Rationing and Peasant Household Behaviour

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Andrew McKay and Alemayehu Seyoum Taffesse

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Centre for the Study of African Economies
Institute of Economics and Statistics
University of Oxford
St Cross Building
Manor Road
Oxford OX1 3UL

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1 Introduction

In many developing countries, a large proportion of agricultural production is undertaken by small-scale peasant households. Such peasant households are typically complex economic units, given that they are engaged, inter alia, in the economic activities of production, consumption and factor supply. Notwithstanding such complexity, an accurate characterisation of their behaviour is important from the point of view of development policy. This is especially the case with regard to their responsiveness to price and other market signals.

This issue is of particular importance for stabilisation and structural adjustment policies, many of which place emphasis on raising the prices of key cash crops in the hope of generating a strong supply response. Other components of such programmes, such as exchange rate devaluation or the removal of subsidies, may affect, intentionally or incidentally, prices of other agricultural inputs and outputs, and consumer goods. The production and welfare consequences of such changes is an issue of considerable policy importance; these consequences will depend on how, and to what extent, peasant households respond to changing prices.

Empirical evidence suggests that supply response in agriculture is weak, at least at the aggregate level (Binswanger et al, 1987) and perhaps also at the level of individual crops (Bond, 1983). Historically, evidence of this type was used to counteract concern about the effects of the anti-agricultural terms of trade bias resulting from development strategies based on the extraction of agricultural surplus. In the present context, such evidence suggests that attempts to reverse this terms of trade bias, which are often implicit or explicit elements of structural adjustment and stabilisation policies, may only have limited effects on increasing agricultural production and reducing rural poverty.

In the light of this and other issues, the question of the behaviour of peasant households has attracted significant attention in the economic literature, from both theoretical and empirical points of view. In this regard, the models associated with the names of Barnum and Squire (1979a) and Singh, Squire and Strauss (1986a, 1986b) represent seminal contributions. These models capture the various household decisions in a framework incorporating the conventional microeconomic theory of consumer and producer behaviour. Implicit in such models is the assumption that peasants are potentially responsive to price. However, a number of studies have recognised that the markets in which peasants operate do not necessarily function perfectly; peasants may face rationing in some markets (Bevan, Bigsten, Collier and Gunning, 1987; Berthelemy and Morrisson, 1987),

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1 In this regard, de Janvry, Fafchamps and Sadoulet (1991) distinguish two schools of thought in characterising peasant behaviour: a "substantivist" school, in which peasants are regarded as not engaging in optimising behaviour and as being unresponsive to market signals, and a "formalist" school, in which peasants are characterised by optimising behaviour, and so will respond to market signals.
whereas other markets may be absent (Strauss, 1986; de Janvry, Fafchamps and Sadoulet, 1991). This absence or imperfection of markets will not only constrain household choice in the markets directly affected, but also in other markets in which they transact. Such market failures might be expected to reduce the responsiveness of peasant households to price and other signals. They might also be expected to have adverse effects on welfare and agricultural output.

Based on the assumption that peasant households are potentially responsive to market signals, but are frequently constrained in their response by market failures, this paper seeks to set out a general model of peasant behaviour in an environment of rationed or missing markets, and to trace out the implications for production and consumption behaviour. Starting from the major contribution of Strauss (1986), to whose formulation this paper owes much, we seek to set out a general model which encompasses existing models of peasant households in the literature, but which generalises and develops them in some directions.

The paper is organised as follows. Building on a behavioural model of a peasant household in the absence of rationing (set out in section 2), a general model of a rationed peasant household is set out in section 3, based on a generalisation of Strauss's (1986) model. The comparative static properties of the model are then examined in two sections, with section 4 deriving general expressions applying to changes in any exogenous variable and section 5 discussing specific instances, in particular the effects of changes in prices. Section 6 concludes.

