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Non-Separable Household Model (Household Production and Consumption Decisions in A Market Failure)

Sinbone Tefera Walkaba * Jima Degaga Aemro Tezaze(Msc)
Department of Agricultural Economics, Haramaya University,
P. O. Box 138 Haramaya University Dire Dawa, Ethiopia

Abstract
Households in developing countries are systematically exposed to market imperfections and shadow prices play a similar role to market prices in the decision process of the household. When they apply, the shadow prices are equal to marginal utility of the consumption of food and leisure, and marginal productivity of labor. They indicate the price that the household would be willing to pay to have the corresponding constraint relaxed by one unit. Hence, household characteristics in consumption, total time endowment, exogenous cash transfer (S), and consumption prices affect production decisions as opposed to the separable household model. Transaction costs should be reduced by the Governmental and non-governmental institutions to narrow the gap between purchasing and selling prices, and increase market participation of households and also increases their gain from changes in price.
Keywords: production and consumption decisions, market failures, shadow price, transaction costs, non-separable
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1. INTRODUCTION

Probably, no less than a quarter of the world population belongs to farm households and most of this population is in the less developed countries (Ellis, 1998). They are the one who creates pressure on natural/environmental resources and food demand/supply (Cakir, 2010). Agricultural production is often importantly dependent on their performance as farmers and world poverty is disproportionately found among them, making understanding the determinants of their welfare is a prime concern in any strategy of poverty alleviation. Agricultural Households in developing countries make joint decision over consumption, production and labor supply (Sadoulet and Janvry 1995, and Taylor and Adelman, 2002). Households are both producer, choosing the allocation of labor and other inputs to crop production, and a consumer, choosing the allocation of income from farm profits and labor sales to the consumption of commodities and services.

Agricultural household models are stable of micro-research in less developed country (Taylor and Adelman, 2002). They are a useful tool to study how household-specific transaction costs shape the impacts of exogenous policy and market changes in rural areas. Separation of production and consumption depends on availability of markets, i.e., perfect market and market failure (Cakir, 2010;Sadoulet and Janvry, 1995). If separable (perfect market exists), the only mediating variable between production and consumption is income, and if non-separable (the case of market failure), complex interaction between household production and consumption exists. Farm households are semi-commercialized. Food produced in excess (shortage) of household consumption is sold (bought) and labor in excess (shortage) of household production requirement is sold (bought).

In higher-income societies their live often seem to come close to approximating the economists' artificial division of economic phenomena between households and firms (Ligon, 2011). Individuals make consumption decisions that depend on the preferences of those in their households; on the prices the household faces, and on the households' resources. Some individuals work for firms, which is where the locus of production is located; for many people there is fairly clear separation between the productive activities they pursue at work and the live they pursue within their households. If perfect market exists for all outputs and factors of production, then prices are exogenous to households (Findeis*et al.*, 2003). In this case, transaction costs are zero and the opportunity cost of any output or factor is its market price. Food produced in excess of household consumption is sold in the product market, and family labor supplied in excess of use on the home plot is sold in the labor market. If production is less than consumption and/or labor supplied less than needs for the plot, the household is a net buyer of food and/or a net employer of a labor. In this case, cash expenditures to buy food have to come from other sources of income such as the sale of cash crops or of labor. Labor can be sold off-farm and be hired in (no efficiency differences). All products and factors are tradable and opportunity cost of any product or factor held by household is its market price. Under this condition, separability holds, and the producer side of the model can be solved prior to consumer (worker) side, with farm profits serving as the hinge between the two problems. Ownership of the variable factors is irrelevant for production decisions and affects consumption decisions only through income level, which is its self determined by ownership.

This separation, however, is often less clear-cut for agricultural households in lower income countries (Ligon, 2011). The household may be the locus for both consumption and production. Farm household cannot be viewed

as separately or independently maximizing profits as a producer and utility as consumer (Lofgren and Robinson, 1999). Depending on the nature of market imperfections, there may be threshold effect whereby policy changes have no effect on household behavior until the changes is large in some measure. When all markets work, the only linkage between production and consumption is through the level of farm income achieved in production (Sadoulet and Janvry 1995). When not all markets work, there are direct interrelations between production and consumption. In developing and transition economies, the lack of markets, the existence of mixed markets, and the presence of risk are well-accepted problems (Findeis*et al.*, 2003). However, even in developed countries the assumption of separability should be questioned. As an example, labor and hired labor may be far from perfect, and risk exists.

