) have an implicit wage for male and /or female labour that differs from the corresponding market wage. The use of a non-recursive model of rural household behaviour when analyzing Côte d'Ivoire data does seem to be advisable on these grounds.

[7] We thank one referee for this argument.

4. Conclusion.

In this paper, we showed that the equality of implicit and market prices of goods that are either produced or used as inputs by agricultural households is a necessary and sufficient condition for the recursivity of their decision making. Moreover, we underlined the fact that the comparison between implicit and market prices may be used to provide information as to why the recursivity condition may not hold. The practical usefulness of the approach developed in the paper is demonstrated using an empirical illustration based on data from Côte d'Ivoire.

The ability to diagnose non recursivity has important implications for economic policy purposes. In fact, in order to predict the response of agricultural households to crop price changes, it is necessary to establish whether decision making is recursive or not and, accordingly, to use an appropriate model. Furthermore, in the case of non recursivity, the response to price changes depends not only on preference parameters but, also, on the reason why the recursivity condition fails to hold true. The methodology developed in this paper provides some indications as to the reason why there may be such a failure.

The approach we present highlights the household specific nature of recursivity, something which has important implications for aggregate models. In fact, if some agricultural households display recursive behaviour while others do not, no representative agent can be defined. Thus, as soon as a sizeable proportion of households have non-recursive behaviour, models used to make policy recommendations should specify demand and production functions which are compatible with non recursive decision making. The error resulting from a failure to correctly specify the model is greater than that obtained when supply functions are estimated in reduced form, a result pointed out by de Janvry, Fafchamps and Sadoulet (1991). The recursivity diagnostic proposed in this paper enables the share of non recursive households to be measured and therefore the appropriateness of macro models to be assessed. The results of the empirical illustration using data from Côte d'Ivoire suggest that the recursivity condition does not hold for female labour for nearly half of the sample and therefore that, in this case, the use of a representative agent framework is open to question.

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Proof of proposition 2.8

Before proving the proposition, we derive the value of removing the cross-constraints in the general program. The marginal effect of binding constraints, $S(c-q-\omega) \leq s$ or $F(c-q-\omega, M) \leq a$ (at the point $a=0$) is given by:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial s} &= \sigma' \\ \frac{\partial \mathcal{L}}{\partial a} &= \delta' \end{aligned}$$

If a constraint is not binding, $\sigma_k = 0$ or $\delta_k = 0$, and there is no effect of removing this constraint on utility. The marginal effect on utility of changes in income and constraints is given by:

$$dV = V_M dM + \sigma' ds + \delta' da \tag{.1}$$

where the marginal effect of removing all cross constraints on utility is obtained by a marginal change:

$$\sigma' ds + \delta' da$$

Now, by definition (2.2) implies that:

$$U_i = p_i^* V_M \tag{.2}$$

Consider changes dM, ds, da and the corresponding changes in consumption $dc = (dc_1, ., dc_i, .)$ and production dq. The marginal effect on utility is given by:

$$dV = \sum_i U_i dc_i = V_M . \sum_i p_i^* dc_i = V_M p^{*\prime} dc$$

By definition (2.2) also implies that:

$$\mu G_i = V_M p_i^*$$

As in all cases that we are going to consider (i, ii, iii) the technological constraint $G(q) \leq 0$ is binding, it implies that:

$$V_M . p^{*\prime} dq = 0$$

and therefore:

$$dV = V_M . p^{*\prime} (dc - dq) \tag{.3}$$

We can turn now to the proof of the proposition. We prove in sequence that $(ii) \Rightarrow (iii) \Rightarrow (i) \Rightarrow (ii)$.

1.$(ii) \Rightarrow (iii)$: Since the budget constraint is binding, $p'(dc - dq) = dM$ and:

$$\begin{aligned} dV &= V_M dM + \sigma' ds + \delta' da \\ &= V_M p'(dc - dq) + \sigma' ds + \delta' da \end{aligned}$$

Using (.3) and $p^* = p$,

$$\sigma' ds + \delta' da = 0$$

There is no effect on utility of removing all cross constraints. (It does not imply necessarily that all Lagrange multipliers are zero at the optimum but that they cancel out. An example of such a case would be a missing market imposing: $q_1 - c_1 \leq 0$ and $c_1 - q_1 \leq 0$. It can happen that the two constraints balance each other and this is the case when $p_1^* = p_1$).

