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Chapter 8

PROGRESS IN THE MODELING OF RURAL HOUSEHOLDS' BEHAVIOR UNDER MARKET FAILURES

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1. HOUSEHOLD BEHAVIOR UNDER MARKET FAILURES

It is well recognized that, in the developing country context, rural households are systematically exposed to market imperfections and constraints, referred to as "failures", and their behavior cannot be understood without reference to the specificity of these failures (Thorbecke, 1993). In some cases, markets do not even exist. In others, high transactions costs must be incurred in accessing markets. In yet others, there are constraints on the quantities that can be exchanged. Market failures are so pervasive for farm households that they have been used as a definitional characteristic of peasantries (Ellis, 1993). In this context, key to the analysis of peasant household behavior is to identify the resource allocation, consumption, investment, and exchange strategies that they devise to reduce the welfare costs of these failures. These countervailing strategies demonstrate peasants' considerable creativity in attempting to derive maximum benefit from the meager resources they control in a particularly adverse context. Indeed, there exists a booming academic industry consisting in marveling about this "creativity in the context of adversity".

Modeling rural household behavior in the context of market failures implies non-separability between production and consumption decisions. This class of non-separable models was first introduced in Singh, Squire, and

Strauss's (1986) seminal book. It has been followed by an explosion of efforts in theory and empirical analysis to characterize the behavior of farm households. What did we learn from these models? How have they helped the specification of empirical strategies? How far have we progressed in measuring the transactions costs that are the causes of market failures? And what contributions have they made to the formulation of policies and programs for rural development and the struggle against rural poverty? It is to these questions that we try to answer in this paper on progress in rural household modeling. Interesting, in particular, is to try to assess in how much is peasant ingenuity in devising countervailing strategies able to shelter them from the welfare costs of market failures. We will see that many of these questions are still poorly addressed, leaving us with a rich research agenda, and some promising departures toward new answers.

In this review, we briefly present the conceptual framework used in formulating non-separable models. We then review many of the results obtained in using these models to understand farm household behavior, design policies and programs, define strategies for empirical analysis, and measure the transactions costs that are the causes of market failures. Finally, we identify new research initiatives that show promise in better explaining and measuring household behavior under market failures.

2. CONCEPTUAL FRAMEWORK

2.1 The concept of non-separability

In terms of model specification, presence of market failures leads to what has been called non-separability (Yotopoulos and Lau, 1974). A household model is said to be non-separable when the household's decisions regarding production (use of inputs, choice of activities, desired production levels) are affected by its consumer characteristics (consumption preferences, demographic composition, etc.). By contrast, in a separable model, the household behaves as a pure profit maximizing producer. The profit level achieved in turn affects consumption, but without feedback on production decisions.

Consider for example the case of variable transactions costs on the market for a food product. Take as a second market failure inexistence of a land market. In Figure 8-1, we represent the supplies of food, $S(p, z_{qi})$, coming from three households, $i = 1, 2, 3$, that own farms of different sizes z_{qi}. To facilitate comparison across households, we assume that they all have the same demand for food, $D(p, z_c)$, which depends on the characteristics z_c of the household as a consumer. Let p^v be the effective sale price (i.e., the market price p^m net of transactions costs t_p^v incurred in selling) and p^a the effective purchase price (that includes the transactions costs t_p^a incurred in buying) of the food product.

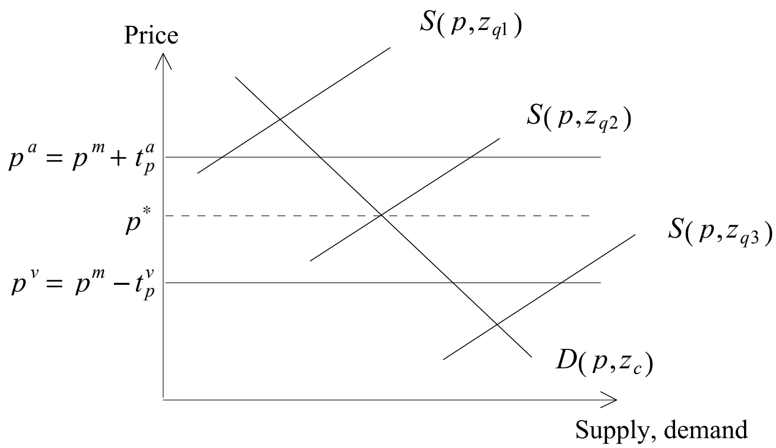

Figure 8-1. [Variable transactions costs and market participation]

This simple graph shows that the decision to participate in the market depends on the relative position of the household's supply and demand functions, and hence on its endowments in productive resources z_q and on its demand characteristics z_c. Because of transactions costs, there exists a non-zero price interval where households do not participate in the market. For these households (of type z_{q2} in the figure), it is optimum to remain in self-sufficiency and to adjust production and consumption decisions to each others. Their behavior is, consequently, of the non-separable type, and their internal equilibrium defines a shadow price $p^*(z_q, z_c)$ specific to each of them. Hence, to the heterogeneity in household resource endowments corresponds a heterogeneity in market participation decisions. A second source of heterogeneity can come from differences in transactions costs t_p^a and t_p^v across households.

In a similar fashion, variable transactions costs on the labor market induce a category of households to opt for an autarkic equilibrium with a shadow price of labor that breaks separability between their consumption and production decisions (Lopez, 1984).

As to fixed transactions costs, they enter in the household model as follows. Considering the case of a single market price (i.e., a case where there are no variable transactions costs), the relative positions of the household's supply and demand curves at that price determine the marketed surplus (which is negative in case of a purchase). When entering the market implies fixed costs, participation will only be preferred to autarky if the value of sales or purchases is sufficient to induce a gain for the household larger than the fixed costs incurred, which defines a minimum level of exchange MS_m to make the transaction worthwhile:

$$\left| q\left(p, z_q\right) - c\left(p, z_c\right) \right| \geq MS_m.$$

These minimum levels of sale or purchase determine again a category of households -- defined by their asset endowments, their preferences, and technology -- that choose autarky. They, too, will have a non-separable behavior. If both variable and fixed transactions costs exist, presence of fixed costs widens the price range over which household autarky is observed. While transactions costs may not be the only reason for food self-sufficiency, they are likely to be a major determinant of such behavior.