2 The Basic Model

As noted above, the purpose of this section is to state a general model of an agricultural household developed by Strauss (1986) such that:

(a) the similarities of other relevant models can be highlighted;

(b) the conditions of recursiveness are spelt out; and

(c) the basic framework for (later) analysing rationing is defined.

Consider a farm household which:

(a) maximises utility subject to a production function, a cash income (or explicit budget) constraint, and a time constraint;

(b) produces a food crop \( (Q_a) \), a part of which it consumes, and a cash crop \( (Q_c) \), all of which it supplies to the market.\(^3\)

\(^2\)Here we just summarise the Strauss (1986) model with the same notation, though making some relations and results more explicit or concise.

\(^3\)As noted by Strauss (1986), we can have more than one food crop, cash crop, variable input, fixed input and consumption good. In this case vectors rather than scalars have to be used.
(c) applies its own labour \((F)\) in farm production; and

(d) participates in the labour market.

\[ \text{2.1 Assumptions} \]

In this section the following assumptions are made:

(a) All relevant markets exist and clear, and the household is a price-taker in all of them.

(b) There exists a single household utility function \((U)\), with household consumption of the food crop \((X_a)\), a market purchased consumer good \((X_m)\) [for greater relevance we call this a manufactured consumer good], and leisure \((X_l)\) as its arguments, which is twice continuously differentiable, monotonically increasing and quasi-concave.

(c) The farm production technology is expressed by an implicit production function \(G(Q_a, Q_c, L, V, A, K) = 0\), where \(L, V, A,\) and \(K\) are total labour input, a variable input, land area, and a fixed input respectively. This function is twice continuously differentiable, increasing in outputs and decreasing in inputs, and quasi-convex.\(^4\)

(d) Farm production is risk-free.

\[ \text{2.2 The Model} \]

Under these assumptions, the short-run (i.e. single agricultural cycle) optimisation problem of the farm household becomes:

Maximise: 

\[ U(X_a, X_l, X_m) \quad (2.1) \]

subject to:

cash income constraint:

\[ p_m X_m \leq p_a (Q_a - X_a) + p_c Q_c - p_l (L - F) - p_v V + E \quad (2.2) \]

time constraint:

\[ X_l + F \leq T \quad (2.3) \]

production function:

\[ G(Q_a, Q_c, L, V, A, K) = 0 \quad (2.4) \]

\(^4\)This general formulation in terms of an implicit production function is a more general formulation than having separate explicit production functions for the cash crop and the food crop. Specifically, the former representation encompasses the latter.
where: \( p_i \) = market price of commodity \( i, i = a, l, m, c, v; (Q_a - X_a) \) = marketed surplus of the food crop; \( (L - F) \) = hired labour [hired-in if positive, hired-out if negative]; \( E \) = non-wage, non-farm, net other income; \( T \) = household's time endowment.

Assuming that constraints 2.2 - 2.4 bind, and substituting for \( F \) in 2.2 from 2.3, we can write the Lagrangean as:

\[
\phi = U(X_a, X_l, X_m) + \lambda_1 [p_l T + (p_a Q_a + p_c Q_c - p_l L - p_v V) + E - p_a X_a - p_l X_l - p_m X_m] + \lambda_2 [G(Q_a, Q_c, L, V, A, K)]
\]

(2.5)

With interior solutions, first order necessary conditions are:

\[
U_a = \lambda_1 p_a
\]

(2.6)

\[
U_l = \lambda_1 p_l
\]

(2.7)

\[
U_m = \lambda_1 p_m
\]

(2.8)

\[
p_l T + (p_a Q_a + p_c Q_c - p_l L - p_v V) + E = p_a X_a + p_l X_l + p_m X_m
\]

(2.9)

\[
p_l = -\frac{\lambda_2}{\lambda_1} G_l
\]

(2.10)

\[
p_c = -\frac{\lambda_2}{\lambda_1} G_v
\]

(2.11)

\[
p_a = \frac{\lambda_2}{\lambda_1} G_a
\]

(2.12)

\[
p_c = \frac{\lambda_2}{\lambda_1} G_c
\]

(2.13)

\[
G(Q_a, Q_c, L, V, A, K) = 0
\]

(2.14)

where: \( U_i = \frac{\partial U}{\partial X_i} \), partial derivative of \( U \) with respect to its \( i^{th} \) argument \( (i = a, l, m) \); \( G_j \) = partial derivative of \( G \) with respect to its \( j^{th} \) argument \( (j = a, c, l, v) \).