■

2. $(iii) \Rightarrow (i)$: if there is no effect on utility of removing all constraints S and F, $(\mathcal{P})$ is equivalent to:

$$\begin{array}{ll} \max_{c,q} U(c) & \\ \text{subject to} & \left| \begin{array}{l} p'(c-q-\omega) \leq M \\ G(q) \leq 0 \end{array} \right. \end{array}$$

The budget constraint and the technological constraint are binding. And we can apply lemma 2.7. ■

3. $(i) \Rightarrow (ii)$: If the program is recursive, then optimal decisions to $(\mathcal{P})$ are obtained by solving $(\mathcal{P}_1)$ and $(\mathcal{P}_2)$. The budget constraint and the technological constraint are binding. By solving $(\mathcal{P}_1)$, we derive that:

$$p_i^* = \alpha p_i$$

where α is a coefficient of proportionality. Using (.3), we have:

$$dV = V_M.\alpha p'(dc - dq)$$

as the budget constraint is binding, $p'(dc - dq) = dM$, then $\alpha = 1$. ■

Table 1: Descriptive statistics

Variable	Mean	Std Dev	Min	Max
LANDT	1.61	1.61	0	15.80
CAP	3.70	12.31	0	90.00
LAND[a]	0.57	0.46	0	2.70
CHIM	1.17	3.71	0	43.97
P	8.41	8.35	0.74	55.61
NMAL	3.39	2.08	0	12.00
NFEM	3.91	2.46	0	15.00
NADTM	1.18	0.99	0	7.00
NADTF	1.92	1.39	0	9.00
LAB	1.28	2.57	0	28.12
HMAL	2.31	1.83	0	10.35
HFEM	2.95	2.61	0	20.30
WH	5.88	2.61	2.5	15.00
YVNET	15.76	43.45	0.16	674.28

Notes: [a]15 households declare a quantity of land used equal to zero and nevertheless report positive agricultural output. They are household with a very low output (average 0.33). It is likely that it is produced mainly on the land located immediately around the house (garden) and not in a field as such, leading to this reported zero land used.

Sample size: 373

Definitions of variables:

LANDT = area of available land, in 1986 (10 ha);

CAP = equipment, in 1986 (10,000 CFA);

LAND = area of land used, in 1986 (10 ha);

CHIM = chemical inputs, in 1986 (expenditures in 10,000 CFA);

P = output price index 1986;

NMAL, NFEM, NADTM, NADTF = number of male, female, adult male and adult female members in the household in 1986;

LAB = quantity of hired labour (1,000 hours), 1986 (under the assumption that a day of hired labour is 10 hours long);

HMAL, HFEM = number of hours worked yearly on the farm respectively by male and female members of the household (1,000 hours), 1986;

WH = local daily market wage for male workers (100 CFA), 1986;

YVNET = output, 1986 (quantity index, net of seeds);

Table 2: Estimates of the production function

Variable	Estimates	T-ratio
$Intercept$	2.5951	0.71
$Chemicals^{\frac{1}{2}}$	1.5809	0.62
$Hired\ labour^{\frac{1}{2}}$	1.5244	0.77
$Land^{\frac{1}{2}}$	-15.8188	1.45
$Capital^{\frac{1}{2}}$	-1.0166	0.62
$Male\ hours^{\frac{1}{2}}$	3.1595	1.42
$Female\ hours^{\frac{1}{2}}$	1.6231	1.03
$Chemicals^{\frac{1}{2}} * Hired\ labour^{\frac{1}{2}}$	-1.0364	0.78
$Chemicals^{\frac{1}{2}} * Land^{\frac{1}{2}}$	3.0862	0.64
$Chemicals^{\frac{1}{2}} * Capital^{\frac{1}{2}}$	0.5587	1.28
$Chemicals^{\frac{1}{2}} * Male\ hours^{\frac{1}{2}}$	1.0584	0.63
$Chemicals^{\frac{1}{2}} * Female\ hours^{\frac{1}{2}}$	-2.5535	2.41
$Hired\ labour$	-1.5337	1.52
$Hired\ labour^{\frac{1}{2}} * Land^{\frac{1}{2}}$	7.1437	2.02
$Hired\ labour^{\frac{1}{2}} * Capital^{\frac{1}{2}}$	-0.1968	0.27
$Hired\ labour^{\frac{1}{2}} * Male\ hours^{\frac{1}{2}}$	-0.9909	0.65
$Land$	2.6942	0.59
$Land^{\frac{1}{2}} * Capital^{\frac{1}{2}}$	1.3425	0.51
$Land^{\frac{1}{2}} * Male\ hours^{\frac{1}{2}}$	-0.7800	0.18
$Land^{\frac{1}{2}} * Female\ hours^{\frac{1}{2}}$	1.4917	0.50
$Capital$	-0.4887	1.97
$Capital^{\frac{1}{2}} * Male\ hours^{\frac{1}{2}}$	-0.8131	0.64
$Capital^{\frac{1}{2}} * Female\ hours^{\frac{1}{2}}$	1.3710	1.86
$Male\ hours^{\frac{1}{2}} * Female\ hours^{\frac{1}{2}}$	-1.1254	0.86