The third category of market failure, the case of a constraint on participation, is easy to understand. Once the maximum level of participation has been reached, the household must solve its internal equilibrium problem between residual supply and demand. This equilibrium defines a shadow price which is a function of the household's resource endowments, its characteristics in demand, and the level of the constraint. In this case as well, the choice problem consists in selecting an idiosyncratic non-separable equilibrium.

Lack of an insurance market, in combination with a market constraint or an imperfection on the credit market, induces households to manage their production decisions to reduce their consumption risk. Indeed, if households do not have access to complete insurance or credit mechanisms that allow them to smooth their consumption ex-post relative to a shock, they will adjust their income generation strategy to reduce income fluctuations (Alderman and Paxson, 1994). This adjustment generally implies a bias toward activities or technologies that are less risky, a greater diversification of income sources, in particular toward off-farm incomes that are less risky than farm incomes or with low covariation with those, storage behavior that accounts for food security considerations (Renkow, 1990; Saha and Stroud, 1994), and lower levels of investment, in particular in soil conservation (Holden, Shiferaw, and Wik, 1998; Shively, 2001).

2.2 Outline of a non-separable household model

Formalizing the behavior of a household under market failure requires specification of the particular types of failures to which the household is confronted. However, most of the commonly encountered market failures can be represented in the following generic model. The household maximizes the expected present value of a stream of utilities (1) under constraints (2) to (8) as follows:

(1) $$\max_{c_t, q_t, x_t, m_t, s_t} E\sum_t \beta^t u\left(c_t; z_c\right)$$

(2) $$\sum_{i=1}^{N}\left[\left(\left(p_{it}^m - t_{pit}^v\right)\delta_{it}^v + \left(p_{it}^m + t_{pit}^a\right)\delta_{it}^a\right)m_{it} - t_{fit}^v\delta_{it}^v - t_{fit}^a\delta_{it}^a\right] + T_t + s_t = 0, \quad \forall t,$$

(3) $$q_{it} - x_{it} + E_{it} - m_{it} - c_{it} = 0, \quad i = 1\ldots N, \quad \forall t,$$

(4) $$m_{kt} \leq \overline{M}_{kt}, \quad k \in K, \quad \forall t,$$

(5) $$G\left(q_t, x_t; z_{qt}\right) = 0, \quad \forall t,$$

(6) $$A_{t+1} = \left(1 + r_t\right)\left(A_t + s_t\right), \quad \forall t,$$

(7) $$A_t \geq A_{\min}, \quad \forall t,$$

(8) $$c_{it}, q_{it}, x_{it} \geq 0, \quad i = 1\ldots N, \quad \forall t.$$

In this model, the decision variables are the consumption vector c_t, the production vector q_t,[ii] the input vector x_t, the vector of marketed surpluses m_t (which is negative in case of a purchase), and the vector of savings s_t (which are negative in case of borrowing), for each year t. In equation (1), β is the rate of discount, and u the utility in period t, which is a function of consumption and of the characteristics z_c of the household's preferences. In the budgetary constraint for year t (equation 2), for each of the N goods or factors i, sales are characterized by $\delta^v = 1$ and $\delta^a = 0$ and purchases by $\delta^v = 0$ and $\delta^a = 1$. The sales price effectively received by a household is the market price p^m net of variable transactions costs t_p^v (which are proportional to the quantity exchanged), and the purchase price effectively paid is the market price net of variable transactions costs t_p^u. In addition, the household incurs fixed transactions costs t_f^v or t_f^u when he participates in the market. T represents exogenous sources of revenue, and s savings. Equation (3) specifies the equilibrium between availability and use of each of these products or factors, including the initial endowment E. Participation constraints to some markets can be written as inequalities (4), where K defines the set of goods that are constrained and M_{kt} the values of the constraints. Equation (5) represents the technology that links production, inputs, and fixed production factors z_q. Equation (6) specifies the law of motion of the (unproductive) asset A, as a function of the yield r_t and annual savings s_t. Inequality (7) specifies the constraint on the level of indebtedness.

This formulation thus captures both variable and fixed transactions costs (in equation (2)), risk aversion behavior (in the objective function (1)), participation constraints in some markets (4), and the credit constraint (7). Use of such a general model is, however, difficult and inefficient. For this reason, we will see that the analysis of specific combinations of market failures is better done in specialized models.

3. IMPLICATIONS OF NON-SEPARABILITY: BEHAVIOR AND POLICIES

3.1 Implications of market failures on transactions in non-failing markets

In the context of non-separability, the household's ability to respond to production incentives in a market without failures is affected by failures in other markets. This allows to explain aspects of household behavior that would otherwise appear irrational from an economic perspective. This is what led anthropologists from the substantivist school to reject the possibility of analyzing peasant behavior on the basis of economic rationality, calling instead on the role of rituals in exchanges or on an objective of simple reproduction of traditional needs (Polanyi et al., 1958). Construction of household models with failures on food, labor, or manufactured goods markets allows to explain these same behavioral patterns in the context of economic calculus. It is the incomplete performance of markets that induces patterns of behavior apparently contrary to economic logic, not a logic specific to peasant households that would remain to be uncovered.