Strauss (1986) shows that totally differentiating these first order conditions results in a block-diagonal system of equations. In other words, the model is recursive. It means that production and consumption decisions, though temporally simultaneous, are logically separable such that the household makes the former independently and incorporates them in reaching the latter. This separability requires the following assumptions relating to goods both produced (or used in production) and consumed by the farm household (Strauss, 1986):

(a) the markets for all such goods exist and clear;

(b) the household is a price-taker in all these markets; and
(c) such goods are homogeneous.\textsuperscript{5}

Given recursiveness, the logical sequence of optimisation then is:

(a) Maximise full income by maximising farm profit subject to the production function and given the levels of fixed inputs and input/output prices [2.10 - 2.14 in the above set of conditions]. This solves for output supplies and input demands, a solution which can be summarised by a profit function $\pi$:\textsuperscript{6}

\[ \pi = p_a Q_a + p_c Q_c - p_l L - p_v V = \pi(p_a, p_c, p_l, p_v, A, K) \] (2.15)

Thus we have maximised full income, $Y_f$, as:

\[ Y_f = p_l T + [p_a Q_a + p_c Q_c - p_l L - p_v V] + E = p_l T + \pi(p_a, p_c, p_l, p_v, A, K) + E \] (2.16)

(b) Maximise utility subject to the full income constraint and given consumption goods’ prices [2.6 - 2.9 in the above set of conditions]. This gives Marshallian (or uncompensated) commodity demands:

\[ X_i = X_i(p_a, p_l, p_m, p_l T + \pi(p_a, p_c, p_l, p_v, A, K) + E) \] (2.17)

where: $i = a, l, m$.

Moreover, once leisure demand is known, family farm labour supply is determined by the constraint $X_i + F = T$.

The above utility maximisation can be formulated as an expenditure (or cost of utility) minimisation problem using duality. Indeed, this reformulation plays a fundamental role in the analysis of rationing in later sections. In this regard, given the producer-consumer nature of the agricultural household, there is a need for defining an expenditure function equivalent to the pure consumer case. Two modifications are evident. First, the arguments of that function have to be net demands, with supplies defined as negative demands. Second, the exogenous income (expenditure) analogue, i.e. $E$, has to be used. In brief, the expenditure that the household minimises is:

\[ E = p_m X_m + p_l (L - F) + p_v V - p_a (Q_a - X_a) - p_c Q_c \] (2.18)

\textsuperscript{5}This assumption can be relaxed if we make, as we do, the common assumption of interior solutions (Strauss, 1986).

\textsuperscript{6}Note that by the properties of the production function, the profit function is convex in all prices, increasing in output prices and decreasing in input prices (McFadden, 1978).
The right hand side of 2.18 is the sum of the values of the net demands for all the commodities in the model. Once we substitute for \( F \) from the time endowment constraint and re- arrange, the household can be thought of as minimising \( E \) subject to the production function and to obtaining a given level of utility \( \bar{U} \), i.e.:

Minimise:

\[
p_a X_a + p_i X_i + p_m X_m - (p_a Q_a + p_c Q_c - p_i L - p_v V) - p_i T
\]

subject to:

\[
U(X_a, X_i, X_m) \geq \bar{U} \tag{2.20}
\]

\[
G(Q_a, Q_c, L, V, A, K) = 0 \tag{2.21}
\]

