How to make a milk market: A case study from the Ethiopian highlands

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G. Holloway, C. Nicholson, C. Delgado, S. Staal and S. Ehui

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

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Authors' affiliations

Dr G. Holloway, International Livestock Research Institute, Addis Ababa, Ethiopia
Dr S. Ehui, International Livestock Research Institute, Addis Ababa, Ethiopia
Dr C. Nicholson, Department of Community Development and Applied Economics, Burlington, Vermont, USA
Dr C. Delgado, International Food Policy Research Institute, Washington DC, USA
Dr S. Staal, International Livestock Research Institute, Nairobi, Kenya

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Abstract

Some smallholders are able to generate reliable and substantial income flows through small-scale dairy production for the local market; for others, a set of unique transactions costs hinders participation. Co-operative selling institutions are potential catalysts for mitigating these costs, stimulating entry into the market, and precipitating growth in rural communities. Trends in co-operative organisation in East African dairy are evaluated. Empirical work focuses on alternative techniques for effecting participation among a representative sample of peri-urban milk producers in the Ethiopian highlands. The techniques considered are a modern production practice (crossbred cow use), a traditional production practice (indigenous cow use), three intellectual-capital-forming variables (experience, education and extension) and the provision of infrastructure (as measured by time to transport milk to market). A Tobit analysis of marketable surplus generates precise estimates of non-participants' 'distances' to market and their reservation levels of the covariates—measures of the inputs necessary to sustain and enhance the market. Policy implications focus on the availability of crossbred stock and the level of market infrastructure, both of which have marked effects on participation, and, inevitably, the social returns to agro-industrialisation.

1 Introduction

A healthy, enlivened debate at the recent conference 'Agro-industrialization, globalization and economic development' (Nashville, Tennessee, USA, 5–6 August 1999) supports two conclusions. First, while we are reasonably sure about the *ceteris paribus* impacts of increased commercialisation in developing food systems, we know less about its 'trickle-down' effects on the rural poor, their predisposition towards exchange, and the institutional and production innovations that underlie these impacts. Second, given the necessary data, there is enormous scope for empirical inquiry around these themes and the use of modern techniques to derive sound policy conclusions.

This paper considers one recent trend in the commercialisation of subsistence agriculture that has potential to catalyse market participation, enhance the velocity of transactions and sustain economic growth in rural communities. The topic is the emergence of co-operative sales organisations among resource-poor, dairy producers in peri-urban settings.

Small-scale dairy production is an important source of cash income for subsistence farmers in the East African highlands. Dairy products are a traditional consumption item with strong demand and the temperate climate allows the cross-breeding of local cows with European dairy breeds to increase productivity. Particularly where infrastructure and expertise in dairy processing exist, such markets allow smallholders to participate in the agro-industrial subsector and potentially in regional export markets and beyond. Moreover, growth in dairy demand in sub-Saharan Africa (SSA) is projected to increase over the next 20 years due to expected population and income growth. Milk production and dairy product consumption are expected to grow in the region of 3.8% to 4% annually between 1993 and 2020 (Delgado et al. 1999). Increased domestic dairy production has the potential in much of SSA to generate additional income and employment and thereby improve the welfare of rural populations (Walshe et al. 1991; Staal et al. 1997). However, there are concerns that the benefits of this expected growth may bypass resource-poor livestock producers unless specific policy actions are taken.

Barriers to smallholder participation in dairy production range from the availability and cost of animals to the labour needed to bring products to market. Despite the potential, smallholder participation in market-led dairy development has not been widespread in SSA outside of Kenya. Even in regions with favourable climates for livestock development, such as the Ethiopian highlands, participation in liquid milk markets by rural smallholders has been limited. Changes in sectoral and macro-economic policies are frequently necessary, but not sufficient, to provide the requisite incentives for smallholders to participate in markets.

Small-scale milk producers face many hidden costs that make it difficult for them to gain access to markets and productive assets (Staal et al. 1997). Among the barriers that may be influenced by policy are transactions costs—the pecuniary and non-pecuniary costs associated with arranging and carrying out an exchange of goods or services. The existence of relatively high marketing costs for liquid milk in Africa, the prevalence of thinness in liquid milk markets and the risk attached to marketing perishables in the tropics suggest that transactions costs play a central role in dairy production and marketing. Under such conditions, producer marketing co-operatives that effectively reduce transactions costs may enhance participation. Hence, it is vital to know what governments can do to better support these organisations and their emergence, and determine whether alternative institutions should be encouraged.

This paper explores the impact of household-level transactions costs and the choice of production technique on the decision of farmers to sell liquid milk to marketing co-operatives using a detailed sample of observations from the Ethiopian highlands (Nicholson 1997). Covariates representing factors affecting production, consumption and marketable surplus are examined to determine the extent to which they influence the milk marketing decision.

In the conceptual framework we use, transactions costs include not only the costs of exchange but also the complete set of costs implied when households must reorganise and reallocate labour to generate a marketable surplus. These costs may be substantial, may dominate other, observable (pecuniary) costs and therefore are scrutinised. In the interests of parsimony we focus on a set of factors conjectured to affect transactions costs, namely, a modern production practice (crossbred cow use), a traditional production practice (indigenous cow use), three intellectual-capital-forming variables (experience, education and extension) and the provision of infrastructure (as measured by time to transport milk to market). We compute estimates from a Tobit specification of marketable surplus and use the estimates to draw policy conclusions.