Take for example the case of a farm household that produces food and cash crops and that faces two market failures, one in the food market and the other in the labor market (de Janvry, Fafchamps, and Sadoulet, 1991). An anthropologist from the substantivist school would observe with reason that a rise in the price of cash crops does not induce any notable response in the production of the latter. However, this lack of response does not come from absence of economic rationality. It derives first from lack of a food market which prevents the household from reallocating its land toward cash crops, in a context where income rose and also the desire to consume more food; and second from lack of a labor market that would allow to employ workers from outside in a context where the desire for additional leisure refrains increasing time worked by the household. Supply response in cash crops cannot come from a decline in food production nor from an increase in family labor. It is consequently confined to technological change, as observed in Guatemala by von Braun et al. (1989), or to an increase in the use of purchased inputs such as fertilizers that are partial substitutes to land and labor. It is consequently not surprising that peasant households' responses to price incentives in cash crops are low under these failures in other markets, to the despair of governments. Taylor and Adelman (2002) use a similar specification to analyze the impact of Mexican trade (NAFTA) and transfer (Procampo) policies on household behavior when labor and food markets may be missing. They find, not surprisingly, that these policy shocks under markets failures have, contrary to expectations of policy makers, remarkably small impacts on production and rural incomes. Embedding household models in a Computable General Equilibrium model, thus providing a rigorous micro-macro linkage, brings these results to the aggregate level. Löfgren and Robinson (2002) show that large transactions costs and the resulting regime switches in market participation by households in response to price and productivity changes create low aggregate response and discontinuities that differ markedly from the smooth responses with separable household models. Their results stress the importance of transactions costs in determining the aggregate gains from increases in the price of cash crops on international markets.

The same phenomenon occurs when it is the market for manufactured consumption goods that is failing. This was the case not only in the Eastern European economies, but also under the policy of industrialization by import substitution that endeared the price of industrial consumption goods in much of the developing world. In this case, forced savings create a disincentive to production of cash crops, resulting in an inelastic supply of these crops (Berthélémy and Morrisson, 1987; Azam and Besley, 1991).

Policy implications from these cross-market effects can be counter-intuitive. Technological change in the production of food crops helps increase the elasticity of supply response in cash crops. In the Sahelian zone of Burkina Faso, we showed that technological change in water harvesting for food crops helps increase the supply response in livestock which is the cash activity for these peasant households (Dutilly-Diane, Sadoulet, and de

Janvry, 2003). A decline in the price of manufactured consumption goods, for instance through trade liberalization when there were import tariffs, creates incentives to the production of cash crops. Conceptualizing household behavior in non-separable models that take into account cross effects between failing markets (food, labor, manufactured consumption goods) and non-failing markets (cash crops, fertilizers) opens perspectives for the interpretation of household behavior and for the choice of policy instruments to use in raising their responsiveness to market incentives.

3.2 Nutrition, health, and productivity

Nutrition and health, like other dimensions of human capital, influence time worked and the productivity of labor, and hence also households' incomes and poverty. However, it is only when a household faces certain types of market failures that production decisions are affected by its own human capital endowment. This will be the case, for example, when health affects management capacity, a direct input in production that is not accessible through the market, or when family and hired labor are imperfect substitutes in production and health affects the wage received by efficiency unit (piece rates). This source of non-separability has been tested and rejected by Pitt and Rosenzweig (1986) and by Deolalikar (1988), while Strauss (1986) shows strong evidence of the positive effect of caloric intake on farm labor productivity. In a dynamic multi-stage household model, Behrman, Foster and Rosenzweig (1997) show evidence of differential productivity effects of calorie consumption at the harvest and planting stage in a sample of households from Pakistan. This suggests that farmers face large costs of transferring resources across stages, implying that improving the operation of the credit market would increase the productivity of small farmers.

3.3 Intensity of factor use and the inverse relation between yield and farm size

If there exists one relation that has captivated the imagination of development economists, it is existence of an inverse relation between yield and farm size. While empirical evidence is far from universal, this relation has been observed in a multiplicity of contexts of traditional agriculture (Berry and Cline, 1979; Carter, 1984; Benjamin, 1995; Barrett, 1996; Lamb, 2003). From an economic policy perspective, implications of this relation are enormous in as much as it helps justify redistributive land reform in terms of efficiency gains, in addition to the obvious equity gains.

From a theoretical point of view, this relation has been attributed to presumption that the opportunity cost of family labor working on the farm is less than the prevailing wage (Barrett, 1996, points to an alternative explanation due to the presence of price risk). Smaller farms thus rationally use a production process that is more labor intensive and, in traditional agriculture where labor is the main variable input, obtain higher yields than larger farms that use hired labor. What household models under market failures contribute is a rigorous conceptualization of this hypothesis based on the differential opportunity cost of labor across farm sizes, and a broadening of the causes that can result in this inverse relation.

To focus on the fundamental role of labor allocation in a farm household, the consumption side of the household is reduced to a trade off between income and leisure. This is done by replacing the objective function in equation (1) by an additive utility in income and the utility for leisure. Transactions costs on labor come from the need to supervise hired labor. In Eswaran and Kotwal's (1986) model, the second market failure is an access to working capital that is proportional to productive assets needed as collateral. The combination of these two market failures leads to a differentiation across farm households, starting from the poorest who do not have enough resources to even make productive use of their own land, through small part time farmers that participate in the labor market, family farms that are self-sufficient in labor, up to large farms that hire labor that they must supervise. Along this gradient of asset endowments, that define farm sizes, one observes a rising labor cost, and hence an inverse relation between yield and farm size. It is important to recall that the mere existence of supervision costs would not be sufficient to produce an inverse relation (Feder, 1985). Indeed, if there were no other market failure, one should see farm sizes adjusting to labor availability.

It is obvious that empirical verification of this relation requires controlling for diseconomies of scale due to production technology and land quality. While there exists some empirical evidence both on existence of this relation and of supervision costs and other imperfections on the labor market (Frisvold, 1994), the link between these two phenomena is hard to establish. Yet, it would be important to know what part of this inverse relation is due to labor market imperfections, as opposed to technological choice, land quality, or measurement errors for example (Carter, 1984; Benjamin, 1995; Lamb, 2003).

