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A Subjective Equilibrium Approach to the Value of Children in the Agricultural Household

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A Philippine sample of agricultural households is studied by a subjective equilibrium model which also accounts for the household's demographic structure. The model becomes a potent tool for integrating the economic and demographic behaviour of the household, since issues such as the value of children can be approached in a utility maximization framework and furthermore, such values can be causally related to the variance in measured fertility among different households (or socioeconomic groups). For example, the low marginal productivity contribution of children in tenant (and small farm-size) households, along with the low fertility control that prevails there, has been combined in confirming the inverse-fertility-endowments hypothesis, which in this instance is based on labour-market failure in periods of peak agricultural labour demand. On the consumption side, on the other hand, the demand for leisure and for other commodities is consistent with the higher valuation of children, and thus higher fertility, in tenant (and small farm-size) households, as compared to owner (and large farm-size) households. The policy implications of such findings from a household equilibrium model are rich.

I. INTRODUCTION

The interest in linking economic to demographic behaviour has been intense and time-honoured, dating at least as far back as Malthus. The agricultural household, by virtue of the fact that it is the locus of the production, consumption and reproduction (or fertility) decision, has been a convenient testing ground of *a priori* notions integrating demography and economics.

Two operational approaches have been used in integrating households' demographic and economic behaviour. One extends the new theory of household economics developed by Becker (1965) and Lancaster (1966, 1971). Children are treated as consumer's durables and are included in the household utility function. Maximization yields the derived demand functions for children, as well as for the other arguments of the utility function. These reduced-form demand functions are

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functions of the exogenous variables such as commodity prices, wage rates, head of household's and wife's educational levels, and asset income. By estimating these demand functions, researchers have quantitatively discussed the factors which affect the fertility behaviour of the household [Rosenzweig (1977), Torres (1978) and De Tray (1979)].

The second research direction adopts a more naive approach for linking the demographic and economic behaviour of the household. It makes fertility a function of the net benefits of children. Net benefits are defined as the net economic (productive) services of children less the costs of having children [Cain (1977), (1978); Cain and Mozumder (1980); Repetto (1976) and Mueller (1976)].

This study proposes to integrate the two research approaches that have been prevalent so far. The model of the subjective equilibrium of the household is extended to include both production and consumption behaviour and to account for the household's demographic structure (age-sex composition, education, etc.). Child labour is considered an endogenous variable on the production side. In this manner the contributions (benefits) of child labour to the agricultural household are directly measured. Moreover, we derive by the duality theorem the profit and factor demand functions. We then estimate explicitly the child labour demand function together with the other variable factors of production, including the adult labour demand function and the output supply function.

The production side becomes an important component of the budget constraint of the household that enters the consumption side. Utility maximization yields the leisure demand functions (conversely the labour supply functions) of adult and child workers along with the demand functions for the other arguments in the utility function. The elasticities estimated from these functions are used to analyze the effects of the exogenous variables, such as the prices of commodities and the wage rates of adult and child labour, on the household's demand for child leisure and conversely their impact on the supply of labour to agricultural production. In addition, the number of children appears as an exogenous variable in the consumption demand functions. Thus, we may analyze the effect of an increase (or decrease) in the number of children on the household's demands for adult and child leisure and for commodities.

The major hypotheses based on the above-described model of the subjective equilibrium of the agricultural household are formulated particularly around the demand for and the supply of child labour. We focus on the economic value of children and we examine how that differs among socio-economic groups that were observed to have distinctly different fertility behaviour – such as owner and tenant farmers and large and small-size farms.

Section 2 sets out the subjective equilibrium model as modified to account for households' economic characteristics. Section 3 presents the econometric specification of the model, based on the profit function for the production side and the linear logarithmic expenditure system for the consumption side. Section 4 describes the data for this study which were collected in a special survey organized by one of the authors in the Northern Mindanao Island of the Southern Philippine Archipelago. Sections 5 and 6 give, respectively, the results of the production and the consumption side. Section 7 is the summary and conclusions.

2. THE SUBJECTIVE EQUILIBRIUM MODEL

The analysis of fertility behaviour has been enriched in the years since Becker (1965) and Lancaster (1966, 1971) developed a new theory of household economics. In this new approach to consumption theory, the consumption activity of the household is regarded as a production process where time and purchased goods are combined to produce "commodities" which yield utility. The number and the "quality" of children (Willis 1973), or the "child services" which are simply a product of the number and quality of children (De Tray 1973), are regarded as durable goods which produce "utility" or "satisfaction" to the parents. This utility or satisfaction is considered as the "value of children".

In agricultural households in LDCs children often make a direct contribution to production, as was stressed by T. W. Schultz (1973, 1974), besides their contribution of providing satisfaction to their parents. The participation of children in agricultural production activities, starting as early as the tender age of six, is often impressive. Children participate in the labour market for certain farming activities.[1] In such cases, the direct contribution of children to the production process may be an important economic factor determining the fertility behaviour of the household.[2] Even more important is that the economic value of children can be measured directly in such cases, as opposed to the indirect contribution of children to the parents' utility, which can only be conjectured.

On the consumption side, the number of children is introduced as an exogenous variable. In this formulation, although we cannot estimate the demand function for children, we can still analyze at least indirectly the effect of an increase (or decrease) in the number of children on the agricultural production, the demand for home-produced agricultural products and its complement, the supply of marketed surplus.

The formal subjective equilibrium model of the household which underlies our analysis is now presented. The point of departure from other similar models[3] which

[1] For example [see Mueller (1976); Cain (1977, 1978) and Cain and Mozumder (1980)]. The Mindanao Survey provides additional evidence of that.

[2] In their household time-allocation model for rural India, Rosenzweig and Evenson (1977) explicitly take into account the economic contribution of children in agricultural production.

[3] See for example Hymer and Resmick (1969) for India, Barnum and Squire (1979, 1980) for Malaysia, Lau, Lin and Yotopoulos (1978) for Taiwan, and Kuroda and Yotopoulos (1980) for Japan.

are based on the subjective equilibrium of the agricultural household is the explicit introduction of child labour in the agricultural production function.[4]

Given our interest in the age/sex composition of the household, we distinguish three categories of family members: (i) adult members older than 16 years of age who engage in agricultural production activities; (ii) dependents, i.e., children and adults who do not engage in any production activities; and (iii) the working children, between 6 and 15 years of age, who may also engage in agricultural production activities.

Furthermore, we introduce two categories of consumer goods: own-produced agricultural commodities and purchased consumer final goods. In addition, the household composition enters parametrically the household utility function.

The utility function of the agricultural household can now be written as

$$U = U(Z_1, Z_2, Z_3, A, C; a_1, a_2, a_3) \quad \ldots \quad \ldots \quad (1)$$

where

Z_1 = leisure time of adult workers;
Z_2 = leisure time of child workers;
Z_3 = leisure time of dependents;
A = amount of consumption of own-produced agricultural commodities;
C = amount of consumption of purchased consumer final goods;
a_1 = the number of adult workers;
a_2 = the number of child workers aged between 6 and 15; and
a_3 = the number of dependents including children younger than 5 years old and old and retired family members.

The utility function is assumed to be well-behaved and to have the usual properties.[5]

[4] In developing a subjective equilibrium model for Indian agricultural households, Rosenzweig (1981) has explicitly introduced child labour in the agricultural production function.

[5] The utility function given in Equation (1) is assumed to possess the following properties. (i) It is a continuous, twice-differentiable, monotonically increasing function of the three kinds of leisure, home-produced agricultural goods, and purchased consumer final goods, with the numbers of the family members of the three different groups being exogenous variables. (ii) It is quasi-concave (in Z_1, Z_2, Z_3, A, and C) so that there exists an inner solution of equilibrium. (iii) There exists non-increasing marginal utility for the three kinds of leisure (Z_1, Z_2, and Z_3) and the two bundles of goods (A and C). (iv) No satiation level exists.

On the production side, the agricultural household is assumed to face the following production function:[6]

$$Q = F(X_1, X_2, X_i; K_j), \; i = 3, \ldots, m, \quad j = 1, 2, \ldots, n. \quad \ldots \quad (2)$$

where

Q = total amount of agricultural output;
X_1 = adult labour time;
X_2 = child labour time, ages 6 to 15;
X_i = variable inputs other than labour such as fertilizers and agri-chemicals, $i = 3, \ldots, m$; and
K_j = fixed inputs such as capital and land, $j = 1, 2, \ldots, n$.

It is assumed that competitive markets exist for adult and child labour as well as for the other variable inputs and agricultural output. This assumption was validated by the Survey. However, substitution between adult and child labour is assumed to be imperfect, but family and hired labour are perfectly substitutable within each category. The agricultural household consumes part of the own-produced output and sells the rest. It also purchases and sells variable factors of production, including adult and child farm labour. It is assumed that both output marketed and consumed, and inputs purchased and sold are homogeneous and perfectly substitutable. With this assumption there exists for each household only one price for output and one price for each input.

The time constraint of the agricultural household is:

For the adult workers in the household,

$$\text{(i)} \quad a_1 \bar{Z}_1 - Z_1 = X_1^f,$$

for the child workers,

$$\text{(ii)} \quad a_2 \bar{Z}_2 - Z_2 = X_2^f,$$

and for the dependents,

$$\text{(iii)} \quad a_3 \bar{Z}_3 - Z_3 = 0,$$

[6] The assumptions made for the production function are as follows. (i) It is strictly non-decreasing, continuous, and twice-differentiable function of two kinds of labour, other variable inputs, and fixed inputs. (ii) It possesses diminishing marginal products with respect to all inputs. (iii) It is strictly quasi-concave so that the unique output supply and factor demand functions may be derived.

where

$\bar{Z}_i$ = the quantity of the maximum leisure per family member in each category;

X_1^f = the total family labour time of the adult workers; and

X_2^f = the total family labour time of the child workers.

The total adult and child labour time on the farm is given respectively as,

$$X_1 = (a_1\bar{Z}_1 - Z_1) + X_1^h + X_1^e = X_1^f + X_1^h + X_1^e, \quad \ldots \quad (3)$$

$$X_2 = (a_2\bar{Z}_2 - Z_2) + X_2^h + X_2^e = X_2^f + X_2^h + X_2^e, \quad \ldots \quad (4)$$

where

X_1^h = the net of hired-in adult labour time;

X_1^e = the net of adult exchange labour time;

X_2^h = the net of hired-in child labour time; and

X_2^e = the net of child exchange labour time.

Finally, the total income and expenditure constraint may be given as follows:

$$(P_A Q - q_1' X_1 - q_2' X_2 - \sum_{i=3}^{m} q_i' X_i) + q_1'(a_1\bar{Z}_1 - Z_1) \quad \ldots \quad (5)$$

$$+ q_2'(a_2\bar{Z}_2 - Z_2) + I_A = P_A A + P_C C,$$

where

P_A = agricultural output price;

q_1' = agricultural wage rate for adult labour;

q_2' = agricultural wage rate for child labour;

q_i' = price of the ith variable input other than labour, $i = 3, 4, \ldots, m$;

I_A = non-labour asset income; and

P_C = price of a Hicksian composite of purchased consumer final goods.

The first term on the LHS of Equation (5) represents the farm non-labour income of the agricultural household which accrues to fixed inputs such as entrepreneurship, capital equipment, and land, after subtracting the costs of variable inputs from the total value of output. We define this as the farm profit of the agricultural household. The second and third terms on the LHS are the total wage income accruing respectively to the adult and child labour in the household. In this case, we impute to unpaid family labour in each category the respective market wage rates

that the household paid or received for hiring labour. In other words we assume that competitive markets for both adult and child labour exist.