Chapter 2 provides a background on the transactions costs issue, considers co-operatives as examples of an agro-industrial innovation with the potential to catalyse the emergence of milk markets, and presents a brief introduction to the organisation of milk marketing in the Ethiopian highlands. Chapter 3 describes the household survey and presents the data. Chapter 4 motivates the Tobit model and presents results. Chapter 5 reports the policy-important distance estimates. Discussion and conclusions are offered, respectively, in Chapters 6 and 7.

2 Transactions costs, co-operatives and milk market development

Transactions costs are the embodiment of barriers to access to market participation by resource poor smallholders. They include the costs of searching for a partner with whom to exchange, screening potential trading partners to ascertain their trustworthiness, bargaining with potential trading partners (and officials) to reach an agreement, transferring the product, monitoring the agreement to see that its conditions are fulfilled and enforcing the exchange agreement.

The nature of milk and its derivatives in part explains the high transactions costs associated with exchanges of liquid milk. Raw milk is highly perishable and, thus, requires rapid transportation to consumption centres or for processing into less perishable forms. Further, bulking of milk from multiple suppliers increases the potential level of losses due to spoilage. These losses limit marketing options for small and remote dairy producers, increase transport costs and imply greater losses due to spoilage than for commodities such as grains. Because milk production typically is a year-round activity, dairy producers often must be concerned with maintaining outlets for their production.

The search for stable market outlets by producers is complicated by significant seasonal variation in milk production and dairy product consumption (Debrah and Berhanu Anteneh 1991; Jaffee 1994). In part due to high perishability, but also due to natural variation, milk quality is variable. Some of its properties (e.g. bacterial counts) are also not ascertained easily. Although not a perfect proxy, we conjecture that distance between production and purchasing points is highly correlated with quality, which declines rapidly after milking. The lack of easily measurable quality standards may also allow agents purchasing raw milk from producers to reject milk without just cause when they have contracted to purchase more milk than can be sold profitably.

Differential transactions costs among households stem from asymmetries in access to assets, information, services and remunerative markets (Delgado 1999). Handling these access problems requires institutional innovation. First, the asset-deficit problem of smallholders is often so great that a net transfer (such as a heifer) is necessary to induce entry. Second, technical and market information for new commercial items is more likely to be useful to individuals with higher levels of schooling, greater work experience, better access to management and technical advice, and better knowledge of market opportunities. Smallholders may require particular support in information and management. Third, access to services is often unequally distributed within communities. Poor infrastructure, low population density and low effective demand necessitate institutions for risk sharing and economies of scale in provision of agricultural services, especially in remoter areas. Fourth, better access to remunerative markets for high value-to-weight items is necessary for promoting growth of smallholder agriculture.

Co-operatives as catalysts

A common form of collective action to address access problems of this type is a participatory, farmer-led co-operative that handles input purchasing and distribution and output marketing, usually after some form of bulking or processing. Farmers gain the benefit of assured supplies of the right inputs at the right time. Frequently, these include credit against output deliveries and an assured market for the output at a price that is not always known in advance but is applied equally to all farmers in a given location and time period. Extension is sometimes part of the services provided, typically at higher levels (and quality) than state extension services. Co-operatives, by providing bulking and bargaining services, increase outlet market access and help farmers avoid the hazards of being encumbered with a perishable product with no rural demand. In short, participatory co-operatives are very helpful in overcoming access barriers to assets, information, services and, indeed, to the markets within which smallholders wish to produce high-value items.

Like contract farming, producer co-operatives can offer processors/marketers the advantage of an assured supply of the commodity at known intervals at a fixed price and a controlled quality. They can also provide the option of making collateralised loans to farmers. For processors or marketers, such arrangements eliminate the principal-agent issues faced by collectives and outgrower schemes in monitoring effort by the individual producer, providing better relations with local communities than large-scale farms, avoiding the expense and risk of investing in such enterprises, sharing production risk with the farmer and helping ensure that farmers provide produce of a consistent quality (Grosh 1994; Delgado 1999).

Producer co-operatives, however, are unlike contract farming schemes with respect to negotiations among different partners. If the issue in contract farming revolves around the power of farmers to negotiate with processors in producer co-operatives, the issue in the co-operatives themselves is the power of members, collectively, to hold management accountable. Producer co-operatives in Africa have had a generally unhappy history because of difficulties in holding management accountable to the members (i.e. moral hazard) leading to inappropriate political activities or financial irregularities in management (de Janvry et al. 1993; Akwabi-Ameyaw 1997) and also due to over-ambitious investment in scale and enterprises beyond management's capability. The degree of moral hazard seems to be greater if co-operatives are general in their orientations rather than created for specific purposes, such as farmer-run local milk marketing co-operatives in Uganda and Kenya (Staal et al. 1997). In Ethiopia, however, the perception exists (Nicholson 1997) that there may be enormous potential for their role, in concert with production innovations, as market precipitators.

Experience in Ethiopia

The traditional system of milk production in Ethiopia, comprising small rural and peri-urban farmers, uses local breeds, which produce about 400–680 kg of milk/cow per lactation period. More recently, intensive systems as diverse as state enterprises and small and large private farms use exotic breeds and their crosses, which have the potential to produce 1120–2500 litres over a 279-day lactation (Debrah and Berhanu Anteneh 1991). Fresh milk marketing is channelled through both formal and informal outlets, with informal markets supplying some 85% of total fresh milk in the Addis Ababa area (Staal 1995). The major formal outlets are dominated by a government enterprise called the Dairy Development Enterprise (DDE), which has established numerous collection centres that buy milk at a uniform government controlled price that requires no minimum delivery. In 1992–93, the DDE supplied 12% of total fresh milk sales in Addis Ababa (Staal 1995). The DDE is concerned primarily with liquid milk marketing, although it does make some cheese and yoghurt in its Addis Ababa processing facilities.