3.4 Management of the intra-annual credit constraint

How a credit constraint is managed should be analyzed in a model that endogenizes savings and credit. However, if one wants to concentrate on the problem of intra-annual credit mainly linked to the seasonality of agricultural costs and incomes, leaving aside considerations of risk and investment, a static annual model reveals a number of interesting phenomena.

The following model is simplified in only considering one period t, and in replacing the savings determination equations (6) and (7) by a static borrowing constraint, for example by setting savings s_t equal to zero. A simple way of formalizing the liquidity constraint for the lean season is to consider the inputs and the goods produced and consumed during the two seasons as different commodities. Let I_k be the set of factors and production or consumption goods during the lean season. Monetary transactions on these products and inputs are constrained by availability of financial liquidity:

$$(4) \qquad \sum_{i \in I_k} \left[\left(p_i^m - t_{pi}^v \right) \delta_i^v + \left(p_i^m + t_{pi}^a \right) \delta_i^a \right] m_i \leq \overline{L},$$

where $\overline{L}$ represents the liquidity available at the beginning of the period. Constrained optimization leads to the definition of a shadow price for liquidity, λ_c, and to what can be called decision prices, equal to transactions prices increased by the implicit value of liquidity:

$\left(p_i^m - t_{pi}^v \right) \left(1 + \lambda_c \right)$ for sales, and $\left(p_i^m + t_{pi}^a \right) \left(1 + \lambda_c \right)$ for purchase.

Hence, even though transactions are done at market prices net of transactions costs, decisions are taken using higher prices. In these conditions, the household will bias its decisions in favor of activities that generate (for sales) or save (for purchases) liquidity. Using a simulation model calibrated for Moroccan households, we show that the credit constraint reduces the capacity of households to take advantage of opportunities offered by a rise in the price of cereals as a consequence of trade liberalization policies, and increases family labor participation in the labor market to generate a flow of liquidity necessary for the agricultural activities (de Janvry, Fafchamps, Raki, and Sadoulet, 1992). These results stress the importance of accompanying the incentive policies for agricultural production with a complementary policy of access to credit for working capital in order to derive full benefit from the new incentives.

Feder, Lau, Lin, and Luo (1990) verified empirically the relevance of this model for a sample of Chinese households. They show that the liquidity available at the beginning of the season affects the level of production of households that are constrained in accessing credit, but not that of other households. Vakis (2002) shows that while credit constraints dramatically decrease adoption rates of potato high yielding varieties in Peru, farmers alleviate these constraints by diversifying their source of through inclusion of cash generating activities such as milk production. Note that identification of the regime to which households belong cannot be done on the basis of the mere observation that households receive credit or not: households that receive credit may be constrained or not on the amount received, and households that do not receive any credit may be excluded by available supply or be on their demand functions. Feder et al. are in a favorable situation where existence of a constraint was made explicit in the survey. In other situations, estimation of the regime to which households belong has to be done on the basis of observed behavior (Carter and Olinto, 2003).

The intra-seasonal specificity of this theory is better captured in a model that explicitly considers the asymmetry between the two seasons, as done by Key (2000). He shows that, when households are constrained on the credit market, the opportunity cost of liquidity is given by the conditions under which savings are made. In terms of economic policy for rural households, this result points to the importance of improving the institutions and instruments used for savings, and not only access to credit.

3.5 Response to food price risk through self-sufficiency

Under insurance market failures, a quasi universal circumstance for small holders, a household subject to a credit market constraint is unable to perfectly smooth its consumption. It is consequently led to use additional instruments, in particular in adjusting its income generation strategy and production decisions. Analysis of the household's adjustment to this situation, including optimal management of savings-credit decisions and production decisions, requires an inter-temporal model. Nevertheless, a number of intuitions about adjustments in production behavior can be derived from a simplified model that does not include optimization on behavior toward savings-credit. One can use a static model without inter-period transfers, like the one in the previous section. The household allocates its resources in production to optimally manage a trade-off between income level and variability. This static approach likely exaggerates the need for adjustment in production since it forces all risk management on a single instrument.

A particularly interesting case in the context of a household model is that of response to food price risk. Under food price risk, portfolio theory predicts that a risk averse producer will reduce production. Consider, however, a farm household that consumes all or part of its food production. And only consider those households that participate in the food market, as sellers or buyers, since they are the only ones subject to price risk on this market. Finkelshtain and Chalfant (1991) show that, in response to price risk, these farm households reduce their food production, but less than would a producer who is not also a consumer. And this all the more that their share of home consumption in production is high and that they are risk averse. Intuition for this result is as follows: the fact of producing food with a price that fluctuates creates a positive correlation between income (imputed for home consumption) and the price of the consumption good. This correlation "protects" the consumer from price fluctuations in as much as income rises and falls along with the price of the consumption good. Food production thus acquires an insurance value, additional to its normal contribution to income. This additional marginal value induces a bias in resource allocation toward food production, thus partially correcting the negative impact of risk on production. This reasoning rationalizes a frequent observation like what farm households perceive food self-sufficiency as a source of protection against price risks in food markets. Fafchamps (1992) develops this model when there are two competing crops, a cash crop and a food crop, with risks on both prices and yields. He shows that the rise in food production at the cost of cash crop production is all the more important that price risk is high and that correlation between price and yield is high, a phenomenon that is accentuated by market segmentation. The same reasoning on self-insurance applies to production of feed crops that serve as inputs into other activities. Note, however, that this self-insurance via the home production of consumption goods has an efficiency cost in as much as it creates a distortion in resource allocation toward food production. Models of storage motivated by risk aversion and considerations of food security have been developed by Renkow (2000) and Saha and Stroud (1994).

These analyses highlight the importance of policies to reduce transactions costs and to promote market integration in order to lower price fluctuations and the correlation between prices and local production. They also show the role of a "consumption" credit system that would free households from the need to self-insure their subsistence needs.