Since $(a_1\bar{Z}_1 - Z_1) = X_1^f$ and $(a_2\bar{Z}_2 - Z_2) = X_2^f$, the first three terms of Equation (5) can be rewritten as,

$$P_A Q - q_1'(X_1^f + X_1^h + X_1^e) - q_2'(X_2^f + X_2^h + X_2^e) - \sum_{i=3}^{m} q_i' X_i + q_1' X_1^f$$

$$+ q_2' X_2^f \quad \ldots \quad \ldots \quad (6)$$

$$= P_A Q - q_1'(X_1^h + X_2^e) - q_2'(X_2^h + X_2^e) - \sum_{i=3}^{m} q_i' X_i.$$

That is, although the labour costs related to the family labour are, in our model, explicitly treated as part of variable costs in the firm's agricultural production, they are in fact implicitly treated as an important source of family income. This implies that although family labour is employed in the self-management of the firm as unpaid labour, it is assumed to yield wage income to the household as evaluated by the market wage rates.

The agricultural household is assumed to maximize utility subject to constraints. By following Becker (1965), we can solve for maximization of the household utility function given in Equation (1) subject to the income constraint given in Equation (5) which includes the production function constraint given in Equation (2) and the time constraint given in Equation (4). A Langrangian multiplier method used for the maximization yields the following first-order conditions:

$$\frac{\partial U^*}{\partial Z_1} = U_{Z_1} - \lambda q_1' = 0, \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$U_{Z_2} - \lambda q_2' = 0, \quad \ldots \quad \ldots \quad (8)$$

$$U_{Z_3} - 0 = 0, \quad \ldots \quad \ldots \quad (9)$$

$$U_A - \lambda P_A = 0, \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

$$U_C - \lambda P_C = 0, \quad \ldots \quad \ldots \quad (11)$$

$$P_A F_{X_1} - q_1' = 0 \quad \ldots \quad \ldots \quad (12)$$

$$P_A F_{X_2} - q_2' = 0 \quad \ldots \quad \ldots \quad (13)$$

$$P_A F_{X_i} - q_i' = 0, \quad i = 3, 4, \ldots, m, \quad \ldots \quad \ldots \quad (14)$$

$$(P_A Q - q_1' X_1 - q_2' X_2 - \sum_{i=3}^{m} q_i' X_i) + q_i' (a_1 \bar{Z}_1 - Z_1)$$
$$+ q_2' (a_2 \bar{Z}_2 - Z_2) + I_A - P_A A - P_C C = 0. \quad \ldots \quad (15)$$

$$Q = F(X_1, X_2, X_i; K_j), \quad i=3, 4, \ldots, m, \; j = 1, 2, \ldots, n. \quad \ldots \quad (16)$$

The equations given in Equation (7) through Equation (16) constitute a system of $(9 + m - 2)$ simultaneous equations in the endogenous variables, $Z_1, Z_2, Z_3, A, C, Q, X_1, X_2, X_i$, and λ $(i=3, 4, \ldots, m)$. The exogenous variables in the system are q_1', q_2', P_A, P_C, K_j, I_A, a_1, a_2, and a_3 $(j = 1, 2 \ldots, n)$. Since the number of the endogenous variables is equal to the number of equations, $(7 + m)$, the system of simultaneous equations can be solved for the equilibrium values of the endogenous variables.

However, equations given in Equations (12), (13), (14), and (16) may be solved jointly for the equilibrium values of Q, X_1, X_2, and X_i $(i= 3, 4, \ldots, m)$, given q_1'/P_A, q_2'/P_A, $q_i'P_A$ $(i=3, 4, \ldots, m)$, and K_j $(j = 1, 2, \ldots, n)$, without reference to the other equations in the complete simultaneous equations system. Given competitive markets for labour, Sasaki and Maruyama (1965) and Jorgenson and Lau (1969) have shown that the production behaviour of the agricultural household is completely independent of the consumption choice. That is, given the agricultural labour wage rates as well as the prices of the agricultural output and the other variable inputs, the agricultural household as a firm first chooses the level of production which maximizes its profit. Then, it assigns the maximized profit as the agricultural non-labour income to the consumption side of the household.

Using this agricultural non-labour income together with income that may accrue from other sources, the agricultural household is now assumed to behave so as to maximize the household utility. In this manner, the agricultural household model in the present study is separable for the production behaviour and the consumption behaviour in that the production choice is completely independent of the consumption choice but the latter in turn depends on the activities of agricultural production in the form of profit. That is, the system is "block-recursive" (Jorgenson and Lau 1969).

In sum, the behaviour of the agricultural household in our model may be considered in two stages: at the first stage, the agricultural household as a firm maximizes its profit and determines the equilibrium quantities of X_1^*, X_2^*, and X_i^* $(i = 3, 4, \ldots, m)$, and Q^* and hence Π^*. At the second stage, the agricultural household behaves as a utility maximizer with the agricultural non-labour income (i.e., the maximized profit, Π^*) and the income from other sources being the budget constraint. That is, subject to the budget constraint Equation (15) in its rewritten form,

$$\Pi^* = q_1' (a_1 \bar{Z}_1 - Z_1) + q_2' (a_2 \bar{Z}_2 - Z_2) + I_A - P_A A - P_C C = 0 \quad \ldots \quad (17)$$

the agricultural household behaves so as to maximize the utility in Equation (1) and determines the equilibrium quantities Z_1^*, Z_2^*, Z_3^*, A^*, and C^*. Given these equilibrium quantities, the maximum level of utility of the agricultural household can be attained.

The reduced-form functions for the equilibrium of the agricultural household on the production side are written as follows:

(i) The profit function,

$$\Pi^* = \Pi^* (P_A, q_1', q_2', q_i', K_j), i=3, \ldots, m, \; j=1, \ldots, n, \quad \ldots (18)$$

(ii) The labour demand functions,

$$X_1^* = X_1^* (P_A, q_1', q_2', q_i', K_j), i=3, \ldots, m, \; j=1, \ldots, n, \quad \ldots \quad (19)$$

$$X_2^* = X_2^* (P_A, q_1', q_2', q_i', K_j), i=3, \ldots, m, \; j=1, \ldots, n, \quad \ldots (20)$$

(iii) The demand functions for the variable inputs other than labour,

$$X_i^* = X_i^* (P_A, q_1', q_2', q_i', K_j), i=3, \ldots, m, \; j=1, \ldots, n. \quad \ldots \quad (21)$$

Simultaneous estimation of these reduced-form equations will give us the reduced-form elasticities of the profit and the demand for labour and the other variable inputs. Note here that we explicitly estimate the demand function for child labour given in Equation (20). This provides an estimate of the benefits from children which are among the determinants of the agricultural household's fertility decisions.

On the consumption side, the reduced-form functions are given as:

$$Z_1 = Z_1 (q_1', q_2', P_A, P_C, \Pi^*, I_A; a_1, a_2, a_3), \quad \ldots \quad \ldots \quad (22)$$

$$Z_2 = Z_2 (q_1', q_2', P_A, P_C, \Pi^*, I_A; a_1, a_2, a_3), \quad \ldots \quad \ldots \quad (23)$$

$$Z_3 = Z_3 (q_1', q_2', P_A, P_C, \Pi^*, I_A; a_1, a_2, a_3), \quad \ldots \quad \ldots \quad (24)$$

$$A = A (q_1', q_2', P_A, P_C, \Pi^*, I_A; a_1, a_2, a_3), \quad \ldots \quad \ldots \quad (25)$$

$$C = C (q_1', q_2', P_A, P_C, \Pi^*, I_A; a_1, a_2, a_3). \quad \ldots \quad \ldots \quad (26)$$

Observe that relations Equation (22) through Equation (26) constitute a simultaneous equations system with each having the same exogenous variables. Moreover, the composition of the household becomes an argument in these equations. Thus we may analyze the effects of a change in the number of children on the demand for leisure and goods. In particular, the effect of a decrease in the number of children on the supply of adult labour (which is immediately obtained from the estimates of the demand function for leisure Z_1) is of great interest. By examining the estimates of elasticities in these equations, we may gain a better understanding of the agricultural household's behaviour with demographic decisions not only in the consumption but also, at least indirectly, in the production.

With the specifications of appropriate functional forms for the production and utility functions, we may estimate the reduced-form equations on both the production and consumption sides of the agricultural household.[7]

Furthermore, in order to examine differences in both production and consumption behaviour between landowners and tenants and between large farms and small farms, the empirical estimations will be carried out for each group of farms.

3. EMPIRICAL IMPLEMENTATION

The Profit Function

Based on the availability of data from the Mindanao Survey, we specify the following Cobb-Douglas production function:

$$Q = AX_1^{\alpha_1} X_2^{\alpha_2} K_1^{\beta_1} K_2^{\beta_2} e^{\sum_{i=1}^{6} \gamma_i D_i} \quad \ldots \quad \ldots \quad (27)$$

where X_1 and X_2 are respectively adult and child labour as the variable inputs; K_1 and K_2 are animal-machinery input and cultivated area, respectively; and A, $\alpha_i (i=1, 2)$, $\beta_j (j=1, 2)$, and $\gamma_\ell (\ell=1, \ldots, 6)$ are parameters to be estimated. The dummy variables (D_i, $i=1, \ldots, 6$) represent land ownership, number of coconut trees, fertilizer utilization, electrification, head of household's educational level (higher than high school), and the share of livestock production in the total production (larger than 0.5), respectively.[8]

[7] In the empirical estimation of these functions, the demand function for Z_3 is dropped since Z_3 does not have the shadow price like Z_1 and Z_2.

[8] When the estimation was carried out for farms categorized by the land ownership criterion, the corresponding dummy variable, D_1, was dropped.

The normalized profit function which is a dual to the production function in Equation (27) may be written as :[9]

$$\Pi = A^* q_1^{\alpha_1^*} q_2^{\alpha_2^*} K_1^{\beta_1^*} K^{\beta_2^*} e^{\sum_{i=1}^{6} \delta_i D_i} \quad \ldots \quad \ldots \quad (28)$$

where Π is the normalized profit (Π'/P_A); q_1 and q_2 are respectively the normalized wage rates of adult and child labour (q_1'/P_A and q_2'/P_A); and A^*, α_1^*, α_2^*, β_1^*, β_2^*, and δ_i ($i=1, \ldots, 6$) are parameters to be estimated.[10]

The adult and child labour demand functions may be written as the share functions which are given as:

$$-\frac{q_1 X_1}{\Pi} = \alpha_1^* \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (29)$$

$$-\frac{q_2 X_2}{\Pi} = \alpha_2^* \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (30)$$

The output supply function can be given by

$$Q = A^* (1-\mu) q_1^{\alpha_1^*} q_2^{\alpha_2^*} K_1^{\beta_1^*} K_2^{\beta_2^*} e^{\sum_{i=1}^{6} \delta_i D_i} \quad \ldots \quad \ldots \quad (31)$$

where $\mu = \alpha_1 + \alpha_2$ is assumed to be less than unity, implying decreasing returns to scale in production with respect to the variable inputs.

The profit function in Equation (28) and the two factor share functions in Equations (29) and (30), and the output supply function in Equation (31) form a system of four equations which can be estimated simultaneously. However, because of the duality between the profit function and the output supply function, one equation is redundant in the system. Therefore, we will estimate the profit and the two factor share functions simultaneously. Given the estimates of these three equations, the output supply function can be directly obtained from Equation (31).

Under the assumption of profit-maximizing and price-taking behaviour of the agricultural household, the parameters in Equation (28) must be equal to the corresponding parameters in the factor share equations given in Equations (29) and (30).

[9] For the derivations of the profit, factor demand, and output supply functions, refer to Lau and Yotopoulos (1972).

[10] These parameters have the following relationships with the corresponding parameters in the Cobb-Douglas production function in Equation (27).

$$A^* \equiv A^{(1-\mu)^{-1}} (1-\mu) \left[\prod_{2=1}^{2} \alpha_j^{\alpha_j (1-\mu)^{-1}} \right]$$

$$\alpha_I^* \equiv -\alpha_i (1-\mu)^{-1} < 0, \quad i=1, 2$$

$$\beta_j^* = \beta_i (1-\mu)^{-1} > 0, \quad j=1, 2$$

This equality provides the basis for a test of the hypothesis of profit maximization. In the present study, we test this hypothesis explicitly.