The informal fresh milk market involves direct delivery of raw milk by producers to consumers in the immediate neighbourhood and sales to itinerant traders or individuals in nearby towns. Milk is transported to towns on foot, by donkey, by horse or public transport and frequently commands a higher price than in the originating locale (Debrah and Berhanu Anteneh 1991). In Ethiopia, fresh milk sales by smallholder farmers are important only when they are close to formal milk marketing facilities such as government enterprises or milk groups. Results from a sample of farmers in northern Shewa in 1986 estimated that 96% of the marketable milk was sold to the DDE (Debrah and Berhanu Anteneh 1991). Farmers far from such formal marketing outlets prefer to produce other dairy products instead, such as cooking butter and cottage cheese (Table 1). In fact, the vast majority of milk produced outside urban centres in Ethiopia is processed into products by the farm household and sold to traders or other households in local markets.

Table 1. *Household sales composition and distance to market.*

	Distance from the DDE[1] collection centre	
	0–3 km	3–10 km
Milk sales (litres/household per day)	3.2	0.1
Butter sales (g/household per day)	7.0	96.9
Cheese (g/household per day)	0.0	11.3
Total milk equivalent (litres/household per day)	3.2	2.4

1. DDE = Dairy Development Enterprise.
Source: Debrah and Berhanu Anteneh (1991).

The other principal outlets for milk are 'milk groups,' which are milk marketing co-operatives recently established by the Ethiopian Ministry of Agriculture's Smallholder Dairy Development Project (SDDP) with the support of the Finnish International Development Association. The milk groups buy milk from both members and non-members, process it and sell the derivative products to traders and local consumers. Although the milk groups sometimes sell liquid milk products such as sour milk, skim milk or buttermilk, most of their revenue is generated by sales of processed dairy products, butter and cottage cheese (Nicholson 1997). The groups do not currently represent a significant source of fresh milk for either rural or urban markets.

3 Empirical application

The SDDP milk groups purchase raw milk from farmers, then use hand-operated equipment to process the milk into butter, local cottage-type cheese (*ayib*) and yoghurt-like sour milk (*ergo*). These dairy products are sold to local households, to local restaurateurs and to traders who, in turn, market them to major urban centres. Typically, the value added from processing the liquid milk into products (less funds retained for maintenance of the groups' facilities) is returned as a semi-annual, lump-sum payment to group members and others who have supplied the group during the period since the previous payment.

At the time of data collection four of these milk groups existed, two in the Shewa Region north of Addis Ababa and two in the Arsi Region near the regional centre Asela. The activities of these groups are focused exclusively on the processing and selling of dairy products. They provide no additional services (i.e. no credit, feeds, veterinary services etc.) to farmers nor to buyers and, therefore, represent the simpler end of the continuum of activities that co-operative organisations might undertake.

Although the number of farmers and the amount of milk received at each group is not a large proportion of regional totals, the formation of these groups has created a new outlet for sales of liquid milk by producers. Before the formation of the groups, the households processed nearly all locally produced milk into butter and *ayib*. Even now, most milk produced in these areas is marketed as home-processed dairy products and sold to traders or other households in local markets. Thus, the milk groups can be considered organisational innovations that increase the number of marketing options available to smallholder dairy farmers and mitigate some of the principal transactions costs that retard entry. We now turn to the identification of remaining factors (technology, infrastructure and household capital accumulation) that may forestall entry.

Data collection procedures

Data were collected from four rural communities called 'Peasant Associations' (PAs) (which are state-designated partitions of rural districts) near two of the four milk groups formed by the SDDP. Preliminary surveys were undertaken in December 1996 and January 1997 to ascertain the extent of crossbred cow ownership. On the basis of the preliminary surveys, the Mirti and Ashebaka PAs in the area of the Lemu Ariya milk group were selected from the Arsi Region, and the Ilu-Kura and Archo PAs were selected near the Edoro milk group in the Shewa Region. One PA in each region was close enough to the milk group that co-operative selling occurred; the other was distant enough that sales were precluded. None of the households in the Ashebaka and Archo PAs participated in the milk groups, whereas a proportion of the households in Mirti and Ilu-Kura PAs delivered milk to the groups.

A census of households in these four PAs was conducted to develop a sampling frame. Using the census results, a sample of 36 households was selected in each of the

PAs, stratified by whether the household owned crossbred cows, participated in the milk group and their distance to the milk group or to another local market where dairy products could be sold. During June 1997, baseline surveys of household characteristics and current cattle management practices were administered to 144 households. From June 1997 to October 1997, data on milk allocation and marketing, significant events occurring in the cattle herd (births, deaths, purchases, sales, illness etc.) and cow feeding practices were collected every 2 to 3 weeks.

From the survey, we focus on the 68 households in the Mirti and Ilu-Kura PAs for which samples were observed on milk sales in the 7 days before 3 respective visits, yielding a total of 1428 = 68 × 7 × 3 observations. Table 2 summarises the data by market participation status.