2. Review on non-separable household models

2.1. Definition of non-separable household models

Household is defined as a person or group of related and unrelated persons who live together in the same dwelling unit or in a connected promises, who acknowledge one adult member as a head of the household, and who have common arrangements for cooking and eating their food (Anonymous, n.d).A household model is said to be non-separable when the household's decision regarding production (use of inputs, choice of activities, desired production level) are affected by its consumer characteristics (consumption preference, demographic composition, etc) (Thorbecke, 1993). Within households, the non-separability and interdependence between production and consumption decisions is likely to be important. Household makes production, consumption and labor allocation decision that may be interdependent up on one another (Taylor and Adelman, 2002).Household production and consumption decisions are non-separable whenever the shadow prices of at least one production or consumption good is not given exogenously by the market but instead is determined endogenously by the interaction between household demand and supply (Lofgren and Robinson, 1999).

2.2 Sources and Uses of Non-Separable Household Model

It is well recognized that, in developing countries context, rural households are systematically exposed to market imperfections (Muller, 2014). Non-separability originates in market failures and in a binding credit constraint, both of which transform the products and factors affected in to non-tradables (Janvry*et al*., n.d). Farm households are located in an environment characterized by a number of market failures for some of its products (some of food, particularly the most perishable or bulky, or those with high price risk) and for some of its factors (low access to labor market or facing discrimination). Market fails when the cost of a transaction through market exchange creates disutility greater than the utility gain that it produces, with the result that the market is not used for transaction. Non-existence of market is the extreme case of market failures. In more general market may exist but, the gains for a particular household may be below or above the cost, with the result that some household will use while some others are not.

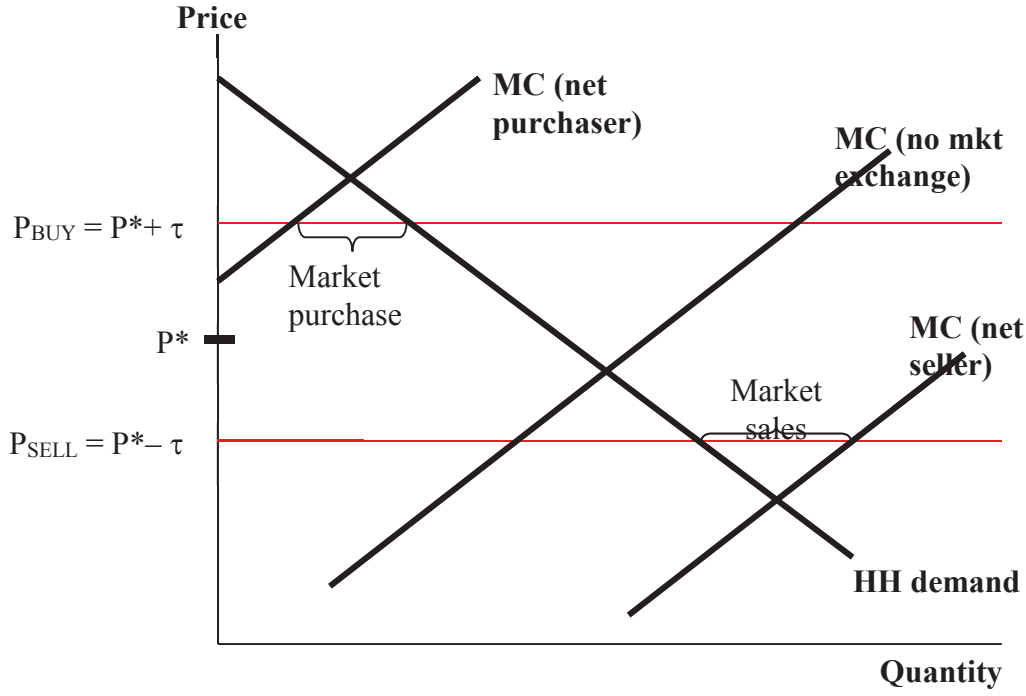

Figure1: The price band and picture Source; Janvry, Fafchamps and sadoulett, 1991.