If the hypothesis of profit maximization is not rejected, a subsidiary hypothesis of constant returns to scale is then tested conditionally on the validity of profit maximization. Constant returns to scale in this study implies that $\beta_1^* + \beta_2^* = 1$.

For the stochastic specification of the model in the statistical estimation, we will follow the usual assumption of an additive error with zero expectation and non-zero finite variance for each of the three equations given in Equation (28) in its natural logarithmic form, Equations (29) and (30). However, non-zero covariances of the three equations are assumed for the same agricultural household. In other words, the dependent variables of the three equations can be mutually interdependent. The covariances of the errors of each equation corresponding to different agricultural households are assumed to be zero. Given this specification of errors, Zellner's (1962) method of asymptotically efficient estimation is used. According to this method, the efficiency of estimation can be increased by the imposition of restrictions on the coefficients, if this is required.

The Linear Logarithmic Expenditure System

In order to analyze the behaviour of the agricultural household on the consumption side, we estimate the linear logarithmic expenditure system which was first introduced by Lau and Mitchell (1970).

As seen in section two, the problem of the agricultural household on the consumption side is one in which it maximizes the utility function given in Equation (1) subject to the budget constraint given in Equation (17), which can be rewritten as:

$$\Pi^* + q_1' a_1 \bar{Z}_1 + q_2' a_2 \bar{Z}_2 + I_A = q_1' Z_1 + q_2' Z_2 + P_A A + P_C C \quad \ldots \quad (32)$$

Following Becker (1965), we define the LHS as the "full" income and the RHS as the full expenditure, denoted by M.

By normalizing prices,

$$P_i^* = P_i/M,\ P_i = q_1', q_2', P_A, P_C;\quad P_i^* = q_1^*, q_2^*, P_A^*, P_C^*, \quad \ldots \quad (33)$$

the budget constraint can be rewritten as $\sum_{i=1}^{4} P_i^* y_i = 1; (y_i = Z_1, Z_2, A, C,)$.

Through the duality theorem, the maximized value of utility, denoted by V^*, is a function of q_1^*, q_2^*, P_A^*, P_C^*, a_1, a_2, and a_3, and will be referred to as the indirect utility function,

$$V^* = V^*(q_1^*, q_2^*, P_A^*, P_C^*; a_1, a_2, a_3). \quad \ldots \quad \ldots \quad (34)$$

As concluded by Lau, Lin and Yotopoulos (1978), in order to analyze the consumption behaviour of the agricultural household, it is sufficient to specify an indirect utility function which depends on normalized prices as well as the other characteristics of the household such as family size and composition. Furthermore, the introduction of the indirect utility function provides us with an econometrical advantage in the sense that the derived demand functions are explicitly functions of only the exogenous variables.

By assuming that the indirect utility function is of the homogeneous (of degree minus one) transcendental logarithmic form, the simplest version of the linear logarithmic expenditure system (LLES) can be derived.[11]

By applying a second-order approximation of Taylor's series expansion around $[P_a^*] = 1$ to the true V^*, the translog function corresponding to Equation (34) is given as:

$$\begin{aligned} \ell n\, V^* = \alpha_o &+ \sum_{i=1}^{4} \alpha_i \,\ell n\, P_i^* + \sum_{j=1}^{3} \beta_j \,\ell n\, a_j \\ &+ 1/2 \sum_{i=1}^{4} \sum_{j=1}^{4} \gamma_{ij} (\ell n\, P_i^*)(\ell n\, P_j^*) \\ &+ 1/2 \sum_{k=1}^{3} \sum_{\ell=1}^{3} \delta_{k\ell} (\ell n\, a_k)(\ell n\, a_\ell) \\ &+ \sum_{i=1}^{4} \sum_{k=1\epsilon}^{3} \epsilon_{ik} (\ell n\, P_i^*)\,\ell n\, a_k), \quad \ldots \quad \ldots \quad (35) \end{aligned}$$

where $P_i^* = q_1^*, q_2^*, P_A^*, P_C^*$ and $a_j = a_1, a_2, a_3$.

Because of the homogeneity assumption we have the following restrictions:

$$\sum_{i=1}^{4} \alpha_i = -1, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (36)$$

$$\sum_{j=1}^{4} \gamma_{ij} = 0,\quad \gamma_i = 1, 2, 3, 4, \quad \ldots \quad \ldots \quad \ldots \quad (37)$$

$$\sum_{k=1}^{4} \epsilon_{k\ell} = 0,\quad \ell = 1, 2, 3. \quad \ldots \quad \ldots \quad \ldots \quad (38)$$

The expenditure functions are given by Roy's identity as:

$$-P_i^* y_i = \frac{\partial \ell n\, V^*}{\partial \ell n\, P_i^*} = \alpha_i + \sum_{j=1}^{4} \gamma_{ij}\, \ell n\, P_j^* + \sum_{\ell=1}^{3} \epsilon_{k\ell}\, \ell n\, a_\ell,$$

$$i = 1, 2, 3, 4,\quad k = 1, 2, 3, 4. \quad \ldots \quad \ldots \quad \ldots \quad (39)$$

[11] See Lau and Mitchell (1970).

It is clear that we have four equations in Equation (39) which have the same exogenous variables, i.e., $\ell n P_j^*$ ($P_i^* = q_1^*, q_2^*, P_A^*, P_C^*$) and $\ell n a_\ell$ (ℓ = 1, 2, 3). They are $-q_1^* Z_1$, $-q_2^* Z_2$, $-P_A^* A$, *and* $-P_c^* C$. However, one of these four equations is redundant, since $q_1^* Z_1 + q_2^* Z_2 + P_A^* A + P_c^* C = 1$ from the budget constraint. Hence, only three out of the four equations are stochastically independent and need to be estimated. In the present study the last three equations are chosen.

Next, by making use of restrictions given in Equation (37) we may further simplify the estimation of the expenditure equations. Writing the equations for the subscripted variables, we have the following equations to be estimated:

$$-q_2^* Z_2 = \alpha_2 + \gamma_{22}\,\ell n(q_2^*/q_1^*) + \gamma_{23}\,\ell n(P_A^*/q_1^*) + \gamma_{24}\,\ell n(P_c^*/q_1^*) + \epsilon_{21}\,\ell n a_1 + \epsilon_{22}\,\ell n a_2 + \epsilon_{23}\,\ell n a_3. \quad \ldots \quad \ldots \quad \ldots \qquad (40)$$

$$-P_A^* A = \alpha_3 + \gamma_{32}\,\ell n(q_2^*/q_1^*) + \gamma_{33}\,\ell n(P_A^*/q_1^*) + \gamma_{34}\,\ell n(P_c^*/q_1^*) + \epsilon_{31}\,\ell n a_1 + \epsilon_{32}\,\ell n a_2 + \epsilon_{33}\,\ell n a_3, \quad \ldots \quad \ldots \quad \ldots \qquad (41)$$

$$-P_c^* C = \alpha_4 + \gamma_{42}\,\ell n(q_2^*/q_1^*) + \gamma_{43}\,\ell n(P_A^*/q_1^*) + \gamma_{44}\,\ell n(P_c^*/q_1^*) + \epsilon_{41}\,\ell n a_1 + \epsilon_{42}\,\ell n a_2 + \epsilon_{43}\,\ell n a_3. \quad \ldots \quad \ldots \quad \ldots \qquad (42)$$

We note that it must be that $\gamma_{23} = \gamma_{32}$, $\gamma_{24} = \gamma_{42}$, and $\gamma_{34} = \gamma_{43}$ in the above three equations if the system of expenditure equations is to be derivable from utility maximization. One can test the hypothesis of utility maximization by testing statistically the above symmetry. Alternatively, the three equations may be estimated jointly, imposing this symmetry constraint. Finally, the coefficients of the remaining equation (in the present study, $-q_1^* Z_1$ equation) can immediately be computed from the restrictions given in Equations (36) to (39).

For the statistical estimation, we assume an additive error with zero expectation and non-zero finite variance for each of the three equations. However, the variance of the three equations is assumed to be non-zero for the same household. The covariances of the errors of each Equation corresponding to different households are assumed to be zero. Given these assumptions, Zellner's (1962) method of an asymptotically efficient estimation is used.

A word needs to be said about the measurement of the variables in the system. Since the translog function is a second-order numerical approximation around $\left[\begin{smallmatrix}\ell n P^* \\ \ell n a\end{smallmatrix}\right] = 0$, the independent variables $\ell n P^*$ and $\ell n a$ should be scaled in such a way that they are approximately close to zero. To accomplish this, we computed the means of the independent variables of the three estimating equations and then measured all the independent variables as deviations from the respective means.

4. THE DATA

A special survey became necessary in order to collect the set of data required for this study. The survey was organized by the senior author and was conducted with Professor Herrin in the Philippines in late 1978 and early 1979. It will be referred to hereafter as the FAO/UNFPA Mindanao Survey, after the two sponsoring organizations.

A sample of 590 agricultural households was drawn from the province of Misamis Oriental, located along the northern coast of Mindanao Island, the second largest island of the Philippines Archipelago.[12] The data were processed in order to obtain the variables used in the profit and factor share functions on the production side and for the Linear Logarithmic Expenditure System (LLES) on the consumption side. The details of the specifications of the variables are fully presented in Appendix A.

The sample of 590 observations was first sorted according to a criterion of positive profits in the production of crops (rice, corn, tobacco, and others), coconuts, and livestock products during the period the survey covered, the 1978 crop year. This yielded 299 agricultural households.

Next, another criterion of positive child labour days was introduced in order to split the 299 observations into two categories. Through this procedure, we obtained 153 agricultural households with positive profits and positive child labour days. In the present study we concentrate our empirical analysis on the former set of observations because of the specification of the model that included child labour as a factor of production.

Finally, households with extreme observations in some variables were omitted in order to obtain a more homogeneous sample. This yielded 123 observations in the set of households with positive profits and positive child labour days.

The sample of 123 observations was subdivided into large-size farms and small-size farms as well as to farms operated by owners and those operated by tenants. Farms with 20 hectares and over are classified as large farms, and those with less than 2.0 hectares as small farms. The numbers of observations are respectively 52 and 71. On the basis of the form-of-tenancy criterion, the owner farms are 80, as compared to 43 tenant farms. These numbers of observations were used in the estimations of the profit and factor demand functions on the production side.

It is of course ideal to use the same sample of observations in the corresponding estimation of the LLES for each category of agricultural households. However, this was not possible because there were households which hire child labour from other households but do not employ their own children. For such households we cannot estimate the child leisure expenditure equation in the LLES.

[12] For description of the setting of the survey and of the sample see Herrin (1982).

By dropping such households from the sample of 123 observations, we obtained 94 observations. These 94 observations were classified in the same manner as on the production side with the criteria of land size and form of tenancy. The numbers of observations for large and small farms are 41 and 53, and those for owners and tenants are 60 and 34, respectively.

5. EMPIRICAL RESULTS: THE PRODUCTION SIDE

The profit and factor share functions are jointly estimated first by single equation ordinary least squares and unconstrained Zellner's methods. The results are presented in Tables 1 and 2 for the four groups of farms. Next, we tested the null hypotheses of profit maximization and constant returns to scale for each group of farms. An F-test was used for this purpose. The computed F-ratios and the critical values of F-ratios at the 5 and 1 percent levels with the appropriate degrees of freedom are presented in Table 3.

According to this table, the null hypotheses of profit maximization and constant returns to scale could not be rejected at either 5 or 1 percent level of statistical significance. That is, the groups of large and small farms and of owner and tenant farms maximized profits with regard to the levels of utilization of adult and child labour and faced constant returns to scale with respect to all the variable and fixed inputs.