Table 2. *Selected characteristics of survey households, by market participation status.*

	Sample means (standard errors)	
	Sold to the milk group (168 observations)	Did not sell to the milk group (1260 observations)
Marketed surplus	4.07 (2.89)	- -
Number of crossbred cows t = 15.32	1.41 (0.99)	0.49 (0.69)
Number of local cows t = −1.81	1.26 (1.03)	1.42 (1.12)
Time to the milk group (min) t = −4.37	35.16 (18.76)	45.53 (29.94)
Farm experience of household head (years) t = −1.22	23.20 (12.58)	24.79 (16.21)
Formal schooling of household head (years) t = 0.22	1.96 (4.01)	1.90 (3.24)
Visits by an extension agent during past year t = 14.74	3.19 (3.59)	0.78 (1.66)

Note: t statistics (1426 degrees of freedom) reported for difference between means.

4 Estimation and results

We use a Tobit specification using a Markov-chain Monte Carlo (MCMC) method to derive estimates of the quantities of interest. Although relatively new, MCMC methods are now widely used in Bayesian inference; however, applications in development economics have thus far been few. Details of the procedure are presented in Chib (1992). His approach combines Gibbs sampling with data augmentation. Seminal contributions in these two areas are Tanner and Wong (1987) and Gelfand and Smith (1990) but very readable introductions are provided by Casella and George (1992), Tanner (1993) and Chib and Greenberg (1995).

The approach is motivated in three steps. First, household maximisation is formalised. Second, relaxing the non-negativity restriction on marketable surplus, a set of latent values are implied for the non-participating households. Third, because we observe the value zero for these households rather than the latent quantities, the data are censored and Tobit estimation is relevant.

Let $\Phi_i(\cdot)$ denote the level of some objective of interest in household 'i' (say, the level of expected utility); let $\varphi_i(\cdot)$ denote its first-order partial derivative with respect to variable v_i (the level of marketable surplus from the household); and let $x_i \equiv (x_{1i}, x_{2i}, \ldots, x_{mi})$ denote a vector of factors affecting the choice of v_i (the composition of the physical capital in the household, the physical distance that it resides from the market and the stocks of intellectual capital that the household has accumulated).[1]

Then, across each of the households i = 1, 2, ..., N, we are concerned with the problem:

$$(1) \quad \max_{V_i} \quad \Phi_i(v_i, x_i) \quad \text{subject to} \quad v_i \geq 0$$

the derivative condition on the objective function:

$$(2) \quad \varphi_i(v_i, x_i) \leq 0$$

the non-negativity restriction on marketable surplus:

$$(3) \quad v_i \geq 0$$

and the complementary-slackness condition:

$$(4) \quad \varphi_i(v_i, x_i)\, v_i = 0$$

1. As highlighted by an internal reviewer's comment, despite the generality afforded the analysis through the general specification of the objective function, it is important to recognise that it is some transformation of the value of marketable surplus to the household that is being maximised and not the quantity of marketable surplus itself. Marketable surplus is, of course, the choice variable at the household's disposal.

Ignoring the restriction in (3) for the moment and assuming strict equality in (2), a first-order MacLaurin-series expansion in the left-hand side yields:

$$(5)\quad \varphi_i + \varphi_{vi} v_i + \sum_{k=1}^{m} \varphi_{ski} X_{ki} = 0$$

where the function φ_i and the partial derivatives φ_{vi} and φ_{xki} k= 1, 2, ..., m, are evaluated at the point $v_i = 0$, $x_i = 0$. Acordingly, we have a (locally) valid expression relating the household's choice of v_i to the levels of the covariates, x_{ki}, k = 1, 2, ..., m, in the linear equation:

$$(6)\quad v_i = \beta_0 + \sum_{k=1}^{m} \beta_k x_{ki} \qquad i = 1, 2, ..., N$$

where $\beta_0 \equiv -\varphi_i \varphi_{vi}^{-1}$ and $\beta_k \equiv -\varphi_{xki} \varphi_{vi}^{-1}$, k = 1, 2, ..., m. But, when v_i is negative we actually observe zero and, therefore, the relevant statistical framework is the censored regression model:

$$(7)\quad Z_i = \beta_0 + \sum_{k=1}^{m} \beta_k x_{ki} + \varepsilon_i \qquad i = 1, 2, ..., N$$

where $\varepsilon_i \sim N(0, \sigma^2)$ and we observe $y_i = \max\{Z_i, 0\}$

Although some interest resides with the parameters in (7), our fundamental concern lies with the levels of the covariates that are required for participation in the market, that is, the measures beyond which positive marketable surplus is implied for the non-participants in the (censor) set $c \equiv \{ i : Z_i \leq 0 \}$. The values of interest follow naturally from setting marketable surplus to zero in (7); solving for each of the covariates:

$$(8)\quad \hat{x}_{ki} = \frac{\beta_0 + \sum_{j \neq k}^{m} \beta_j x_{ji} + \varepsilon_i}{-\beta_k} \qquad k = 1, 2, ..., m, \quad i \in c$$

and computing means across the set of non-participating households, say n in total:

$$(9)\quad \hat{x}_{ki} = \frac{1}{n} \sum_{i \varepsilon c} \hat{x}_{ki}, \quad k = 1, 2, ..., m$$