In spite of its conceptual importance, this approach has not been accompanied by systematic empirical analyses. Is the phenomenon quantitatively important? Is insurance through food self-sufficiency only of marginal importance relative to other determinants of food production? One would like to have answers to these questions. Difficulty with empirical analysis consists in the need to jointly estimate production and consumption behavior. In a recent analysis on a sample of villages in Pakistan, Kurosaki and Fafchamps (2002) estimated this type of structural model and showed that price risk on feed in itself reduces by 20% the area planted in basmati rice, resulting in a 9% welfare loss. If these results are confirmed in other studies, it will become clear that the good performance of markets as politically sensitive as those for food and feed should have high priority in economic policy.

3.6 Risk management in a context of insurance and credit market failures

As indicated above, inter-temporal modeling is needed to analyze responses to risk using credit and savings as instruments. Under insurance market failure, responding to risk calls upon two types of mechanisms. Mechanisms to protect (or smooth) consumption at a given level of income, and mechanisms to reduce exposure to risk through adjustments in income strategies. Consumption smoothing is done through insurance (mutual insurance in particular), and through credit and savings. Income strategies to reduce risk include contracts (e.g., sharecropping), the choice of activities, and production decisions. These two dimensions of risk-reducing strategies are not independent. Indeed, in as much as adjustments in production imply efficiency costs, optimal use of these risk management instruments depends importantly on possibilities and costs of ex-post smoothing.

We do not consider in this paper the literature on consumption smoothing (and the credit and savings instruments used) where implications on production decisions are not taken into account (see Deaton, 1992). This excludes, in particular, the very important literature on the consequences of market failures in credit and insurance on nutrition and health. We do not consider either the literature on contracts, even though risk management through contracts such as sharecropping influences production decisions (see Hayami and Otsuka, 1993). It calls on a conceptual framework that does not directly belong to household modeling. We consequently limit ourselves to analyses that explicitly link risk management to production decisions in the context of a household model.

In these inter-temporal analyses, the basic model is generally simplified by only considering one consumption good, one production good, and neither transactions costs nor constraints on markets for these goods. Thus, equations (2) to (4) in the general model are replaced by:

$$(2') \qquad p_{ct}c_t + s_t = \pi_t + w_t L_t, \quad \forall t,$$

where π_t represents profit in period t, and $w_t L_t$ potential income to family labor L_t paid at the wage w_t. Production behavior (5) is directly specified in a profit function:

$$(5') \qquad \pi_t = \pi\left(p_t, A_t, \varepsilon_t, d; z_q\right), \quad \forall t,$$

where p_t represents the price of the production good, A_t productive assets, and ε_t risk. The decision variable d is added in an ad-hoc fashion to indicate the possibility of choice of an income strategy (choice of technology, level of diversification in crops, etc.).

In this model (composed of equations (1), (2'), (5'), (6), and (7)), one can distinguish two processes that link risk management to the production and income strategy. One comes from the use of productive assets (A) as savings instruments, and the other from the choice of productive resources and labor allocation in order to reduce income risk, i.e., the choice of d in the profit function.

An important feature of rural households' saving behavior is that nearly all the assets they own contribute directly to production. However, only assets that can easily be transformed into cash can additionally provide insurance services. This insurance function gives them an additional value and induces a distortion in the optimum assets portfolio relative to a portfolio for expected profit maximization. Use of a productive asset for insurance purposes has a double implication for income generation. On the one hand, its insurance function induces the household to over-invest in this liquid asset; on the other hand, in as much as accumulation and decapitalization follow the needs for insurance, households that have suffered a series of negative shocks are under-capitalized relative to the optimum for production. These shocks can push the household into a vicious circle of decapitalization, higher risk, and poverty traps.

This differential insurance function of assets is illustrated in a pioneering article by Rosenzweig and Wolpin (1993) where they contrast investments in oxen and irrigation pumps in India's ICRISAT villages. Using the same information, Fafchamps and Pender (1997) show that a potentially highly profitable investment in irrigation pumps is made both less attractive due to its irreversibility and more difficult because of its indivisibility. In this context, a policy of investment subsidies would have little impact, when access to credit (for insurance) would induce a strong increase in investment. Dercon (1998) uses a similar model to show that poor households specialize in low return, low risk activities as imperfect credit market limit their entry into the lumpy and profitable investment in cattle.

In the context of insurance market failures, households are induced to follow less risky income strategies. Morduch (1990) thus showed that credit constrained households adopt a more diversified crops portfolio and use less high yielding varieties that are more profitable but also more risky. Rosenzweig and Binswanger (1993) show that the degree of adjustment that households make in their investment decisions in response to risk depends on their ability to smooth consumption. The contribution of their analysis consists in the identification of two different aspects of the relation between wealth and portfolio risk. On the one hand, wealth can have a direct impact on portfolio choice, in as much as richer households are less risk averse. They can consequently choose a more risky assets portfolio. On the other hand, and this is the phenomenon we are interested in here, wealth that also indicates access to ex-post consumption smoothing instruments, enables households to engage in less ex-ante risk management. This relation is established by showing that the link between climate risk and portfolio choice declines with household wealth. Recognizing that the agricultural cycle extends over the year, Fafchamps (1993) estimates a production model with progressive revelation of uncertainties and sequential decision-making. He shows that poor farm households in Burkina Faso respond to climate risk by choosing flexible production techniques that enable them to adjust their decisions in response to random events.

These arguments are, in essence, present in Eswaran and Kotwal’s (1989) paper where they use an extreme form of liquidity contrast in considering that savings can only take the form of non-productive monetary reserves or of irreversible productive investments. They use a two-periods model to show that development of consumption credit as an instrument for insurance would facilitate adoption of new technologies for two reasons: first by releasing for investment resources otherwise held to respond to shocks; and second by allowing households to assume higher risks. Thus, risk aversion and the need for self-insurance affect the structure of capital accumulation, and they force rural households into long term income generation strategies.