Based on the results of these F-tests, we re-estimated the profit and factor share functions for each group of farms with restrictions of both profit maximization and constant returns to scale. The estimated results are given in Tables 1 and 2. These are the final specifications of the profit and factor share functions in the present study and are used for further analysis.

The Output Supply and Labour Demand Behaviour of the Agricultural Household

In order to study price response, the output supply and the labour demand functions are derived. The estimating equations of the output supply of the agricultural household are given by taking natural logarithms of both side of Equation (31) as,

$$\ell n\, Q = \ell n\,(1 - \sum_{i=1}^{2} \alpha_i) + \ell n\, A^* + \alpha_1^* \,\ell n\, q_1' + \alpha_2^* \,\ell n\, q_2' + \beta_1^* \,\ell n\, K_1 + \beta_2^* \,\ell n\, K_2 - \sum_{i=1}^{2} \alpha_i^* \ell n\, P_A + \sum_{j=1}^{6} \delta_j D_j \quad \ldots \ldots \ldots \quad (43)$$

Table 1

The Cobb-Douglas Profit and Factor Share Functions for Landowners and Tenants

Variables	Parameter	Landowners (80 obs.) OLSQ	Landowners Zellner's Efficient Estimation: No Restrictions	Landowners Zellner's Efficient Estimation: 3 Restrictions $\alpha_1^* = \alpha_1^*, \alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$	Tenants (43 obs.) OLSQ	Tenants Zellner's Efficient Estimation: No Restrictions	Tenants Zellner's Efficient Estimation: 3 Restrictions $\alpha_1^* = \alpha_1^*, \alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$
Constant	$\ell n A^*$	3.968*	4.217*	4.426*	3.075*	4.188*	4.077*
		(3.674)	(4.249)	(9.889)	(1.835)	(2.721)	(7.879)
$\ell n\, q_1$	α_1^*	−0.685	−0.417	−0.469*	−1.091	−0.946	−0.475*
		(−0.954)	(−0.633)	(−4.842)	(−0.516)	(−0.488)	(−4.759)
$\ell n\, q_2$	α_2^*	0.921*	0.769**	−0.094*	1.650	1.367	−0.181*
		(1.822)	(1.657)	(−1.808)	(0.863)	(0.779)	(−2.533)
$\ell n\, K_1$	β_1^*	0.076**	0.101*	0.135*	0.097	0.106**	0.146*
		(1.515)	(2.177)	(2.768)	(1.321)	(1.577)	(2.057)
$\ell n\, K_2$	β_2^*	0.619*	0.562*	0.865*	0.463*	0.408*	0.854*
		(4.710)	(4.661)	(17.800)	(2.076)	(1.995)	(11.990)
D_1							
D_2		−0.212	−0.153	−0.411**	0.150	−0.127	−0.240
		(−0.771)	(−0.603)	(−1.574)	(0.330)	(−0.305)	(−0.566)
D_3		0.711*	0.294	0.178	1.501*	1.043*	1.030*
		(1.913)	(0.862)	(0.483)	(2.829)	(2.142)	(2.099)
D_4		−0.514*	−0.571*	−0.501*	0.003	−0.157	−0.280
		(−2.197)	(−2.657)	(−2.146)	(0.008)	(−0.434)	(−0.736)

Continued –

Table 1 – (*Continued*)

Variables	Parameter	Landowners (80 obs.) Zellner's Efficient Estimation: OLSQ	No Restrictions	3 Restrictions $\alpha_1^* = \alpha_1^*$, $\alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$	Tenants (43 obs.) Zellner's Efficient Estimation: OLSQ	No Restrictions	3 Restrictions $\alpha_1^* = \alpha_1^*$, $\alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$
D_5		0.486*	0.564*	0.628*	0.727*	0.441	0.184
		(1.897)	(2.398)	(2.465)	(1.596)	(1.053)	(0.413)
D_6		–0.506	–0.206	–0.010	0.731	0.176	0.388
		(–1.461)	(–0.648)	(–0.030)	(1.281)	(0.336)	(0.687)
R^2		0.499			0.494		
$\beta_1^* + \beta_2^*$		0.695	0.663	1.000	0.560	0.614	1.000
Adult Labour Demand fn	α_1^*	–0.5094*	–0.5094*	–0.4688*	–0.4995*	–0.4995*	–0.4748*
		(–5.097)	(–5.097)	(–4.842)	(–4.908)	(–4.908)	(–4.759)
Child Labour Demand fn	α_2^*	–0.117*	–0.117*	–0.094*	–0.197*	–0.197*	–0.181*
		(–2.232)	(–2.232)	(–1.808)	(–2.731)	(–2.731)	(–2.533)

Notes : Figures in parentheses are computed asymptotic *t*-ratios.
Coefficients with * and ** are statistically significant at the 5- and 10-percent levels, respectively.

Table 2

The Cobb-Douglas Profit and Factor Share Functions for Large and Small Farms

Variables	Parameter	Large Farms (52 obs.) Zellner's Efficient Estimation: OLSQ	No Restriction	3 Restrictions $\alpha_1^* = \alpha_1^*$, $\alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$	Small Farms (71 obs.) Zellner's Efficient Estimation: OLSQ	No Restriction	3 Restrictions $\alpha_1^* = \alpha_1^*$, $\alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$
Constant	ℓnA^*	4.563*	4.164*	4.377*	3.392*	3.800*	4.173*
		(2.008)	(1.945)	(6.685)	(2.807)	(3.637)	(12.220)
$\ell n\, q_1$	α_1^*	–0.039	–0.019	–0.424*	–0.221	–0.237	–0.486*
		(–0.033)	(–0.017)	(–3.147)	(–0.236)	(–0.293)	(–6.354)
$\ell n\, q_2$	α_2^*	0.724	0.624	–0.072*	0.465	0.520	–0.157*
		(0.762)	(0.697)	(–3.181)	(0.711)	(0.923)	(–2.266)
$\ell n\, K_1$	β_1^*	0.115	0.106	0.137**	0.112*	0.112*	0.130*
		(1.407)	(1.383)	(1.728)	(2.222)	(2.582)	(3.152)
$\ell n\, K_2$	β_2^*	0.446	0.511**	0.863*	0.563*	0.567*	0.870*
		(1.265)	(1.537)	(10.860)	(2.705)	(3.155)	(21.120)
D_1	d_1	–0.423	–0.398	–0.516	–0.206	–0.175	–0.240
		(–1.142)	(–1.140)	(–1.424)	(–0.910)	(–0.896)	(–1.178)
D_2	d_2	–0.416	–0.363	–0.570	0.167	0.091	0.042
		(–0.965)	(–0.894)	(–1.382)	(0.573)	(0.363)	(0.158)
D_3	d_3	0.627	0.720	0.675	1.178*	0.611*	0.689*
		(1.082)	(1.320)	(1.172)	(3.566)	(2.141)	(2.472)

Continued –

Table 2 – (*Continued*)

Variables	Parameter	Large Farms (52 obs.) OLSQ	Large Farms: Zellner's Efficient Estimation – No Restriction	Large Farms: Zellner's Efficient Estimation – 3 Restrictions $\alpha_1^* = \alpha_1^*, \alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$	Small Farms (71 obs.) OLSQ	Small Farms: Zellner's Efficient Estimation – No Restriction	Small Farms: Zellner's Efficient Estimation – 3 Restrictions $\alpha_1^* = \alpha_1^*, \alpha_2^* = \alpha_2^*$, $\beta_1^* + \beta_2^* = 1.0$
D_4	d_4	–0.819*	–0.672*	–0.621*	–0.140	–0.125	–0.055
		(–2.343)	(–2.041)	(–1.797)	(–0.565)	(–0.582)	(–0.244)
D_5	d_5	0.256	0.153	0.199	0.714*	0.633*	0.552*
		(0.600)	(0.380)	(0.467)	(2.689)	(2.756)	(2.320)
D_6	d_6	–0.824	–0.423	–0.430	0.080	–0.113	–0.035
		(–1.196)	(–0.653)	(–0.635)	(0.252)	(–0.410)	(–0.124)
R^2		0.279			0.487		
$\beta_1^* + \beta_2^*$		0.561	0.617	1.000	0.675	0.679	1.000
Adult Labour Demand fn α_1^*		–0.484*	–0.484*	–0.424*	–0.522*	–0.522*	–0.486*
		(–3.500)	(–3.500)	(–3.147)	(–6.607)	(–6.607)	(–6.354)
Child Labour Demand fn α_2^*		–0.076*	–0.076*	–0.072*	–0.196*	–0.196*	–0.157*
		(–3.938)	(–3.938)	(–3.181)	(–2.730)	(–2.730)	(–2.266)

Notes: Figures in parentheses are computed asymptotic *t*-ratios.
Coefficients with * and ** are statistically significant at the 5- and 10-percent levels, respectively.

Table 3

F-Ratios for Tests of Profit Maximization and Constant Returns to Scale

Hypothesis	Landowners	Tenants	Large Farms	Small Farms
1. Profit Maximization	4.513	2.008	2.481	3.381
	(2 228)	(2,117)	(2,143)	(2,200)
Critical Values at: 005	3.00	3.07	3.00	3.00
Critical Values at: 001	4.61	4.79	4.61	4.61
2. Constant Returns to Scale	5.739	3.068	0.289	2.594
	(1,230)	(1,119)	(1,145)	(1,202)
Critical Values at: 005	3.84	3.92	3.84	3.84
Critical Values at: 001	6.63	6.85	6.63	6.63

Note: The figures in parentheses attached to the computed *F*-ratios are degrees of freedom.

Furthermore, by taking the natural logarithms of both sides of the equations in Equations (29) and (30) and substituting the profit function in its natural logarithmic form, we can obtain the adult and child labour demand equations of the agricultural household,

$$\ell n\, X_1 = \ell n(-\alpha_1^*) + \ell n\, A^* + (\alpha_1^* - 1)\,\ell n\, q_1' + \alpha_2^*\,\ell n\, q_2' + \beta_1^*\,\ell n\, K_1 + \beta_2^*\,\ell n\, K_2 + (1 - \sum_{i=1}^{2} \alpha_i^*)\,\ell n\, P_A + \sum_{j=1}^{6} \delta_j D_j, \quad \ldots \quad (44)$$

$$\ell n\, X_2 = \ell n(-\alpha_2^*) + \ell n\, A^* + \alpha_1^*\,\ell n\, q_1' + (1 - \alpha_2^*)\,\ell n\, q_2' + \beta_1^*\,\ell n\, K_1 + \beta_2^*\,\ell n\, K_2 + (1 - \sum_{i=1}^{2} \alpha_i^*)\,\ell n\, P_A + \sum_{j=1}^{6} \delta_j D_j. \quad \ldots \quad (45)$$

Note here that we introduced the relationship $q_i = q'_i / P_A$ for $i = 1, 2$. The estimated elasticities of the output supply and labour demands with respect to the exogenous variables are given in Tables 4 and 5 for owner and tenant farms and for large and small farms, respectively.

As an illustration, the elasticities of Table 5 for large and small farms are examined. Examination of the owner and tenant farms yields equivalent results. Referring to the elasticities of output supply and labour demands first, they all have the appropriate signs as expected from the theory of the profit function; the supply elasticities with respect to input prices are negative; the elasticities with respect to the output price and quantities of the fixed inputs are positive. In general, the results show the responsiveness in the output supply to changes in prices by both large and small farms. The results also indicate the importance of an increase in area cultivated for increasing the supply of farm output in both large and small farms.

In comparing the elasticities of output supply between large and small farms, we note the conspicuous difference in the elasticity with respect to the child labour wage rate (q_2'), while the elasticities with respect to the adult wage rate (q_1'), animal-machinery capital (K_1) and area cultivated (K_2) are almost identical between the two classes of agricultural households. That is, small farmers are more responsive in their output supply to a change in the child labour wage rate than large farmers; the magnitudes of the elasticities are -0.16 and -0.07, respectively. Mainly because of this difference, small farmers are slightly more responsive to a change in the output price (P_A) than large farmers.[13]

The elasticities of demand for adult and child labour are now discussed. The results are as expected from the theory of the profit and factor share functions.