PBUY and PSELL are the boundaries of the households' price band.If the household's MC Market may fail for a particular household when it faces wide price margins between the low price at which it could sell a commodity or factor and the high price at which it could buy that product or factor (Sadoulet and Janvry, 1995). Faced with thus price band, the household may be better off choosing self-sufficiency in that good or factors if it is subjective price (defined as the price which equates its demand to supply) falls inside the band (Janvry*et al.,* 1991). If the shadow price is above price band, the household should buy the commodity until the shadow price that equates supply and residual. (supply curve) crosses its demand curve within the price band, the household doesn't participate in the market. Because, it is more advantageous to the household to neither buy nor sell commodities. If the household's MC (supply curve) crosses its demand curve above the price band, the household is a net purchaser until the shadow price that equates supply and residual demand for home production fails to purchase price. If the household's MC (supply curve) crosses its demand curve below the price band, the household should sell the commodity until the shadow price that equates residual supply after sell of a marketed surplus, and demand rises to the sale price. According to (Sadoulet and Janvry, 1995), the magnitude of price band may be increased by; High transaction costs**,** Shallow local market(in a good season household could have a marketed surplus and when there is a drought household's supply fails) and price risk and risk aversion (the greater the level of price risk and the greater aversion to risk, the wider the effective price band and market failure).

2.3. Model specification

According to Sadoulet, (2006) the model can specified as; Consider a household producing two crops, a cash crop (q_c) and a food crop (q_a) with two inputs, labor (q_l) and other inputs such as fertilizers (q_x). The production technology is represented by $G[q_a,q_c,q_x,q_l;z^q]$ where outputs (q_c,*and* $q_a > 0$) and inputs (q_x,*and*$q_l > 0$), z^q is fixed factors in production and producer characteristics. On the consumption side, household consumes food (c_a,), a manufactured good (c_m), leisure (c_l) which is the complement in total time of its labor supply. It may also has total time endowment (E) and exogenous cash transfer (S). There is farm get sale price of cash crops (P_c) and farm gate purchase prices of other inputs (P_x,andP_m) which are provided by the market. The household is assumed to maximize a utility function subject to a cash income constraint for the commodities tradable on the market, a technology constraint and equilibrium conditions for tradables and non-tradables.

$$Max\ U\ [c_a,\ c_m,\ c_l;\ z^h]$$

$$q_a,\ q_c\ q_l,\ q_x\ c_a,\ c_m,\ cl$$

Subject to

$p_x\ q_x + p_m\ c_m = p_c\ q_c + S$ ----------*cash income constraint*

$G[q_a,q_c,q_l,q_x;\ z^q] = 0$ ----------*production technology*

$p_i = \bar{p}$*for* $i = c, x, m$ ----------*exogenous market price for tradables*

$c_a = q_a$*and*$c_l = E - q_l$----------*equilibrium for non-tradables*

The lagrangean associated with the constrained maximization problem is written as;

$L = U[(c_a,c_m,c_l;z^h) + \lambda[p_x\ q_x + p_m\ c_m - p_c\ q_c - S] + \emptyset g + \mu_a[q_a - c_a] + \mu_l[c_l + q_l - E)]$

First order condition;

$\frac{\partial L}{\partial q_c}: \emptyset g'_c = -\lambda p_c$; $\frac{\partial L}{\partial q_x}: \emptyset g'_x = \lambda p_x$ ----------tradables

$\frac{\partial L}{\partial q_a}: \emptyset g'_a = -\mu_a$; $\frac{\partial L}{\partial q_l}: \emptyset g'_l = \mu_l$ ----------non-tradables

$\frac{\partial L}{\partial c_m}: u'_m = \lambda p_m$---------- tradables

$\frac{\partial L}{\partial c_k}: u'_k = \mu_k, k = f, l$----------non-tradables

$\frac{\partial L}{\partial \emptyset}: g = 0$----------technology constraint

$\frac{\partial L}{\partial \lambda}: p_x q_x + p_m c_m = p_c q_c + S$----------cash income constraint

$\frac{\partial L}{\partial \mu_a}$: $c_a = q_a$----------equilibrium condition for food

$\frac{\partial L}{\partial \mu_l}$: $c_l = E - q_l$----------equilibrium condition for labor

Decision price P^* is defined as follows;

$P_a^* = \frac{\mu_a}{\lambda}$, $P_l^* = \frac{\mu_l}{\lambda}$----------shadow prices for the non-tradables food and labor

$P^* = \bar{P}_l$----------effective market prices for the tradablesc, m, x

Combining the last three condition gives the full income constrain as follows;