4. GUIDE FOR EMPIRICAL ANALYSIS STRATEGIES

4.1 The first tests of non-separability

The concepts of a household’s subjective equilibrium and of the shadow price of family labor derive from Chayanov’s (1925) analyses of peasant households’ time allocation between production and leisure. Through the 1950’s and 1960’s, this analysis of household behavior under market failures has been revisited, formalized, and expanded, notably by Nakajima (1970), to culminate in Singh, Squire, and Strauss’ edited book (1986). This collection of articles, considered as the fundamental reference in the field of household behavior, offers a formal analysis of the household model under market failure, and considers different types of market failures that lead to non-separability. The sources of non-separability discussed in that book are in particular: the combination of an imperfect substitution between off-farm labor and farm labor for household members, with an imperfect substitution between hired labor and family labor on the farm; presence of a margin between the prices of labor sold and hired (that can come from transportation costs) resulting in a price band and in a self-sufficiency zone; credit rationing combined with fixed factors in production; and insurance market failures combined with a credit constraint.

The first tests of non-separability used the reduced form of a household model. One of the consequences of non-separability is that the household's characteristics in consumption z_c affect production decisions. These tests yielded mixed results. For example, Lopez (1984) rejected separability with Canadian data, Benjamin (1992) could not reject it with a sample of Javanese rural households as well as Bowlus and Sicular (2003) with a sample from China, and Grimard (2000) rejected it for Côte d'Ivoire. One could likely explain these differences by calling upon differences in context, even though in this particular contrast one would have expected more market imperfections in Java than in Canada. However, the more fundamental weakness of these studies is that they do not recognize heterogeneity in the household population, even though it is so clearly emphasized in the theory. As we have seen above in the case of a price band, non-separability is an idiosyncratic characteristic of a household and not of the market. Even when the context is not specific to each household, as would be the case if transactions costs were the same for all, households' responses, especially in terms of their decision to participate or not to the market, are specific to each. In this context, the result one can expect from a global estimation is unclear at best.

Recognizing household heterogeneity in the analysis creates difficulties. It requires a more structural approach that considers more explicitly the prevailing types of market imperfections. We will see in the following sections what progress has been made in this direction.

4.2 Direct measurement of the shadow price of labor

Rural labor markets are ridden with imperfections. It is important to first recognize the heterogeneity of what is called "labor": heterogeneity of workers' qualifications and tasks, heterogeneity due to seasonality. For some of these labor categories, a market simply does not exist, particularly for child labor and, in many cultural contexts, for female labor outside the family enterprise. Unemployment on the labor market places a constraint on time worked. Difficulty to find workers in peak seasons creates a constraint for employers. In addition, some supervision is necessary to counteract moral hazard behavior among hired labor (Frisvold, 1994). All these market imperfections create a situation whereby the marginal productivity of labor is not necessarily equal to the wage observed on the market. We will see in the following sections that credit market imperfections can also lead to a separation between marginal productivity and labor cost. Whatever the cause, comparisons between labor productivity and the observable market wage reveal market imperfections and situations of non-separability.

Many analyses have thus attempted to estimate the marginal productivity of labor, by estimating either a production function (Jacoby, 1993; Skoufias, 1994; Lambert and Magnac, 1992; Bhattacharyya and Kumbhakar, 1997) or a cost function. From a production function, Jacoby and Skoufias derive a measure of the marginal productivity of labor for every household. For the subset of household members that also work outside the farm, and for whom we have an observed wage (mainly men), the comparison can be made by regressing marginal productivity on wage. All these analyses reject equality between wage and marginal productivity of labor, and hence reject separability of production decisions. The approach followed by Lambert and Magnac allows for a better characterization of heterogeneity. This is because they can calculate for every household the average value and the standard deviation of marginal productivity. This allows them to test individually for each household the equality between marginal productivity of labor and wage offered. They derive from this a classification of households depending on whether separability is rejected or not. Applied to the LSMS for Côte d'Ivoire, they find that one can reject equality between labor productivity and wage for 90% of men, but only for 50% of women, the others having a productivity significantly lower than the wage. Bhattacharyya and Kumbhakar use a parametrization of shadow prices that they make a function of fixed factors and exogenous prices. Estimation of an indirect production function (function of input prices and fixed factors) allows them to identify the shadow prices for all factors. In their data for Bengal, they find large distortions on labor and draft animals relative to other inputs, with the surprising result that large farms under-value these two inputs more than small farms.

Even though the approach is undeniably interesting, the quality and credibility of these results crucially depends on specification of a production function. One has to admit that to represent an agricultural production process that unfolds over several months, with shocks, sequential decisions, irreversible choices, and complementarities and substitutabilities among inputs, by a production, cost, or profit function as simple as a Cobb-Douglas, or even a Translog, can make every production economist skeptical. The consequence is that the quality of estimations is weak, and inaccuracies in the measurement of marginal productivities very large.

4.3 Transactions costs, market participation, and supply and demand functions

The analysis of transactions costs and of the magnitude of transactions made on a particular market is illustrated in Figure 8-1. Note first an important result, though frequently neglected in empirical analyses: there is a single reference price for the production and the consumption of a particular household. This means that, for a net buyer, the opportunity cost of production is the purchase price of the product; and that for a net seller; the opportunity cost of consumption is the sales price. As a result, analyses of supply that consider the "producer price" as the reference price for all producers, and analyses of demand that take the "consumer price" for all households, are incorrect.