[13] Note that the elasticity of output supply with respect to the output price is given by $-(\alpha_1^* + \alpha_2^*)$.

Table 4

Computed Elasticities of Output Supply and Adult and Child Labour Demands, Landowners and Tenants

Variable	Landowners			Tenants		
	Output Supply ($\ell n\, Q$)	Adult Labour Demand ($\ell n\, X_1$)	Child Labour Demand ($\ell n\, X_2$)	Output Supply ($\ell n\, Q$)	Adult Labour Demand ($\ell n\, X_1$)	Child Labour Demand ($\ell n\, X_2$)
$\ell n\, q_1'$	−0.4688	−1.4688	−0.4688	−0.4748	−1.4748	−0.4748
$\ell n\, q_2'$	−0.0939	−0.0939	−1.0939	−0.1808	−0.1808	−1.1808
$\ell n\, P_A$	0.5627	1.5627	1.5627	0.6556	1.6556	1.6556
$\ell n\, K_1$	0.1346	0.1346	0.1346	0.1464	0.1464	0.1464
$\ell n\, K_2$	0.8654	0.8654	0.8654	0.8536	0.8536	0.8536

Note: For the computation of the elasticities, the coefficients with restrictions of equalities and constant returns to scale given in Table 1 were used.

Table 5

Computed Elasticities of Output Supply and Adult and Child Labour Demands, Large and Small Farms

Variable	Large Farms			Small Farms		
	Output Supply ($\ell n\, Q$)	Adult Labour Demand ($\ell n\, X_1$)	Child Labour Demand ($\ell n\, X_2$)	Output Supply ($\ell n\, Q$)	Adult Labour Demand ($\ell n\, X_1$)	Child Labour Demand ($\ell n\, X_2$)
$\ell n\, q_1'$	−0.4237	−1.4237	−0.4237	−0.4861	−1.4861	−0.4861
$\ell n\, q_2'$	−0.0718	−0.0718	−1.0718	−0.1572	−0.1572	−1.1572
$\ell n\, P_A$	0.4955	1.4955	1.4955	0.6333	1.6333	1.6333
$\ell n\, K_1$	0.1373	0.1373	0.1373	0.1299	0.1299	0.1299
$\ell n\, K_2$	0.8627	0.8627	0.8627	0.8701	0.8701	0.8701

Note: For the computation of the elasticities, the coefficients with restrictions of equalities and constant returns to scale given in Table 2 were used.

The elasticities of demand for adult and child labour are negative with respect to own prices; the elasticities with respect to the output price and the fixed inputs are positive.

It is significant that the elasticities of the demand for adult and child labour with respect to their own prices are all greater than unity for both large and small farms. This indicates that both large and small farms respond elastically to changes in the farm wage rates of adult and child labour in their respective demands. The elasticities with respect to the output price are 1.50 and 1.63 for large and small farms, respectively, indicating that the demand for adult and child labour by both types of farms is strongly influenced by changes in the output price. In addition, an increase in area cultivated plays an important role in increasing the demand for adult and child labour for both large and small farms.

The major difference in output supply and labour demand behaviour between large and small farms lies in the elasticities with respect to child wage rates. Small farms respond negatively with higher elasticity to an increase in child wage rates. Correspondingly they have higher elasticities with respect to output price. The same broad results appear if one examines the situation for owners and tenants.

The Indirect Estimates of the Production Elasticities

In order to interpret the above findings from a different angle, we indirectly estimate the production elasticities for each group of farms based on the restricted estimation of the profit and factor share functions given in Tables 1 and 2. The results are reported in Table 6.

First, in both large and small farms, the land production elasticity is the largest with the numerical value of 0.53 ∿ 0.58, indicating that the area of cultivation is the most important factor of production. Second, the adult labour production elasticity is around 0.28 ∿ 0.30 for both large and small farms, while the elasticity with respect to the animal-machinery capital is around 0.08 ∿ 0.09. All three elasticities are almost identical for both large and small farms. The same is true for owner and tenant farms.

There is, however, a very clear difference in the production elasticity with respect to the child labour between large and small farms, although the absolute values are fairly small, 0.05 and 0.10, respectively. The contribution of child labour in terms of the production elasticity on small farms is twice as large as that on large farms.

The fertility analysis of the same sample of households reported in a sequel study by Shulte, Yotopoulos, Herrin and Eliason (1981) may be brought to bear on the production behaviour of the farm households. It was found that the large (and owner) groups of farms exercised more conscious fertility control than the small (and tenant) farm households. This finding appears inconsistent with the higher

Table 6

Indirect Estimates of the Production Elasticities

Variable	Parameter	Landowners	Tenants	Large Farms	Small Farms
$\ell n\, X_1$	α_1	0.3000	0.2868	0.2833	0.2958
$\ell n\, X_2$	α_2	0.0601	0.1092	0.0480	0.0957
$\ell n\, K_1$	β_1	0.0861	0.0884	0.0918	0.0790
$\ell n\, K_2$	β_2	0.5538	0.5156	0.5769	0.5295
$\sum_{i=1}^{2} \alpha_i + \sum_{j=1}^{2} \beta_j$		1.0000	1.0000	1.0000	1.0000

Notes: 1. For the computation of the production elasticities, the coefficients with restrictions of equalities and constant returns to scale given in Tables 1 and 2 were used.
2. The relations between α's and β's and α^*'s and β^*'s are given by $\alpha_i^* = \alpha_i (1-\mu)^{-1}$ and $\beta_j^* = \beta_j (1-\mu)^{-1}$ where $\mu = \alpha_1 + \alpha_2$ and $i = j = 1, 2$.

productivity of child labour in large (and owner) households reported in this study. For the explanation of the phenomenon, Yotopoulos (1982) introduces the inverse fertility-endowments hypothesis that rests on differential access to fragmented labour markets. The labour bottleneck in agricultural work occurs at peak seasons when labour is in short supply and wage rates are high. High is also the marginal product of labour on a peak-season day since the household is likely to lose the entire crop if it does not take in the harvest at the appropriate time. Suppose there is some queuing for labour services at peak seasons since demand exceeds the quantity supplied. If so, one would expect the better-endowed households (such as large farms and owners) to be better able to hire peak-season labour. The year-round wage rate applicable for these households becomes high relative to the ones not hiring peak-season labour, due to the weighting of wages by seasonal rates and quantities employed.[14] The less-well-endowed households, on the other hand, which do not resort to peak-season labour have lower weights of high wages and as a result operate with a lower overall wage rate. In a maximizing framework (tested and accepted in this study) one would expect the better-endowed households to equate their year-round marginal product of labour to higher wage rates and the less-well-endowed households to have lower marginal products, equal to lower year-round wage rates. This is precisely what happens with the large-farm (and owner) versus the small-farm (and tenant) households.

How do the less-well-endowed households satisfy their peak labour demands, having been queued out of the labour market? They must rely on additional family labour for peak-season work. Thus follows the higher fertility of the small and tenant farmers. Additional family labour, on the other hand, is likely to lead to more intensive labour utilization year-round, which further depresses marginal productivities.

It must be emphasized that the issue here is not an economic-demographic explanation of higher fertility for the less-well-endowed agricultural households. This can be easily explained in a multiperiod model by the function of children as insurance against risk (Yotopoulos 1982). The poorer households may view additional children as diversifying their portfolio for old-age-security by increasing the probability of producing a successful offspring. Tenant households, similarly, may want additional children to decrease the risk that upon death of the head of the household with no male heir the widow will lose the land tenure (Cain 1978). Large farm households, on the other hand, may have an incentive to control their fertility so that the land is not fragmented to many heirs in countries where the right of primogeniture does not exist. The issue rather here is reconciliation of high marginal productivities of child labour with low fertility in a one-period model. This is the specific formulation of the inverse fertility-endowments hypothesis.

[14] See appendix on specifications of variables.

6. EMPIRICAL RESULTS: THE CONSUMPTION SIDE

Tests of Hypotheses and the Final Specifications of Parameters

Equations (40), (41) and (42) given in section three were estimated first without restrictions for large and small farms. The results are presented in Appendix Table 1.

On the basis of the estimates of the three equations without restrictions, we test three null hypotheses. The first hypothesis to be tested is that the theory of demand is valid, that is, the agricultural household maximizes utility. Operationally, this implies that we should test the symmetry restrictions in the three equations: $\gamma_{23} = \gamma_{32}$, $\gamma_{24} = \gamma_{42}$, and $\gamma_{34} = \gamma_{43}$.

Given the validity of the utility maximization hypothesis, the remaining hypotheses to be tested are restrictions on the functional form and on the effects of household size and composition. First, we test the hypothesis of linear logarithmic utility, that is, the optimal budget shares are constants independent of prices and total expenditures. This hypothesis implies six additional restrictions: $\gamma_{22} = \gamma_{23} = \gamma_{24} = \gamma_{33} = \gamma_{34} = \gamma_{44} = 0$. Next, we test a set of nine hypotheses in parallel on the effects of household size and composition on the demands for child workers' leisure, home produced agricultural commodities, and purchased consumer final goods.

We first test the hypotheses of no adult worker effect on demands for child workers' leisure, agricultural, and purchased consumer final goods, respectively. Given symmetry, these hypotheses require one restriction each: $\epsilon_{21} = 0$, $\epsilon_{31} = 0$, and $\epsilon_{41} = 0$. Second, we test the hypotheses of no child worker effect on the demands for the three categories of commodities. These hypotheses require one restriction each, given symmetry: $\epsilon_{22} = 0$, $\epsilon_{32} = 0$, and $\epsilon_{42} = 0$, respectively. Finally, we test the hypotheses of no dependent effect on the demands for the three categories of commodities as above. Again, given symmetry, these hypotheses require one restriction each. $\epsilon_{23} = 0$, $\epsilon_{33} = 0$, and $\epsilon_{43} = 0$, respectively.

To test the validity of the restrictions implied by the hypotheses of utility maximization and various specifications on the form of the indirect utility function, we employ test statistics based on *F*-ratios. To control the overall level of significance of our series of tests, we set the overall level of significance at .05. This implies that the probability of rejecting a true hypothesis in our series of tests is five percent. We first assign a level of significance of .01 to the test of the symmetry restriction implied by utility maximization. We then assign a level of significance .04 to the two sets of tests of restrictions on (1) the form of the indirect utility function and (2) effects of household size and composition. These two sets of tests are nested; under the null hypothesis the sum of levels of significance provides a close approximation to the level of significance for both sets of tests simultaneously.

We test the hypotheses of linear logarithmic utility, no adult worker effect, no child worker effect, and no dependent effect in parallel, proceeding conditionally on the validity of utility maximization. These tests are not nested so that the sum of levels of significance for each of the ten hypotheses is an upper bound for the level of significance of tests of the ten hypotheses considered simultaneously. We assign a level of significance of .01 to each of the hypotheses of linear logarithmic utility, no adult worker effect, no child worker effect, and no dependent effect, respectively.

We further decompose each of the last three hypotheses into three sub-hypotheses: no effect on the demand for child workers' leisure, no effect on the demand for home-produced agricultural commodities, and no effect on the demand for purchased consumer final goods. We divide the level of significance assigned to each of the three hypotheses, 0.1, equally between these three alternatives so that each of the nine possible sub-hypotheses on household size and composition effect is assigned a level of significance equal 0.0033. Again, these tests are not nested, so that the sum of levels of significance for each of the three sub-hypotheses is an upper bound for the level of significance of the three sub-hypotheses considered simultaneously. Our test procedure is presented schematically in Figure 1. Test statistics for large and small farms are presented in Table 7. At a level of significance of .01 we cannot reject the hypothesis of utility maximization for the two groups of farms. The test statistics, and therefore the results, for the groups of owner and tenant farms were equivalent.