$P_x q_x + P_m c_m + P_a^* c_a + P_l^* c_l = P_c q_c + P_a^* q_a + P_l^* (E - q_l) + S$ ----*full income constraint*

The first order condition for the non-separable model can be rewritten using decision prices P^*as;

$\emptyset g'_i = -\lambda P_i^*$, i= c, a---------- products

$\emptyset g'_j = \lambda P_j^*$, $j = l, x$---------- factors

g = 0 ---------- technology

$u'_k = \lambda P_k^*$, $k = m, a, l$---------- consumer goods

$\sum_{k=a,m,l=} P_k^* c_k - \sum_{i=a,c} P_i^* q_i - \sum_{j=l,x} P_j^* q_j + S$ -------- full income constraint

As producer, the household chooses the level of input which maximizes its output, and which is equivalent to maximizing a generalized profit function defined over all tradable and non-tradable commodities. This leads to a system of input demand and output supply;

$q_i = q_i\,(P_a^*, P_c^*, P_l^*, P_x^*; z^q)$, $i = a, c, l, x$

Profit and full income can be written as follows;

$\Pi = \sum_{i=a,c} P_i^* q_i - \sum_{j=l,x} P_j^* q_j y^* = \Pi^* + P_l^* E + S$

As a consumer, the household chooses the level of consumption which maximizes its utility under the full income constraint. This leads to a consumption system;

$c_k = c_k\,(p_a^*, p_m, p_l^*, y^*; z^b)$, $k = a, m, l$

Equilibrium conditions for non-tradables:

$c_a\,(p^*, y^*; z^h) = q_a\,(p_a^* p_c^* p_l^* p_x^*; z^q)$

$c_l\,(p^*, y^*; z^h) = E - q_l(p_a^* p_c^* p_l^* p_x^*; z^q)$

Solving these equilibrium conditions for the shadow prices of non-tradables:

$p_j^* = p_j^*\,(p_c p_x p_m; z^q, z^b, E, s)$, $j = a, l$

The p^*, for non-tradables are a function of the prices of the tradable consumption goods and ofz^q, z^b, E, s. Therefore;

$q_i = q_i\,(P_a^*, P_l^* p_c p_x; z^q)$, $i = a, c, l, x$

$c_k = c_k\,(P_a^*, P_l^* p_m y^*; z^b)$, $k = a, m, land$

$p_j^* = p_j^*\,(p_c p_x p_m; z^q, z^b, E, s)$, $j = a, l$

Hence, household characteristics in consumption (z^b), total time endowment (E),exogenous cash transfer(S) and consumption prices(p_m) affect production decisions as opposed to the separable household model. By substituting the expression just derived for the shadow prices p_j^* into production and consumption decision can give the reduced form as below;

$q_i = q_i\,(p_c p_x p_m; z^q, z^b, E, S)$, $i = a, c, l, x$

$c_k = c_k\,(p_c p_x p_m; z^q, z^b, E, S)$, $k = a, m, l$

Non-tradables prices (shadow prices) play a similar role to tradables' prices in the decision process of the household. When they apply, the shadow prices are equal to marginal utility of the consumption of food and leisure, and marginal productivity of labor. They indicate the price that the household would be willing to pay to have the corresponding constraint relaxed by one unit.

2.4. Empirical results with non-separable household model

2.4.1. Market failures in food and labor in Africa

According to Sadoulet and Janvry (1999), the following features have been assumed in the model; Products - a cash crop and food crop, Factors -labor and fertilizer, and Consumption - food, manufactured goods and home time (leisure). Four alternative structural conditions considered were; market failure for both food and labor, market failure for labor only, market failure for food only and no market failure (perfect market exists for features

considered). The model questions how household respond to 10% increase in price of cash crops, manufactured goods and productivity of food crops (technological change) respectively and the result is depicted on the table (1). When there are no market failures at all, the household increases factor use and shifts its resources from food, with a 5.4% decline in production, to cash crops which increases by 9.9% (Sadoulet and Janvry, 1999). As real income increases, more food, manufactured goods, and leisure are consumed. Since both home time and labor used in the production rise, the hiring of outside labor increases by 6.1% to fill the deficit. And since less food is produced while more is consumed, demand for food on the market increases by 7.9%. When both the markets fail, by contrast, the elasticity of supply response of cash crops drops from 0.99 to 0.18, showing very little response (Janvry*et al.,* 1991). This is due an inability to reduce food production by any significant amount, since the family needs to feed itself while income rises, with only some substitution in consumption between food and the manufactured good, and an inability to use more labor in production since the consumption of leisure rises slightly as income improves. Output response mainly comes from increased use of fertilizer. On the consumption side, the reward to household is increased consumption of manufactured goods. When the labor market fails but the food market is used, the shock can be exported on the food market. The household responds by shifting out of food production and buying food instead, as demonstrated by an elasticity of cash crop production of 0.93. This allows an increase in food consumption, but without corresponding increase in leisure, since the family needs to produce a labor effort. When it is only the food market fails, response in cash crops is enhanced as revealed by an elasticity of 0.55, by hiring labor from outside. This allows an increase of consumption of leisure, but not that of food, which declines slightly as resources are shifted to cash crops.