Table 3 reports results of the estimation. All but one of the covariates (experience) is significant at the 5% level. Thus, each of the other covariates has a significant impact on marketable surplus and, therefore, entry into the milk market. Focusing on the parameter estimates themselves, the addition of one crossbred cow increases surplus by about 4.4 litres of milk per day and the addition of one local cow increases surplus by about 1.8 litres—a clear and obvious difference between the modern and the traditional production techniques. Conversely, distance to market causes surplus to decline. We estimate that for each one-hour reduction in return time to walk to the milk group,

Table 3. *Marketable-surplus Tobit-equation estimates.*

Regressor	Estimate (standard error)
Number of crossbred cows	4.43 (0.38)
Number of local cows	1.81 (0.26)
Time to the milk group (min)	-0.06 (0.01)
Farm experience of household head (years)	0.0027 (0.0233)
Formal schooling of household head (years)	0.28 (0.10)
Extension agent visits during the past year	0.94 (0.11)
Constant	-12.40 (1.39)
Square root of the variance	27.47 (3.98)
	Summary statistics
	Uncensored observations
R^2	0.35
Positive predicted values	63
Negative predicted values	105
	Censored observations
R^2	0.98
Positive predicted values	21
Negative predicted values	1239

marketable surplus increases by about 3.5 litres. Of the capital-forming variables (experience, education and extension), education and visits by an extension agent are significant but marketable surplus is unresponsive to farm experience. The estimates of the responses to education and extension are, perhaps, more important for our study because these variables are potentially more likely to be affected directly by policy.[2] For each additional year of formal schooling of the farm decision-maker, daily marketable surplus increases by about 0.30 litres and, for each additional visit by an extension agent, increases by almost 1.0 litre. The summary statistics suggest a reasonable amount of fit given the high proportion of censoring in the sample—approximately 85% are non-participants.

2. One appealing interpretation offered by a reviewer is that the so termed intellectual-capital-forming variables are actually reflective of the household's ability-cum-inability to access information.

5 Distance estimates

Average distance estimates

Table 4 reports point estimates of the 'distance' statistics (equation 9). These estimates report levels of change in the covariates that are required, *ceteris paribus*, for the representative non-participant to enter the market. It is important to emphasise that these reports are in the nature of comparative static experiments wherein other possible changes are set to zero.

Table 4. *Distance estimates.*

	Distance estimate (standard error)
Marketable surplus	-9.81 (5.63)
Number of crossbred cows	2.52 (0.13)
Number of indigenous cows	6.45 (0.67)
Time to the milk group (min)	-114.26 (33.50)
Farm experience of household head (years)	-757.12 (58,289.48)
Formal schooling of household head (years)	45.26 (444.96)
Extension agent visits during the past year	10.43 (0.91)

The estimates for numbers of crossbred cows, numbers of indigenous cows, time to the milk group and extension are each significant at the 5% level; the estimate for marketable surplus is significant at the 10% level; years of farm experience and years of formal schooling are both insignificant. The results indicate that, to effect entry, the representative non-participant must increase surplus by about 9.8 litres per day. Such an increase, it appears, could be effected by a variety of (*ceteris paribus*) techniques, including additions to the milking herd of 2.5 crossbred animals or, instead, by an addition of 6.4 local cows, a feasible but nonetheless substantial increase in productive assets. Of the remaining covariates for which the distance estimates are significant, entry could also be effected by reducing transport time by almost 2 hours or by increasing the frequency of extension visits to around 10 per household per year.

In interpreting the figures, conceptual problems arise when the covariate coefficient estimate is negative. In this case, only the distance-to-market variable has a negative impact on marketable surplus (Table 1). When considering reductions in time to market as a feasible, *ceteris paribus* policy, the maximum reduction possible is, of course, bounded by the household's observed distance from the market. It follows that the range between zero and the household's actual distance dictates the feasible range for policy. The same is not the case for a covariate that has a positive impact on marketable surplus (as is the case, for example, with respect to crossbred cows, local cows and extension visits). In the latter cases, the feasible range for policy (although it is obviously bounded above by institutional and, possibly, political factors, let alone the respective costs of each policy) is not bounded in the same way. Put simply, when the estimated distance measure for the negative-impact covariate lies outside the stated range, reductions in the level of the variable *per se* is an infeasible policy for effecting participation.

Figure 1 illustrates the situation for three, hypothetical covariates. The vertical axis reports marketable surplus and the horizontal axis reports the corresponding covariate value. The respective line segments AB, CD and EF report the (hypothetical) relationship between marketable surplus and the three, respective covariates. The covariate corresponding to line segment AB has a positive relationship with marketable surplus whereas the covariates corresponding to line segments CD and EF have negative relationships. Note that the intercept values are different in all three cases. This observation is important and arises due to the fact that in each respective case, a different quantity (viz. the sum of the Tobit regression coefficients multiplied by the average values of each of the remaining covariates) is being held constant. Line segment AB signifies that (positive) quantity B is required for the agent to enter the market and that entry occurs at all covariate values to the right of point B. Line segment CD indicates that (positive) quantity C is required for entry and that entry occurs at all covariate values below quantity C. Line segment EF, however, predicts that (negative) quantity E is required for entry and that all quantities below E will also call forth entry. Clearly, when each of the covariates is positive valued—as they are, currently, in our empirical example—only quantities B and C represent feasible policies. Quantity E is an infeasible measure.