Proceeding conditionally on the validity of the hypothesis of utility maximization, at a level of significance of 0.1, we reject the hypothesis of linear logarithmic utility for the two groups of farms.

Again, proceeding conditionally on the validity of the hypothesis of utility maximization, we reject, at a level of 0.0033 each, the hypotheses of no adult worker effect on child workers' leisure demand and no child worker effect on child workers' leisure demand for both large and small farms. However, we cannot reject the hypotheses of no adult worker effect and no child worker effect on the demand for home-produced agricultural commodities and purchased consumer goods, and no dependent effect on child workers' leisure demand, the demand for home-produced agricultural commodities and purchased consumer goods.

Based on the results of tests of the hypotheses which could not be rejected, the three Equations (40), (41) and (42) were re-estimated with the appropriate restrictions. In addition, the implied coefficients of the $(-q_1^* Z_1)$ equation were computed by making use of the equations given in Equation (36) through Equation (38). The results are reported in Appendix Table 2. These parameter estimates are the final specifications in the present study and will be used to derive the elasticities of demands for leisure and consumption goods, of supplies of labour, and of supply of marketed surplus of the agricultural households.[15]

[15] We also tested, and could not reject for any of the farm groups, the hypotheses of monotonicity and quasiconvexity of the homogeneous translog function. For the test procedures for monitonicity and quasiconvexity, [see Lau, Lin and Yotopoulos (1978)].

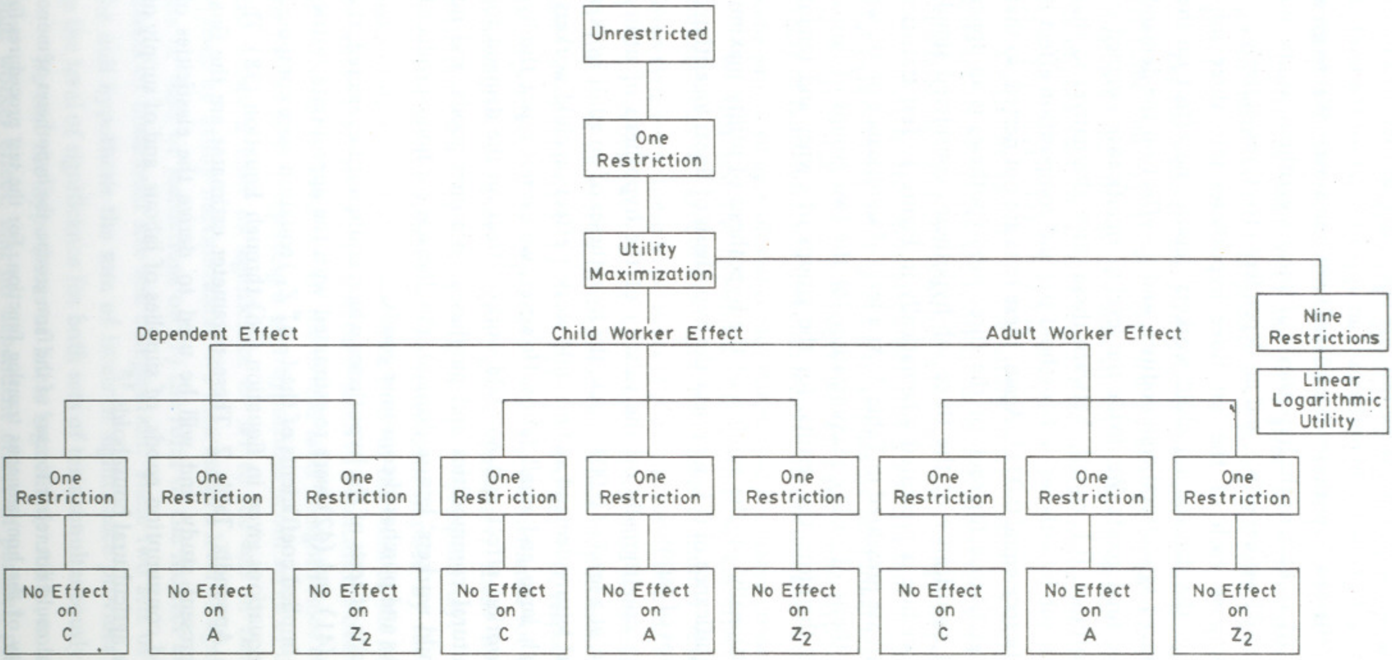

Fig. 1. Test Procedure

Table 7

Test Statistics, Large Farms and Small Farms

Hypothesis	Large Farms					Small Farms				
	Degrees of Freedom		Level of Significance	Critical Value	Actual Value	Degrees of Freedom		Level of Significance	Critical Value	Actual Value
	V_1	V_2				V_1	V_2			
1. Utility Maximization Symmetry	3	102	0.01	3.85	1.991	3	138	0.01	3.78	1.986
2. Linear Logarithmic Utility	6	105	0.01	3.06	6.32	6	141	0.01	2.80	19.67
3. Household Size and Composition										
3.1 Adult Workers										
3.1.1 No Adult Worker Effect on Z_2	1	105	0.0033	9.23	66.24	1	141	0.0033	9.13	160.1
3.1.2 No Adult Worker Effect on A	1	105	0.0033	9.23	0.602	1	141	0.0033	9.13	0.019
3.1.3 No Adult Worker Effect on C	1	105	0.0033	9.23	0.204	1	141	0.0033	9.13	0.540
3.2 Child Workers										
3.2.1 No Child Worker Effect on Z_2	1	105	0.0033	9.23	232.1	1	141	0.0033	9.13	309.6
3.2.2 No Child Worker Effect on A	1	105	0.0033	9.23	4.964	1	141	0.0033	9.13	0.707
3.2.3 No Child Worker Effect on C	1	105	0.0033	9.23	5.751	1	141	0.0033	9.13	6.910
3.3 Dependents										
3.3.1 No Dependent Effect on Z_2	1	105	0.0033	9.23	0.064	1	141	0.0033	9.13	2.125
3.3.2 No Dependent Effect on A	1	105	0.0033	9.23	0.613	1	141	0.0033	9.13	0.517
3.3.3 No Dependent Effect on C	1	105	0.0033	9.23	0.081	1	141	0.0033	9.13	1.206

Elasticities of Demands for Leisure and Consumption Goods and for Supplies of Labour and Marketed Surplus

The estimates of the Linear Logarithmic Expenditure System (LLES) as such cannot lead directly to useful economic interpretations. For this purpose, we need to compute elasticities of demands for leisure and consumption goods and of supplies of labour and marketed surplus. From the estimates of the LLES two sets of elasticities were computed for each group of farms at the means of the exogenous variables: first, by holding the full income of the household constant, and second, by taking into account the effects of changes in prices (such as the agricultural output price and the wage rates of adult and child labour) and in the quantities of the fixed inputs of agricultural production on the full income.[16] The computed elasticities appear in Tables 7 and 8 for large and small farms and for owners and tenants, respectively.

The estimation of elasticities with full income variable is a welcome (and unusual) departure in the literature and makes eminent sense in analyzing the agricultural operation. Income is taken as an exogenous variable for the consumption behaviour in estimating the full-income-fixed elasticities. In such a case, application of Slutsky's decomposition on the elasticities yields the traditional income and substitution effects of a change in the respective price variables. In the agricultural household, however, income is endogenously determined as a function of a set of exogenous variables, some of which appear on both the production side and the consumption side. the wage rates of adult and child labour (q_1' and q_2'), the price of farm output (P_A) and the quantities of the fixed inputs (K_1 and K_2). In this case, analysis of the elasticities on the basis of the Slutsky's decomposition into income and substitution effects will not suffice to describe fully the behaviour of the agricultural household. We must, in addition, distinguish an *effect on income*.

The effect on income in the present study has two components: first, the "wage component" which has been noted in the literature (Yotopoulos and Nugent, 1976, p. 131ff.) and second, the "production component" which acquires special importance in the analysis of the agricultural household.

The wage component accounts for the fact that a change in the price of a commodity which appears in both the production and consumption sides of the agricultural household (i.e., leisure of adult or child workers), has an effect on income

[16] For the procedure of computing the elasticities refer to Lau, Lin and Yotopoulos (1978, pp. 860–864). In computing each set of the elasticities we utilized the results of the profit and factor demand functions from the production side. In doing so, we are assuming that although the sample of each group of farms used for the analysis of the consumption behaviour is smaller than the sample used for the analysis of the production behaviour, the estimates of the profit and factor demand functions of the corresponding samples are identical. Furthermore, the test of the hypothesis of no-dependent-effect revealed that the elasticities with respect to the number of dependents (A_3) were all zeros. This might have been caused by misspecification of that variable, resulting from our increasing the number of dependents by one in all observations to avoid dropping from the sample households which have no dependents.

Table 8

Matrix of Elasticities of the Consumption System, Full Income Fixed and Variable, Landowners and Tenants

Exogenous / Endogenous Consumption Demands	Full Income Fixed							Full Income Variable				
	q_1	q_2	P_A	P_C	a_1	a_2	a_3	q_1	q_2	P_A	K_1	K_2
Owners												
Leisure of Adults (Z_1)	−.491	−.254	−.069	−.185	.537	−.285	−.003	−.088	.002	.293	.031	.201
Leisure of Children (Z_2)	−.414	−.321	−.178	−.087	−.525	.650	.027	−.011	.185	−.087	.031	.201
Own-produced Agricultural Goods (A)	−.172	−.271	−.549	−.007	−.125	−.092	−.001	.230	−.014	−.186	.031	.201
Purchased Final Goods (C)	−.634	−.182	−.010	−.173	−.165	−.266	−.025	−.231	.074	.353	.031	.201
Adult Labour Supply (X_1)	2.690	1.394	.381	1.015	−2.944	1.561	.048	.481	−.012	−1.608	−.151	−.974
Child Labour Supply (X_2)	8.951	6.951	3.845	1.878	11.365	−14.065	−.585	.236	1.404	−4.005	−.698	−4.491
Marketable Surplus (MS)	−2.757	−0.293	4.139	.008	.137	.101	.001	−1.040	−.242	3.482	.240	1.844
Tenants												
Leisure of Adults (Z_1)	−.303	−.576	.016	−.137	.424	−.426	−.027	.012	−.200	.495	.042	.247
Leisure of Children (Z_2)	−.469	−.271	−.119	−.141	−.365	.526	.021	−.154	.105	.353	.042	.247
Own-produced Agricultural Goods (A)	.031	−.274	−.735	−.022	−.015	−.308	.073	.346	.102	−.257	.042	.247
Purchased Final Goods (C)	−.465	−.584	−.039	.088	.109	−.183	−.126	−.150	−.209	.439	.042	.247
Adult Labour Supply (X_1)	.792	1.504	−.043	.359	−1.108	1.113	.070	−.031	.522	−1.293	−.094	−.553
Child Labour Supply (X_2)	7.109	4.105	1.804	2.132	5.532	−7.966	−.313	2.333	−1.587	−5.448	−.615	−3.586
Marketable Surplus (MS)	−2.151	−.596	3.512	.017	.012	.241	−.056	−1.074	−.378	3.151	.219	1.276

Note: The elasticities are derived from the coefficients of the restricted estimation, i.e., insignificant coefficients have their actual estimated values.

in addition to the substitution and income effects. For example, while an increase in a wage rate leads to a decline in the real income of the household because of the corresponding consumption of leisure, the same increase in the wage rate increases the money income of the household to the extent that the household is also a supplier of labour. More specifically in the present study, the two variables, i.e., the adult labour wage rate and the child labour wage rate, enter the analysis expressed as shares of the full income, that is,

$q_1^* \bar{Z}_1$ $(= q_1' \bar{Z}_1/M)$ and $q_2^* \bar{Z}_2$ $(= q_2' \bar{Z}_2/M)$. Changes in q_1' and q_2' will therefore affect the respective income shares of adult labour and child labour of the full income of the household. The wage component of the effect on income, in turn, plays an important role in determining the signs and magnitudes of the elasticities. An increase in the wage rate, for example, would have a positive impact on the demands for leisure and consumption goods and a negative impact on the supplies of labour and marketed surplus.