Table 1; Simulation results under four types of market failures

	Impact of 10% increase in the price of cash crops				Impact of 10% increase in the price of manufactured goods				Impact of 10% increase in productivity of food production			
	Market failures				Market failures				Market failures			
	Percentage change over base				Percentage change over base				Percentage change over base			
Consumption	Food and labor	Labor	Food	None	Food and labor	Labor	Food	None	Food and labor	Labor	Food	None
Food	-0.5	3	-0.8	2.1	1.1	1.8	1	1.7	8.8	4.5	8.8	3
Leisure	0.4	0.6	4	2.7	0.2	0.3	0.9	0.6	0.8	0.5	1.3	3.9
Manufactured good	15.8	7.7	9.5	5.6	-12.8	-15	-14	-15	1	11.4	0.2	8
Production												
Food crop	-0.5	-6.4	0.8	-5.4	1.1	-0.2	-1	-	8.8	16.4	8.8	18
Cash crop	1.8	9.3	5.5	9.9	-1.7	-0.1	-1	-	0.7	-8.8	1.2	-7.7
Fertilizer	4.7	2.8	3.1	2.2	0.5	0.1	0.2	-	0	2.4	-0.2	1.5
Labor	-0.6	-1	3.9	1.7	-0.4	-0.4	0.5	-	-1.2	-0.7	-0.6	3.7
Prices												
Food crop	8.8	-	5.8	-	1.9	-	1.3	-	-11	-	-11.4	-
Cash crop	10	10	10	10	-	-	-	-	-	-	-	-
Fertilizer	-	-	-	-	-	-	-	-	-	-	-	-
Labor	9.3	4.5	-	-	1.7	0.7	-	-	1.3	7.4	-	-
Manufactured good	-	-	_	_	10	10	10	10	_	_	_	_
Net labor supply	-	-	-10.6	-6.1	-	-	-1.7	-0.8	-	-	-1.7	-9.7
Market surplus of food	-	-10	_	-7.9	-	-0.2	_	-1.5	-	10.3	-	12.7

Note: the sign (–) indicates that no changes relative to base value Source; Janvry, Fafchamps and Sadoulet, 1999

3. CONCLUSION

Under perfect market conditions all products and factors are tradable and opportunity cost of any product or factor held by household is its market price. Under this condition, separability holds, and the producer side of the model can be solved prior to consumer (worker) side, with farm profits serving as the hinge between the two problems. Ownership of the variable factors is irrelevant for production decisions and affects consumption decisions only through income level, which is its self determined by ownership.

This separation, however, is often less clear-cut for agricultural households in lower income countries. The household may be the locus for both consumption and production. Farm household cannot be viewed as separately or independently maximizing profits as a producer and utility as consumer. Households in developing countries are systematically exposed to market imperfections and shadow prices play a similar role to market prices in the decision process of the household. When they apply, the shadow prices are equal to marginal utility of the consumption of food and leisure, and marginal productivity of labor. They indicate the price that the household would be willing to pay to have the corresponding constraint relaxed by one unit. Hence, household characteristics in consumption, total time endowment, exogenous cash transfer (S), and consumption prices affect production decisions as opposed to the separable household model.

4. RECOMMENDATION

Depending on the review undertaken the following recommendation has been given;

- ✓ Transaction costs should be reduced to narrow the gap between purchasing and selling prices, and increase market participation of households.
- ✓ Enhancing infrastructural and institutional facilities such as market information and road are necessary to reduce market failures and increase farmers gain from their product.
- ✓ Enhancing of multi-purpose agricultural cooperatives to reduce the number of middle men involved in the market and increase farmers gain from the market.

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