Consider for instance the case of a food item that is produced and consumed (without initial endowments and not used as an input). Assume that all other goods are exchanged on markets at exogenous and observable prices (that can be sales or purchase prices). Solution of the model leads to the definition of a shadow price p^* for the self-sufficient household equilibrium:

$$q\left(p^*, p_q; z_q\right) = c\left(p^*, p_c, y^*; z_q\right),$$

where p_q and p_c represent price vectors for the other goods produced and consumed, and y^* is the household's income in which food production q is valued at the shadow price. Following the notations in equation (2) above, this income can be written as:

$$y^* = p^* q + p'_q q_q + T,$$

where q_q represents the vector of other production goods (factors and products). This shadow price is thus function of the prices of all consumption and production goods, of fixed factors z_q and z_c, and of exogenous transfers T. With no fixed transactions costs, one can show that participation in the food market depends on the value of this shadow price relative to the two boundaries of the price band, $p^m - t_p^v$ and $p^m + t_p^u$. With fixed costs, market participation will only occur if the gain in utility is sufficient to compensate for the fixed costs. Denoting indirect utility by V, which is function of prices and income, the rule for market participation as a seller is thus:

$$V\left(p^m - t_p^v, \left(p^m - t_p^v\right)q + p'_q q_q + T - t_f^v; z_c\right) \geq V\left(p^*, y^*; z_c\right). \quad (9)$$

The left hand side term measures the utility level for the seller household for whom the price of the food product would be $p^m - t_p^v$ and income would be reduced by the fixed cost t_f^v. The right hand side term measures utility under autarky. We can thus show that entry into the market as seller occurs when p^* reaches not $p^m - t_p^v$ but an even lower level, and that, upon entering, the seller sells a finite quantity, not an infinitesimal one. A similar reasoning on the side of purchasing shows that the household will only enter the market as a buyer when its shadow price will be sufficiently above the upper boundary $p^m + t_p^a$ of the price band.

The supply function, that includes these market participation decisions, takes the shape ABB'C'CD as shown in Figure 8-2.

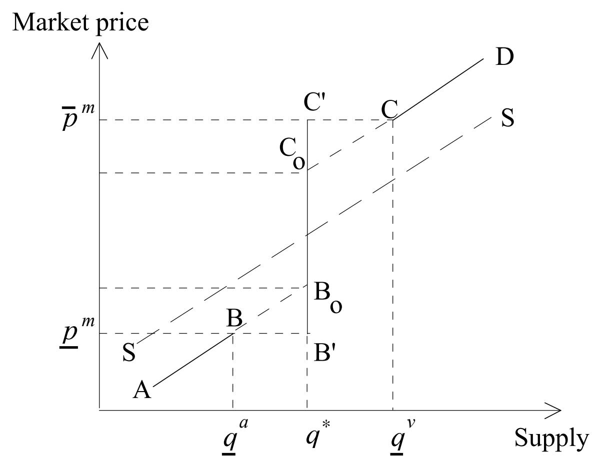

Figure 8-2. [Supply response when there are fixed and variable transactions costs]

When the market price is below the $\underline{p}$ threshold, the household is a net buyer and produces along the line segment AB. When the market price exceeds this threshold, the household becomes self-sufficient and produces q^*. Note the discontinuity in production from $\underline{q}$ to , which indicates that, the moment the household enters the market as a buyer, he buys the quantity $q^{*} - \underline{q}$. The household remains in self-sufficiency between the two thresholds $\underline{p}$ and $\overline{p}^m$, beyond which he enters the market as a seller with production $\overline{q}$, and a minimum sales threshold $\underline{q} - q^{*}$. We are far from the simple supply function SS that would hold if there were no transactions costs.

Different empirical strategies have been used to estimate this complex supply function (and hence also the underlying behavioral response SS without transactions costs). Note first that a simple estimation that does not account for transactions costs would consist in fitting a line to the observations. It would estimate an elasticity much lower than that which motivates the underlying producer behavior.

A first empirical problem is about the measurement of transactions costs. Few transactions costs are directly observed and measured in household surveys. More fundamentally, while some of the transactions costs are observable (such as transportation costs, labor supervision costs, travel time, etc.), others such as the time and effort necessary to collect information and to carry negotiations are hardly so, and they are likely to be large as shown in a study of Peruvian transactions on potato markets done by Vakis, Sadoulet, and de Janvry (2003).

One can, however, observe the factors that determine the transactions costs. Using this approach, Goetz (1992) estimated the participation decisions to the grain market in Senegal as seller or buyer, using a bivariate probit corresponding to the reduced form in equation (9). Conditional on this decision, quantities sold or purchased can then be estimated. An interesting result from this analysis is to be able to decompose the impact of a rise in the price of grains between entry of new sellers and increase in the sale of producers already engaged in the market.

Making more explicit use of the existence of production thresholds $\bar{q}$ and $\underline{q}$ identified above, we were able to identify separately the determinants of fixed and variable transactions costs though a joint estimation of these thresholds and of the supply function for the corn market in Mexico (Key, Sadoulet, and de Janvry, 2000). While we did not get to the point of actually measuring the size of these transactions costs, those are clearly identified on Figure 8-2 (the distance B_oC_o is exclusively determined by proportional transaction costs, while distances BB' and CC' are exclusively determined by fixed transactions costs in entering the market as buyer and seller, respectively). Fixed and variable transactions costs can thus be measured through the estimation of such a semi-structural model. Note also that if one draws the demand curve, both transactions costs can also be recovered from the observation of purchases by buyers and sales by sellers.

In a study of the rural labor market, we followed rigorously the concept of price band and estimated the participation decision as an ordered probit (for the shadow price p^*) with idiosyncratic thresholds for each household, representing the opportunity cost of selling and buying labor (Sadoulet, de Janvry, and Benjamin, 1998). Using the same theoretical framework, but observing the purchasing and selling prices for all individual households, and hence implicitly the proportional transaction costs they would face, Renkow, Hallstrom and Karanja (2004) are able to quantify the fixed transactions costs facing households from Kenya. They find that on average fixed transactions costs are equivalent to a 15% ad-valorem tax (but as high as 70% for some households), while purchasing prices are on average 35% above selling prices. Finally, Skoufias (1995), using a simpler specification of transactions costs, estimated directly net land rental, jointly for tenants and landlords, as a friction model.