The production component of the effect on income refers to the fact that the full income of the agricultural household, M, is a function of P_A, q_1', q_2', K_1, and K_2 which are the exogenous variables of the profit (or output supply) and factor demand functions. In examining these variables from the production side we find their effects varied and at times possibly offsetting one another. For example, an increase in either the adult or the child labour wage rate has a negative impact on the demands for leisure and consumption goods but a positive impact on the supplies of labour and marketed surplus. An increase in either the price of output or the quantities of the fixed inputs, however, has a positive impact on the demands for leisure and consumption goods and on the supply of marketed surplus, but a negative impact on the supplies of labour.

The agricultural household is *par excellence* the economic unit which not only produces but also consumes a good portion of its own output. Allowing therefore for the effect on income becomes especially important for the proper specification of the consumption behaviour of the agricultural household in developing countries. This becomes clear from several reversals of signs in considering the impact of q_1', q_2', and P_A on full income income fixed and variable in Tables 8 and 9.

Implications of the Distribution between Owners and Tenants

Tables 8 and 9 present the matrix of elasticities of the consumption system for the two groups of farms, owners and tenants and large and small, respectively. The elasticities of the four consumption demands (adult and child leisure, own-produced agricultural goods and purchased final goods) and those of labour supply and marketed surplus are estimated with respect to the exogenous variables (their respective prices, the composition of the household between adult workers, children of

Table 9

Matrix of Elasticities of the Consumption System, Full Income Fixed and Variable, Large and Small Farms

Endogenous \ Exogenous	Full Income Fixed q_1	q_2	P_A	P_C	a_1	a_2	a_3	Full Income Variable q_1	q_2	P_A	K_1	K_2
Large Size Farms												
Leisure of Adults (21)	-.465	-.247	.178	-.109	.450	.323	-.065	-.149	.075	.366	.050	.314
Leisure of Children (22)	-.298	-.522	-.096	-.084	.509	.596	.014	.022	.200	.448	.050	.314
Own-produced Agricultural Goods (*A*)	-.385	-.172	-.665	-.122	.110	.199	.090	-.065	.150	-.120	.050	.314
Purchased Final Goods (*C*)	-.359	-.227	-.185	-.228	.076	.274	.038	-.039	.095	.359	.050	.314
Adult Labour Supply (X_1)	2.002	1.063	.769	.474	-1.939	1.394	.279	.624	-.324	-1.577	.215	-1.353
Child Labour Supply (X_2)	3.253	5.705	1.051	.914	5.561	-6.507	-.147	-.241	2.187	-.897	-.346	-3.431
Marketable Surplus (*MS*)	-1.082	-.125	1.873	.066	.060	.108	-.049	-.636	.287	2.374	.189	1.161
Small Size Farms												
Leisure of Adults (21)	-.372	-.376	-.063	-.189	.403	-.093	.029	.052	.088	.213	.022	.146
Leisure of Children (22)	-.485	-.265	-.156	-.094	-.474	.611	.048	-.061	.023	.119	.022	.146
Own-produced Agricultural Goods (*A*)	-.147	-.284	-.558	-.011	-.013	-.081	-.066	.277	.004	-.283	.022	.146
Purchased Final Goods (*C*)	-.665	-.256	-.016	-.062	-.103	-.342	-.136	-.241	.032	.259	.022	.146
Adult Labour Supply (X_1)	1.452	1.469	.245	.738	-1.573	.364	-.115	-.201	.345	-.830	-.083	-.569
Child Labour Supply (X_2)	65.783	35.913	21.174	12.739	64.305	-82.827	-6.521	8.335	-3.122	-16.175	-2.952	-19.775
Marketable Surplus (*MS*)	-6.482	-1.526	10.396	.027	.032	.195	.159	-1.695	-.374	6.295	.391	2.619

Note: The elasticities are derived from the coefficients of the restricted estimation, i.e., insignificant coefficients have their actual estimated values.

working age and dependents, and the fixed factors of production of animal-machinery input and land). The results presented in the two tables are roughly comparable, and the differences that exist are due to the fact that owners and large size farms and tenants and small size farms are not perfectly overlapping groups. The discussion that follows will focus on Table 8 since the owner-tenants split was found in an earlier section to be statistically better related to the observed fertility differentials and as a result constituted the basis for the formulation of the inverse endowments-fertility hypothesis. The discussion here will highlight the elasticities which relate to that hypothesis.

We examine first the case of full income fixed. An increase in the number of children of working age (a_2) results in a decrease in the leisure of adults that is greater for tenant households. This is the result of the two components of benefits and costs of children that are more pronounced in tenant households. The complementarity between child and adult labour (discussed in the previous section) implies that the increased child labour in the household has to be matched by additional adult labour. On the cost side, additional children place further consumption burdens on the household that must be born by adult members working harder. Both effects are stronger for tenant households that rely more on child labour and have meager budget and resources in comparison to owner households. The same effect appears in the decrease in consumption of own-produced goods (i.e., an increase in the surplus that is marketed) that is more substantial for the tenant households.

An increase in child wage rate (q_2) decreases leisure of children, but less in tenants than in owner households. This is again consistent with the hypothesis that the less advantaged group relies more on labour of own children while the more advantaged relies more on hired labour (of adults and children). As a result the latter households are likely to react more strongly through the market place to an increase in the wage of child labour.

With full income variable an increase in the price of own-produced goods (P_A) increases leisure of adults and children markedly in tenant households, while the effects are smaller and mixed for owners. The effect of an increase in the price of output is to increase the value of the surplus the household markets (effect on income) and hence profits. In fact the supply of marketed surplus responds in all cases positively and markedly to an increase in output price. The resulting increased wealth of the household is cashed in to relieve some of the pressure on the intensively utilized household resource of adult and child labour. Such is the case of tenant households. On the other hand, the same increase in price leads, through the substitution effect, to a decrease in consumption of own-produced goods (and increase in marketed surplus). This adjustment also is stronger for the less privileged tenant households.

An increase in the wage rates (q_1 and q_2) has as own-elasticity effects an increase in leisure (Z_1 and Z_2) which is more pronounced in tenant households. This

is mostly the effect on income, since the leisure component of the full expenditure has increased. The cross-elasticity effects decrease leisure, again more drastically in the tenant households. These results are also consistent with the postulated more pronounced complementarity between family child and adult labour for tenant households and with the greater strain on their resources. Finally, an increase in the fixed factors of production of animal-machinery input (K_1) and land input (K_2) has a more pronounced impact on the households with lower initial endowments, the tenant households.

The labour supply is derived as a residual from the total time available once the respective demands for leisure have been estimated. Since the time available has been set arbitrarily,[17] the elasticities of labour supply appear to be rather unstable. One should place more emphasis on the signs rather than the absolute magnitudes of these elasticities. With respect to wage rates and the number of workers the elasticities of labour supply have the expected opposite signs from those of leisure.

The results of the consumption analysis, and in the full-income-variable case of the integration of production and consumption behaviour in an equilibrium model, seem to strengthen the case for the inverse fertility-endowments hypothesis. It appears that the less privileged tenant households register a strong impact from changes in exogenous variables that relate to the economic (net) contribution of children. The direction of that impact is always consistent with the hypothesis that children are more valuable in tenant, as compared to owner households, despite the fact that their marginal product of labour was measured to be lower in the former that in the latter.

7. SUMMARY AND CONCLUSIONS

This paper is a prelude to fully integrating the economic and demographic behaviour of the household. On the economic side, we have extended the subjective equilibrium model of the household to include both production and consumption behaviour and to account for the household's demographic structure, especially with respect to children's contributions in production and their impact in consumption. In this manner the value of children to the agricultural household could be obtained within a consistent utility maximization model. As a next step, this evaluation of children's net services could be compared to the differential fertility behaviour that was observed among different socio-economic groups.

The model was applied on primary data collected from a sample of agricultural households in the Province of Misamis Oriental in the northern part of Mindanao Island in the Philippines. This summary intends only to highlight some of our results.

[17] The length of the working day and hence the quantity of maximum possible leisure per day is defined arbitrarily. So is the number of possible workdays in the year (365 in this study). While this does not affect the estimated coefficients, it can affect their complements, e.g., the supply of labour (Barnum and Squire 1979, p. 66).

The analysis was carried out for two groupings of the households: on the criterion of form of tenure, for landowner and tenant households; on the criterion of size of operation for large-farm and small-farm-size households. The utility maximization hypothesis was explicitly tested and could not be rejected for any of the socio-economic groups distinguished. The criterion of static efficiency, in the sense of rationality, was thus satisfied in all groups. The production analysis revealed that the major difference in the groups distinguished, owner-tenant farms and large-small size operations was in the input of child labour. This translated to higher marginal products of child labour – as well as for all other factors of production – in the groups of better-endowed households, i.e., the owner and large-size farms, as compared to tenant and small-size operations. Especially in relation to owner-tenant farms, the results are consistent with the recent literature[18] which finds that the share-tenancy equilibrium is optimal with respect to certain constraints (such as initial endowments, imperfect markets, etc.) in other words it is a second-best optimum. This, however, appears to be only a local optimum. When the results of the model of the equilibrium of the household are combined with the demographic analysis which found higher fertility in tenant and small-size households, it appears that tenancy does not also represent a global optimum equilibrium. Indeed, the coexistence of low marginal contributions of children with low fertility control in tenant (or small size) farms can be explained only in terms of the inverse fertility-endowments hypothesis which is actually based on market-failure when it comes to labour markets at times of peak agricultural activities (Yotopoulos 1982). Examination of the consumption side of the utility maximization model reveals demands for leisure of children and adults and consumption demands for other commodities that are consistent with the higher valuation of children (and thus higher fertility) in tenant (and small-size) households, as compared to owner (and large-size) households.

The analysis of the household equilibrium with demographic characterization suggests important policy implications for population growth and social equity. The evidence suggests that the differences in initial endowments account for the higher marginal products of the better-endowed households and that tenant (and small-farm-size) households compensate for such differences through higher fertility. In such a situation a policy of social equity in agriculture that improves endowments at the bottom could trickle up in terms of higher productivities and lower population growth.

[18] For reviews of this literature [see Bardhan (1980) and Binswanger and Rosenzweig (1981)].

Appendix

SPECIFICATION OF THE VARIABLES

Profit and the Quantity and Price of Output

The money profit of the agricultural household denoted by Π', is defined as:

$$\Pi' = P_A Q - \sum_{i=1}^{2} q'_i X_i - OC \qquad \ldots \qquad \ldots \qquad \text{(A-1)}$$

where $P_A Q$ is the gross output in pesos; X_1 and X_2 are respectively adult and child labour days and q'_1 and q'_2 are the corresponding wage rates in pesos per day; and OC is the other variable costs in pesos, consisting of the expenses of seeds, chemical fertilizers, agri-chemicals, feeds, irrigation, fuels, clothing, and others. The gross output consists of rice, corn, coconuts, tobacco, livestock products, and other crops such as bananas, vegetables, peanuts, sweet potatoes, and mangoes.

Our model requires that the profit be normalized by the output price (P_A). A number of operations are necessary for this purpose. First of all, the output price should be farm specific. This means that we should consider the fact that farms sell outputs at different times and in different markets and may therefore obtain different "average" prices, even in a regime where the markets are competitive. We need therefore to weight all these individual prices obtained in order to get the average price of outputs for each farm. We consider that a geometrically weighted average price is the most relevant since it reflects the share of each product in the total production of a farm.

In the estimation of the weighted average price of agricultural products, we may use a standard unit like kilograms. However, in the Mindanao Survey, the quantities of tobacco products are not given in kilograms. Instead, they are given in *manos* and *paldos* which could not be converted to a standardized unit of kilograms given the present state of information.