Notes: The dependent variable is YVNET . The sample size is 373.

The instruments are: price indices for different production groups in 1985, geographical dummies respectively for east-forest, west-forest, savannah and Kassou lake surroundings, quantity of seeds used in 1985, quantity of other inputs used in 1985 (transport), number of male and female family members in 1985 and some cross-products of these instruments. The specification search was controled by tests of overidentifying restrictions in an ascending order.

Sargan test : 31.97, with 29 df (Prob=0.321)

Table 3: Market and shadow wages of hired labour and male and female family labour.

3.A. Market Wages:

	Hired labour	*Male hours*	*Female hours*
Mean	5.90	5.85	5.77
Sample standard deviation	2.62	2.62	2.59

3.B. Shadow Wages:

	Hired labour	*Male hours*	*Female hours*
Quantile 25%	0.81	-1.96	0.26
Median	5.99	0.44	1.84
Quantile 75%	18.02	2.51	4.48
Mean	15.72	0.62	3.14
Sample standard deviation	37.02	22.57	18.28
Correlation with market wages	0.22	0.08	-0.05

3.C Comparison between market wages and shadow wages

	Hired labour	*Male hours*	*Female hours*
<	0.00	0.00	0.02
IC	0.89	0.89	0.49
>	0.11	0.10	0.49
N.a.	37	43	38

Notes: This table presents the proportion of observations such that market wage is below (<) the lower boundary of the 90% confidence interval, belong to this interval (IC) or is above its upper boundary (>). Non applicable (N.a.) indicates the number of households who do not use the corresponding input.

Table 4: Comparison between non-recursive and recursive households (with respect to female labour)

	$w^* < w$ n=163		$w^* = w$ n=171	
	mean	S.D.	mean	S.D.
*Land (*LAND)	0.60	0.42	0.53	0.49
*Output price (*P)**	5.76	6.59	11.05	9.01
Number of male members (NM)**	3.78	2.27	3.15	1.92
*Number of female members (*NF)**	4.40	2.55	3.71	2.34
*Capital (*CAP)**	1.26	5.70	6.33	16.62
*Seeds (*SEMV)**	9.25	13.75	3.32	5.01
*Male hours (*HMAL)**	2.82	1.89	1.93	1.69
Female hours (HFEM)**	3.95	2.94	2.63	1.91
*Market wage (*WH)**	6.36	2.89	5.19	2.11
*Production index (*YVNET)**	2.39	6.14	0.85	1.80
*Off farm hours (*HOFF)	0.07	0.27	0.09	0.30
*Off farm hours per head (*HOFF/FS)	0.021	0.09	0.03	0.13
*Hired/family labour ratio (*LAB/HON)**	0.16	0.24	0.30	0.54
*Off/on farm labour ratio (*HOFF/HON)	0.02	0.11	0.045	0.30
Net production per head (YVNET/ADT)**	0.78	1.95	0.33	0.53

Notes: Means and standard deviations (S.D.) are computed using the two samples. ** indicates that the difference between the two groups is significant at a 5% level; * indicates that the difference between the two groups is significant at a 10% level.