All these approaches differ in their characterization of transactions costs and especially in their econometric specification of the distribution of error terms. None is yet fully satisfactory in either of these dimensions. None has yet succeeded in rigorously estimating transactions costs. One can expect, however, that this approach could allow to identify non-observable transactions costs as revealed through the behavior they induce on markets.

An even more fundamental difficulty which remains to be overcome is the correct definition of regime. Indeed, in the price bands approach, one makes the assumption that there is no constraint on the level of market participation. This assumption is likely to be valid for product markets, but it is generally too restrictive for the labor market. When there is unemployment, many households may not be able to work the desired amount, even though they participate in the labor market. Market participation in this case does not allow to identify the constrained regime. What is necessary, then, is to identify the regime on the basis of the determinants of behavior (separable or non-separable) and not observed participation (see Carter and Olinto, 2003, for the credit market; Vakis, Sadoulet, de Janvry and Cafiero, 2002, for the labor market). A more satisfactory approach would be to make sure that household surveys collect information not only on quantities purchased or sold, but also on the possible existence of constraints, thus avoiding having to rely on econometric techniques to reveal these constraints.

5. WHAT HAVE WE LEARNED FROM MODELING HOUSEHOLD BEHAVIOR UNDER MARKET FAILURES?

We have seen that farm households, in the context of developing economies, are systematically embedded in complex configurations characterized by incomplete and failing markets (Thorbecke, 1993). This opens the door to the analysis of their behavior through the formulation of non-separable models where consumption and production decisions are jointly determined to accommodate these failures. We have reviewed the theoretical and empirical contributions that followed this approach, taking as a starting point the seminal advances made by contributors to the book by Singh, Squire, and Strauss (1986).

A <u>first conclusion</u> that derives from this review is that many observed behavioral patterns would be incomprehensible without taking into account the specificity of the context of failing markets where farm households make their decisions. In the papers reviewed, we have seen that this is in particular the case for: (1) The way health, nutrition, and education decisions affect production choices. (2) How market participation decisions are made and the conditions under which participation occurs. (3) Supply response to price incentives when there are fixed and proportional transactions costs. (4) Reasons for the existence of an inverse relation between productivity and farm size. (5) Implications of failures on some markets for behavior on complete markets. (6) Management of the credit constraint when insurance markets are not accessible. (7) Responses to price risks on food markets when risk coping instruments are missing.

There are of course many aspects of household behavior that still require interpretation, leaving us with an array of unresolved Schultzian puzzles. This includes, for instance, imperfect risk sharing within households (Goldstein, 2000), and observations of low levels of adoption of profitable activities, such as pineapple production in Ghana (Goldstein and Udry, 1999) and fertilizer use in Kenya (Duflo, 2003), that cannot be explained by insurance or credit market failures. Further theoretical and empirical work on household behavior under market failures is thus needed to address these puzzles.

The possibilities for farm households to adjust their behavior in order to optimize the use of their resources in a context of imperfect markets, however creative and ingenious their strategies may be, are sharply limited by their assets positions and by the contexts where they operate. Their limited access to productive assets and the unfavorable contexts where they operate result in high levels of risk aversion and credit market failures. In this fashion, poverty changes the set of options available to households, making poverty hard to escape (Duflo, 2003). One can wonder how close to a first best situation do these countervailing strategies allow households to get. Ten percent or ninety percent? And what is the cost of these responses? Here is where we still lack empirical evidence. This is consequently the <u>second conclusion</u> that we derive from this review. The important theoretical advances on household behavior under market failures that have been made starting in the early 1980's, and that were subsequently pursued in a multiplicity of directions that we reviewed here, leave us with a large gap in empirical validation and confirmation of the importance of these phenomena. Many theoretical propositions that derive from non-separability are all too often blindly accepted as truths when they remain to be empirically verified, their order of magnitude in explaining observed behavior remains to be ascertained, and their usefulness in the design of policies to be shown. Heterogeneity of rural household behavior, given their control over assets and the particular contexts where they make decisions, remains to be characterized. Gains to be derived from differentiated policies will not materialize until this heterogeneity has been sufficiently quantified.

If transactions costs are large, they need to be measured and explained. We have argued that attempting to observe them directly will always underestimate their importance, quite likely by large amounts. We showed, however, that they can be derived from observed behavior. This, however, requires the construction of structural models where behavior is specified. Lack of direct data is thus replaced by structural models, and the quality of the models will determine the quality of the measurements made. These household models need to capture the relevant dimensions of behavior, given assets and a particular context. Our third conclusion is thus that making advances in the measurement of transactions costs will require improved specification of structural models, which in turn requires better understanding of what processes make transactions costs so pervasively large for poor farm households. This may require imaginative field work and interdisciplinary efforts to better specify the dimensions of behavior under market failures. Structural household models have been estimated by Fafchamps (1993) and Kurosaki and Fafchamps (2002). In spite of progress in computational capacity, these models remain cumbersome to estimate. Specification and estimation of semi-structural models as in Key, Sadoulet, and de Janvry (2000) are more likely to provide a compromise between precision in the specification of behavior and empirical expediency.

It is thus important to conclude cautiously when observing rural households' response strategies to market failures, however clever they may be. These countervailing strategies likely only compensate for a small fraction of the market failures under which households operate, in part because the effectiveness of these strategies is itself limited by poverty, and they are generally implemented at very high costs in foregone expected incomes. Cunningness under low assets endowments and extensive market failures is unlikely to be sufficient to enable rural households to overcome poverty.

NOTES

[i] We thank John Strauss for useful comments and references.

[ii] Time is treated as a commodity used as input under the form of labor and as a consumption good under the form of leisure. Labor market participation is considered as an activity that uses labor as the only input.

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