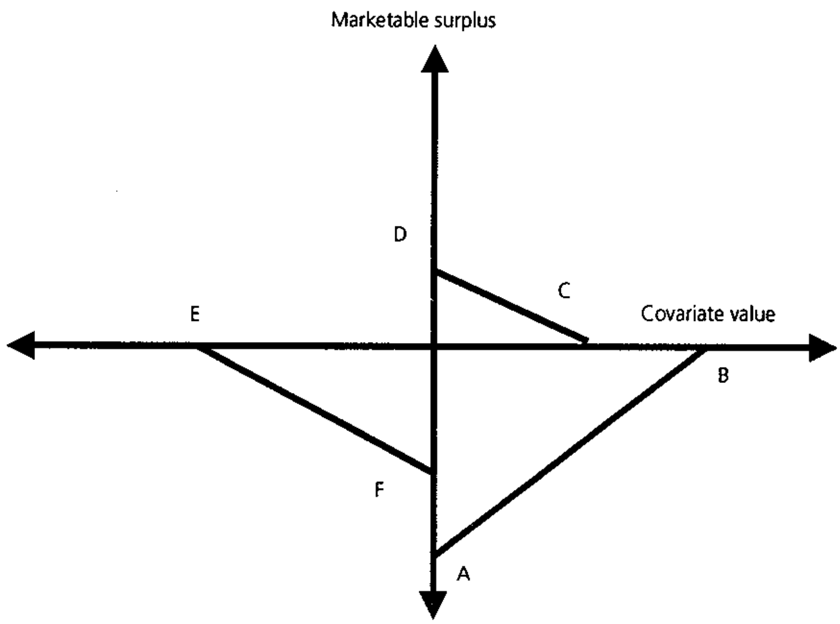

Figure 1. *Interpreting the distance estimates.*

The distance estimate corresponding to the time-to-market variable coincides with a situation like point F and line segment EF. The distance estimate, therefore, represents an infeasible, *ceteris paribus* policy. In comparing the distance-to-market estimate in Table 4 (-114 min) with the observed level for the average non-participant in the sample from Table 2 (46 min) we find that reductions in time to transport milk-to-market (whether enacted through improvements in infrastructure or through capital improvements leading to vehicular transport) is not a potent policy for the sample of households we are studying. However, increases in numbers of crossbred cows, local cows and visits by an extension agent appear to be feasible for the representative household. Recommendations about the impacts of increases in each of the other covariates (experience and education) are marred by lack of precision.

Individual distance estimates

Turning focus away from the average non-participant, a potentially revealing set of conclusions arises about the precise impacts of adjustments across the entire sample of non-participating households. Figures 2–5 plot the effects on participation of adjustments in the levels of crossbred cows, local cows, time to the milk market and visits by an extension agent when these adjustments are granted to each non-participant in the sample.

The regression model predicts that 84 households (observations) are participants, given their currently observed covariate endowments; and we study the required levels of adjustment needed to effect entry in the entire (1428 observations) sample. From Figure 2 we see that the rate of response of entry to a one-unit addition to the crossbred milking

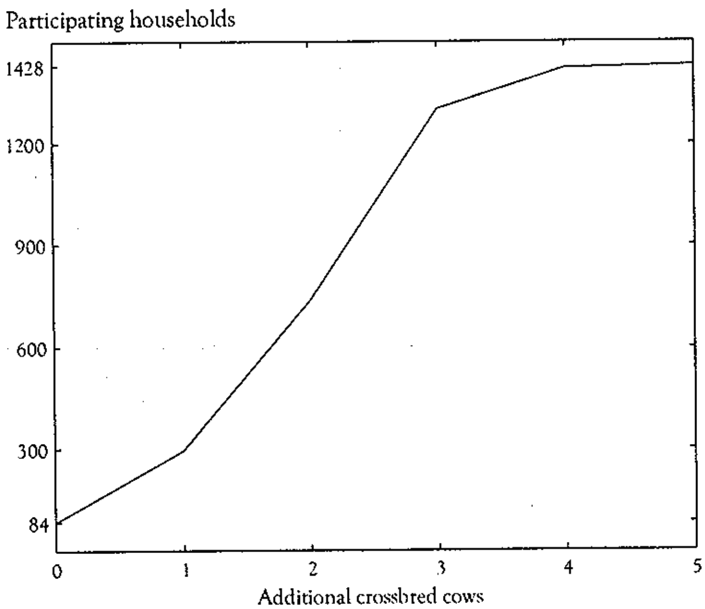

Figure 2. *Impact of crossbred cows on market participation.*

herd to each non-participant increases participation only slightly. More responsive rates are achieved with the second- and third-unit additions and only modest increments are achieved with the fourth- and fifth-unit additions, at which point the entire sample participates in the market.