Duality ensures that the first-order necessary conditions for this problem are the same as those of the utility maximisation problem. The resultant expenditure function is:

\[
e'(p_a, p_c, p_i, p_m, p_v, T, A, K, \bar{U}) = p_a X_a + p_i X_i + p_m X_m - (p_a Q_a + p_c Q_c - p_i L - p_v V) - p_i T \tag{2.22}
\]

\( e' \) is the minimum exogenous income (expenditure) required to achieve \( \bar{U} \), and using 2.15 may be written:

\[
e'(p_a, p_c, p_i, p_m, p_v, T, A, K, \bar{U}) = e(p_a, p_i, p_m, \bar{U}) - \pi(p_a, p_c, p_i, p_v, A, K) - p_i T \tag{2.23}
\]

where \( e = p_a X_a + p_i X_i + p_m X_m \).\(^7\) We can have a more compact relation if we define a new full income \( Y_f^* = \pi + p_i T \). Then

\[
e'(\cdot) = e(\cdot) - Y_f^* \tag{2.24}
\]

Obviously, given the properties of \( \bar{U} \), \( e' \) is twice continuously differentiable and concave. Moreover, by Shepherd’s Lemma, its first order partial derivatives with respect to prices are Hicksian net demands, while those of \( e \) are Hicksian total demands. Accordingly, in order to equate Marshallian and Hicksian demands, we have to define the former at \( e' \) or, more precisely, in equilibrium \( E = e' \), so that:

\(^7\) Strauss (1986) suggests that \( e(p_a, p_i, p_m, \bar{U}) \) is the expenditure function which is required in order to relate compensated and uncompensated virtual prices. In fact, formally the dual of the utility maximisation problem of the agricultural household in general is the minimisation of \( E \). In the special case of a recursive model, however, the distinction between \( e' \) and \( e \) is not crucial, since \( Y_f \) is exogenous to consumption decisions.
\[ X_i(p_a, p_t, p_m, e'(p_a, p_c, p_t, p_m, p_v, T, A, K, \bar{U})) = X_i^c(p_a, p_t, p_m, \bar{U}) \] (2.25)

with \( c \) denoting compensated demand. This equality holds even under rationing, except that in that case virtual prices have to be used.

Before we close this section, we briefly note the generality of the basic model considered above. Its generality follows from its ability to encompass most agricultural household models formulated in the absence of rationing, including the models of Barnum and Squire (1979a, 1979b); Singh, Squire and Strauss (1986a, 1986b); Lundahl and Ndulu (1987); and the recursive or sequential versions of the models of de Janvry \textit{et al} (1991), Benjamin (1992), Lambert and Magnac (1992). And as will be shown in the next section, the rationed version of this model is also able to encompass many of the models of agricultural household under rationing.

3 A general peasant household model with rationing

A number of strong assumptions underlie the peasant household model set out in the previous section. In this paper we wish to focus on the consequences of the relaxation of one of these assumptions, the assumption of the existence of, and absence of rationing in, all markets in which the household trades, whether as producer or consumer and whether as supplier or demander. The interest in relaxing this assumption stems from the fact that in many developing country contexts it is not an appropriate characterisation of the situation in which many peasant households find themselves. For a variety of policy, institutional, infrastructural and other reasons, many markets in rural areas may be subject to rationing (quantity constraints) or be missing; others may exist in general, although particular households may choose not to undertake transactions in those markets (de Janvry \textit{et al}, 1991). The rationing or absence of markets, whether it affects all or just some households, represents an additional constraint under which households operate which therefore must be taken into account in modelling their behaviour. Indeed, the failure to allow for rationing in a situation in which rationing is present will lead to misleading inferences.

In this section, the model of the previous section is modified to provide a general model of peasant household behaviour under rationing. In an analogous way to the case of consumer behaviour under rationing (Neary and Roberts, 1980; Deaton and Muellbauer, 1980) the rations may be incorporated by the inclusion of additional constraints in the model, taking the form of quantity constraints on the rationed commodity.

Of the five markets in which the household trades (those for the cash crop, the food crop, labour, the purchased input and the consumer good) it will be