This difficulty was avoided by utilizing the computational method of a price index over time. That is, the individual price of a certain period of time is normalized by the individual price of the initial period and hence this gives a price index in terms of a constant price as follows:

$$\frac{P_c^t}{P_c^o} = \prod_{k=1}^{n} \left(\frac{P_k^t}{P_k^o} \right)^{\alpha_k},$$

where P_k^o and P_k^t are, respectively, the prices of commodity k in the initial and t periods of time, and α_k is the weight represented by the value share of commodity k in the total value of n commodities.

We employed this method for the estimation of the farm specific price index instead of price per standardized unit. Mathematically, it is written as,

$$\frac{P_A^i}{P_A^o} = \prod_{k=1}^{5} \left(\frac{P_k^i}{P_k^o} \right)^{\alpha_k}, \quad i = 1, 2, \ldots, 590, \quad \ldots \quad \ldots \quad \text{(A-2)}$$

where P_k^i is the price of commodity k in the ith farm; P_k^o is the sample average price of commodity k; and α_k is the value share of commodity k in the total value of production of rice, corn, coconut, tobacco, and livestock products.

Quantities and Prices of Adult and Child Labour

The quantities of adult and child labour used on the farm, X_1 and X_2, are defined, respectively, as the sums of family labour, X_1^f and X_2^f and of hired labour, X_1^h and X_2^h. We assume no quality-of-labour difference within each labour category. Moreover, the quality of male and female labour in each category is assumed to be equal for both adult and child labour, since the wage rates and/or replacement costs for male and female labour reported in the Mindanao Survey are equal for almost all production activities.

The computation of the quantities of adult and child labour is straightforward. First, the labour days for each farming activity of every single crop or livestock product were summed up separately for adult and child labour. In this way, we obtained the total labour days of adults and children separately for the production of rice, corn, coconuts, tobacco, and livestock products. Finally, these labour days were aggregated in order to obtain the total labour days of adults, X_1 and children, X_2.

Next, the computation of the adult and child wage rates, q'_1 and q'_2, was carried out as follows: In the Mindanao Survey, each farm reported either the hired labour wage rate or the replacement cost if it did not hire labour for certain activities or outputs. By making use of this information, the geometrically weighted average wage rate was computed for adult and child labour separately. This is shown as,

$$q'_{ij} = \prod_{k=1}^{m} (q'_{kij})^{\alpha_{kij}} \quad i = 1, \ldots, 6; \text{ and } j = \text{adult, child}, \quad \ldots \quad \text{(A-3)}$$

where q'_{ij} is the geometrically weighted average wage rate for the ith output; q'_{ki} is either the hired wage rate or the replacement cost for the kth activity for the ith output; and α_{ki} is the weight defined as the share of the labour cost for the kth activity in the total labour costs for the ith output. That is,

$$\alpha_{kij} = \frac{q'_{kij} X_{kij}}{\sum_{k=1}^{m} q'_{kij} X_{kij}}, \quad i = 1, \ldots, 6; \text{ and } j = \text{adult, child} \quad \ldots \quad \text{(A-4)}$$

where X_{kij} is the amount of labour used for the kth activity in the ith output.

Then, these q'_{ij}'s were again geometrically weighted by shares of labour costs of each crop in labour costs for all output in order to obtain the average wage rate q'_j (j = adult, child). That is,

$$q'_j = \prod_{i=1}^{6} (q'_{ij})^{\beta_{ij}}, \quad j = \text{adult, child}, \quad \ldots \quad \ldots \quad \text{(A-5)}$$

where

$$\beta_{ij} = \frac{\sum_{k=1}^{m} q'_{kij} X_{kij}}{\sum_{i=1}^{5} \sum_{k=1}^{m} q'_{kij} X_{kij}}, \quad j = \text{adult, child},$$

i.e., the value share of labour of the ith output in the total labour costs (j = adult, child).

The adult and child wage rates are expressed as pesos per day. These money wage rates were normalized by the output price index (P_A) to yield q_1 and q_2, respectively. Needless to say, for farms which do not report any use of child labour, one could not compute the child wage rates.

Finally, the total labour costs are given by,

$$WC = \sum_{j=1}^{2} \sum_{i=1}^{6} \sum_{k=1}^{m} q'_{kij} X_{kij} \quad \ldots \quad \ldots \quad \text{(A-6)}$$

The wage costs, WC, as well as the other costs, OC, were substracted from the total value of output, $P_A Q$, yielding the money profit, Π'. This money profit was normalized by the output price index (P_A) to yield the normalized profit, Π.

Animal-machinery Input and Area Cultivated

In order to obtain the animal-machinery input, K_1, the following method was used:

$$K_1 = w_A X_A + 0.06 X K_M + D_M + R_M, \quad \ldots \quad \ldots \quad \text{(A-7)}$$

where $w_A X_A$ is the animal service costs; K_M is the stock value of machinery and tools and D_M is their depreciation; and R_M is maintenance and repair costs. All costs are expressed in terms of pesos.

The animal service costs were computed as follows: There are many farms which do not hire animal services but use carabaos they own. For such farms, the animal wage w_A could not be obtained. We computed the average wage rate of animal services for the farms which hire animals and had recorded animal service wage rates. The average of these animal service wage rates was assigned to the farms which utilize only their own animals in order to obtain the animal service costs.

The cultivated area, K_2, is the sum of areas planted with rice, corn, coconuts, tobacco, and other crops. The land input is expressed in terms of hectares.

Quantities and Prices of Adult and Child Leisure and Labour

The total leisure time of adult and child workers can be given by,

$$a_1\overline{Z}_1 - X_1^f = Z_1, \qquad \ldots \qquad \ldots \qquad \ldots \qquad \text{(A-8)}$$

$$a_2\overline{Z}_2 - X_2^f = Z_2, \qquad \ldots \qquad \ldots \qquad \ldots \qquad \text{(A-9)}$$

where $\overline{Z}_1$ and $\overline{Z}_2$ are the maximum amounts of leisure time of adult and child workers; X_1^f and X_2^f are the family labour days of adult and child workers, respectively; and a_1 and a_2 are the numbers of adult and child workers, respectively. We assign the maximum number of days, 365 days, to $\overline{Z}_1$ and $\overline{Z}_2$.

The price of leisure is set at the opportunity cost of labour, which is the respective wage rate, q_1' and q_2', for adult and child workers.

Price of Own-produced Agricultural Goods and Expenditure

The value of home consumption of farm products is given by $P_A A$ where P_A is the geometrically weighted average price index. As stated in Section 2, we assume the same price for farm output sold and consumed at home. The value of marketed surplus supplied, denoted by M_S, is

$$P_A M_S = P_A Q - P_A A \qquad \ldots \qquad \ldots \qquad \ldots \qquad \text{(A-10)}$$

Price of Purchased Final Goods and Expenditure

The expenditure on purchased final goods, denoted by $P_C C$, is simply the sum of expenditures on various goods and services purchased, including processed food commodities, durables, nondurables, health and education, and transportation.

The estimation of the average price of purchased final goods poses the same problem that was noted in Section 1 with reference to tobacco. It is almost impossible to convert different units of goods such as salt, pants and movie theater admissions to a standardized unit such as kilograms. The same method described earlier of computing a geometrically weighted average price index of purchased consumer goods, P_C, was used in this case. The relevant equation appeared above as Equation (A-2).

Non-labour Asset Income

We define the non-labour asset income I_A as the sum of the incomes from fishing, business and trade, and from other sources, less taxes. We did not include in

this computation savings and liabilities simply because the figures reported in the Mindanao Survey were not considered reliable. The asset income so defined is expressed in terms of pesos.

Full Income, Full Expenditure and Normalized Prices

The final data-processing procedure was to compute the full income and expenditure, denoted by M. It is measured in pesos. The full income and expenditure, M, was then used to normalize the prices q_1', q_2', P_A, and PC. This yielded, respectively, q_1^*, q_2^*, P_A^* and P_C^*.

Appendix Table 1

Unconstrained Efficient Estimates of the Linear Logarithmic Expenditure System, Large and Small Farms

		Constant	$\ell n q_1^*/q_1^*$	$\ell n P_A^*/q_1^*$	$\ell n P_C^*/q_1^*$	$\ell n \alpha_1$	$\ell n \alpha_2$	$\ell n \alpha_3$
Large Farms (observations 41)	$-q2^*Z_c$	–0.319 (–43.44)	–0.183 (–3.627)	0.010 (.305)	0.030 (1.407)	0.164 (8.281)	–0.191 (–15.33)	–0.006 (–0357)
	$-P_A^*A$	–0.179 (–18.81)	0. 153 (2.354)	–0.055 (–1.340)	0.024 (0.852)	0.019 (0.754)	0.037 (2.274)	–0.010 (–0.471)
	$-P_C^*C$	–0.118 (–15.82)	–0.031 (–.611)	0.032 (0.995)	–0.094 (–4.351)	–0.010 (–0.488)	0.030 (2.388)	–0.008 (–0.484)
Small Farms (observations 53)	$-q_2^*Z_c$	–0.312 (–60.47)	–0.259 (–7.094)	–0.033 (1.686)	0.032 (3.238)	0.149 (12.860)	–0.191 (–17.830)	–0.011 (–1.079)
	$-P_A^*A$	–0.172 (–21.40)	0.174 (3.060)	–0.065 (–2.165)	–0.005 (0.295)	–0.005 (0.281)	0.020 (1.191)	–0.001 (–0.012)
	$-P_C^*C$	–0.114 (–15.86)	0.028 (0.540)	0.016 (0.578)	–0.108 (–7.945)	0.010 (0.619)	0.038 (2.564)	0.017 (1.003)

Notes: 1. The estimating equations are Equations (40), (41) and (42).
2. Figures in parentheses are computed asymptotic t-ratios.

Appendix Table 2

The Final Specification of the Linear Logarithmic Expenditure System, Large and Small Farms

		Constant	$\ell n q_1^*$	$\ell n q_1^*$	$\ell n P_A^*$	$\ell n P_C^*$	$\ell n \alpha_1$	$\ell n \alpha_2$	$\ell n \alpha_3$
Large Farms (observations 41)	$-q_1^*Z_1$	–0.385	–0.265	0.158	0.103	0.005	–0.172	0.173	0.0
	$-q_2^*Z_2$	–0.319 (–42.74)	0.158	–0.155 (–3.426)	–0.038 (1.298)	0.039 (1.845)	0.172 (–16.51)	–0.173	0.0
	$-P_A^*A$	–0.179 (–17.44)	0.103	–0.038 (1.298)	–0.072 (–1.753)	0.007 (0.034)	0.0	0.0	0.0
	$-P_C^*C$	–0.118 (–15.00)	0.005	0.035 (1.845)	0.070 (0.344)	–0.120 (–5.441)	0.0	0.0	0.0
Small Farms (observations 53)	$q_1^*Z_1$	–0.402	–0.267	·0.162	0.025	0.080	–0.149	0.187	0.0
	$-q_2^*Z_2$	–0.312 (–58.71)	0.162	–0.241 (–7.213)	0.048 (2.590)	0.032 (3.339)	0.149 (13.71)	–0.187 (–19.18)	0.0
	$-P_A^*A$	–0.171 (–20.90)	0.025	0.048 (2.590)	–0.074 (–2.554)	0.001 (0.104)	0.0	0.0	0.0
	$-P_C^*C$	–0.114 (–14.74)	0.080	0.032 (3.339)	0.001 (0.104)	–0.113 (–8.190)	0.0	0.0	0.0

Notes: 1. The estimating equations are Equations (40), (41) and (42). The symmetry restrictions, i.e., $\gamma_{23} = \gamma_{32}$, γ_{42}, and $\gamma_{34} = \gamma_{43}$, were imposed.
2. The coefficients of $-q_1^*Z_1$ were obtained by making use of Equations (36), (37) and (38).
3. Figures in parentheses are computed asymptotic t-ratios.

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