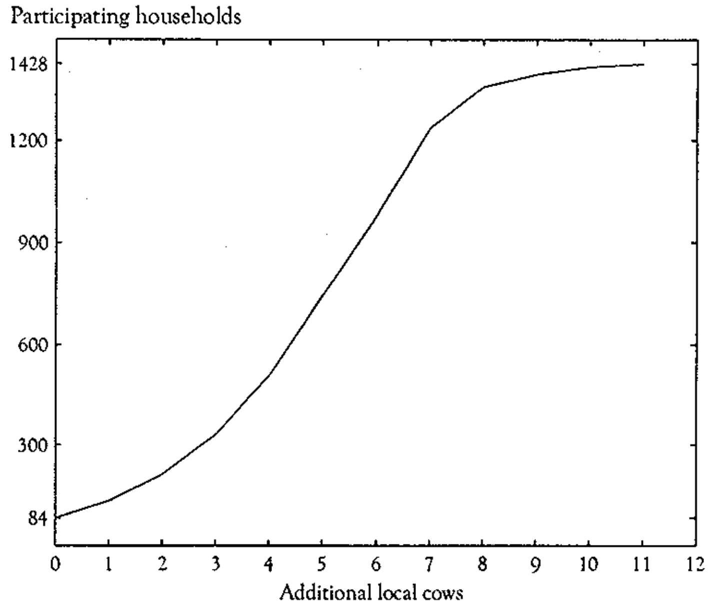

Figure 3. *Impact of local cows on market participation.*

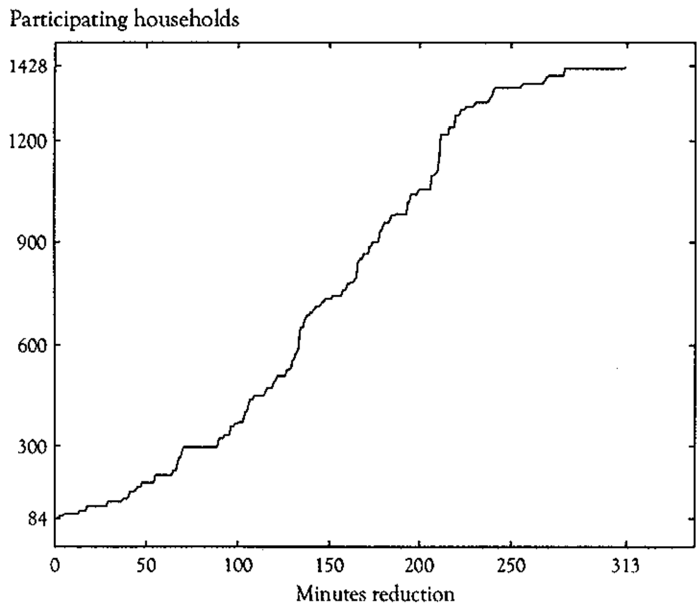

Figure 4. *Impact of distance on market participation.*

A similar relationship is observed in response to the addition of local milking cows (Figure 3). Responses per unit addition are lowest for the first three animals and for the last three animals but they are greatest for the fourth- to seventh-unit additions; the entire sample is predicted to participate if each non-participant is granted 11 additional animals.

Figure 4 reports rates of response to reductions in the time it takes to walk milk to the co-operative. In reviewing the figure, one must keep in mind that the maximum observed return time is 130 minutes. This figure should be compared with the estimated level that is required to effect entry for the entire sample, which is 313 minutes. The correct interpretation is that beyond the 130-minute reduction, the remaining impact of time reduction must be channelled through another source (say, additions to the milking herds or through extension) and must be equivalent in impact to a time reduction in the order of around 183 minutes.

Finally, responses to extension are quite linear (Figure 5), with the entire sample predicted to participate given an additional 20 visits per year.

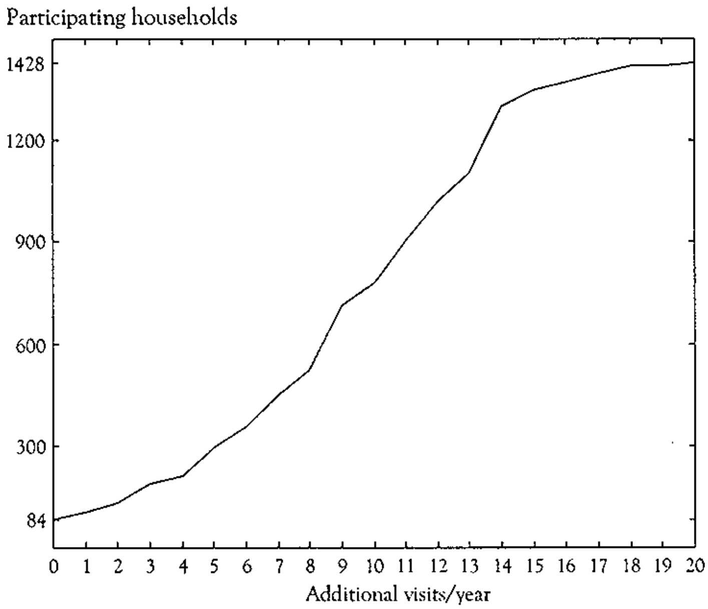

Figure 5. *Impact of extension on market participation.*

6 Discussion

The policy-relevant variables having the greatest impact on participation in liquid milk markets are cow numbers, time to the milk group and visits by an extension agent. Deriving a precise account of their impacts on marketable surplus from the household is, of course, difficult because without further restrictions on household preferences and technology, most comparative static effects are ambiguous. Nevertheless, a credible account proceeds as follows. The number of cows kept affects marketable surplus through both total production and the marginal costs of production. An increase in total milk production by the household decreases the marginal utility of milk consumption and, thus, should increase marketable surplus. In the case where additional cows lower marginal costs of production, this also increases marketable surplus because the household is assumed to equate marginal costs of production and milk price net of transaction costs. Finally, a higher marketable surplus per farm potentially reduces that farm's average costs of milk transfer to the group, as well as lowering average production costs on the farm. Thus, pooling activities, especially milk collection and transport activities, has potential to mitigate costs. However, problems of co-ordinating and monitoring agreements between participants and the costs engendered by such ventures is likely to dissipate any potential gains from exploiting scale economies.

Our empirical analysis does not distinguish among possible scale effects but this does not appear to be crucial for policy purposes given the net, positive impacts of cow numbers (of both breeds) on marketable surplus. The difference between the impacts of local and crossbred cows on marketable surplus and liquid milk market participation has more relevance for policy. In theory, the marginal costs of milk production are equated for crossbred and local cows if the household owns both types. However, not all households own both types of cows and other market imperfections (e.g. feed and services availability) may imply higher marginal costs for crossbred animals. Higher marginal costs for crossbred cows imply a negative gross effect (despite the positive net impact of crossbreds) on marketable surplus compared with local cows. The magnitude of this effect can be approximated using annualised milk yield per day for crossbred cows and local cows, and multiplying these by the 'distance' estimates from Table 4.

Annualised milk yields per day from a farm survey in the peri-urban area of Addis Ababa are 3.9 litres for crossbred cows and 1.2 litres for local cows. Multiplying these milk yields by the Tobit distance estimates of cow requirements (2.52 and 6.45 for crossbred and indigenous cows, respectively) daily milk production levels implied for market entry are 9.8 litres for crossbred cows and 7.7 litres for local cows. If the estimates reflected only the transactions costs related to the level of marketable surplus, we would expect the difference between these two values to be statistically insignificant. The difference in milk requirement is 2.1 litres, which appears to be fairly large when compared with the mean daily milk production from the sample (3.25 litres). Further, given the standard deviation of output in the sample (3.07 litres), the difference does not appear to be significant. In addition, since milk prices paid to farmers in this sample do not distinguish between milk from local and crossbred cows, milk quality can be assumed safely not to contribute to this difference. The difference can thus be presumed to relate to differences in technology (including scale effects). Thus the higher level of milk production needed from crossbred cows suggests that some 27% more 'milk production potential' (capacity) is needed in the form of crossbred cows compared with local cows to effect entry. Whether this is related to downside risk of disease, different feed requirements or differential scale effects on unit production and transfer costs, is uncertain. However, the size of the difference suggests that although transactions costs related to technological obstacles are evident, they are not insurmountable. Further, to the extent that policy and other interventions can reduce this difference in marginal costs, crossbred cows will have a larger impact on marketable surplus of liquid milk.

The Tobit estimate of time to milk group shows that sales to the milk group could be effected by reducing the milk delivery time from farm to collection point by an average of 114 minutes. This is clearly related to the transactions costs of reallocating family labour to milk delivery. Given the current limited number of milk groups in Ethiopia and the very large number of rural households with cattle, this result suggests a potentially simple policy intervention. Currently, many potential liquid milk-marketing households are hours distant from any milk group. Setting up new groups would clearly reduce the time to group for a number of households close to the group. Of course, the actual number of households that would benefit depends on local population densities. A reviewer identifies another point that is worth emphasising. This is the importance of keeping newly emerging milk groups small and geographically limited to ensure proximity and avoid large groups that would tend to increase average travel times. Any policy support to increase smallholder participation in milk marketing based on our analysis of factors influencing liquid milk sales would necessarily have to weigh public costs against the expected gains by smallholder households, the magnitudes of any positive or negative externalities that arise and so on. In this context, a limiting factor in the blanket increase of crossbred animals lies in the possibility that increased intensity may lead to increases in disease. This issue is important in comparing an increase in crossbred animals and an increase in the number of co-operatives as viable, alternative strategies that expand market participation.

The existing milk groups were established by a development project at an estimated cost of 44,350 Ethiopian birr (EB) each (US$ 1 = EB 8.198 at 22 May 2000). Given prices at the time of group formation, the cost of a milk group is roughly equivalent in market value to some 10 crossbred cows. Granted the density of households in many parts of rural Ethiopia, one such investment is likely to bring about market entry of more than four households, the number implied by the yield of 10 cows. Further, the availability of crossbred cows for purchase by smallholders is limited. Policies to promote expansion of crossbred numbers—currently less than 100,000 in Ethiopia—rely on expansion of the domestic herd, largely at government-owned facilities. Imports of crossbred cattle are severely restricted (particularly from Kenya) due to fears of disease risk. The resulting slow growth of the domestic herd of crossbred animals also provides support for the formation of co-operatives, with or without the provision of additional crossbred animals.

The ultimate benefits of participation in liquid milk sales—and the survival of the milk groups themselves—will depend on their continued ability to capture the value added in dairy processing and return that added-value to their members. This, in turn, relies on the groups' abilities to offer producers a higher return net of transactions cost than alternative market outlets. Whether they will continue to do so remains to be seen but first impressions from our two sample sites are positive.

7 Conclusions

The ideas developed here are simple and so is the message we are motivating. Institutional innovations by themselves are insufficient to catalyse entry; a mix of other inputs including infrastructure, knowledge and asset accumulation in the household must accompany them. Although it is not surprising that milk groups increase the participation of smallholders in liquid milk markets in Ethiopia's highlands, our empirical results provide insights about how to promote further market participation by smallholder producers. Locating groups so as to minimise the time required to market milk increases the number of participating producers and the level of marketable surplus. Given the difficulty and cost of providing crossbred animals (as experienced by such heifer loan schemes as the Heifer Project International in other parts of Africa (Morton et al. 1999)), investment in infrastructure such as milk groups provides a low-cost mechanism for increasing smallholder participation and furthering the integration of traditional producers into agro-industrial systems. These results are likely to hold relevance for other perishable and time-constrained agricultural products, such as winter vegetables, cut flowers and the like and, perhaps, a wide and broader set of circumstances.

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