Demand, Supply and Willingness-to-Pay for Extension Services in an Emerging-Market Setting

Garth John Holloway and Simeon K. Ehui

Although it may be wholly inappropriate to generalize, the most important resource available to a subsistence household is the total amount of time that its members have available to spend in productive enterprises. In this context, services that minimize the time that it takes to perform productive activities are valuable to the household. Consequently the household is willing to relinquish quantities of other resources in exchange for quantities of the time-saving service. These simple observations motivate a search for the values that subsistence households place on time-saving services. This search is especially important when it is realized that extension services promote productivity, enhance the surplus-generating potential of the household and can, as a consequence, promote immersion into markets that are currently constrained by thinness and instability. In this capacity, extension visitation has the potential to overcome one of the principal impediments to economic development, namely lack of density of market participation. In this article, we consider this issue in the context of a rich data set on milk-market participation by small-holder dairy producers in the Ethiopian highlands (Nicholson). Previous work with the data (Holloway et al.) suggests that extension visitation is a potentially important catalyst for market expansion. Consequently, a number of important questions arise concerning the actual impacts of extension on participating and non-participating households; the amount that extension-requesting households would be willing to pay for the service if it was privatized; the corresponding demand schedule for extension services; and the requisite conditions for the existence of a private market for the service. These questions are central to the development of markets, to the issues raised in this session and are answered in this paper in the context of our Ethiopian data.

Milk-Market Development in the Ethiopian Highlands

Small-holder dairy production in the Ethiopian highlands received an enormous catalyst when, in 1997, at two sites close to Addis Ababa, the inauguration of two milk cooperatives provided incentive for farmer participation in milk-marketing. Small-holder dairy producers in the highlands face a number of barriers to marketing including poor access to information, low levels of infrastructure and problems of transportation and perishability, leading to low levels of participation in markets otherwise constrained by significant search costs. Along with the introduction of the milk cooperatives ("milk groups") a production innovation with enormous potential for improving productivity among small-holders is the crossbreeding of exotic dairy-producing breeds with grade indigenous stock. Although susceptible to disease and requiring more labor intensive management practices than purely indigenous

This paper was presented at the ASSA winter meetings (New Orleans, LA, January 2001). Papers in these sessions are not subjected to the journal's standard refereeing process.

Garth John Holloway is visiting scientist and and Simeon K. Ehui is coordinator, Livestock Policy Analysis Program, International Livestock Research Institute.

The authors are grateful to Chris Barrett, Chris Delgado, and Ariel Dinar for providing inspiration; Mohammed Ahmed, Graeme Donovan, and Bill Thorpe for supportive conversations; Abebe Misgina and Yigezu Atnafe for information about extension services in the Ethiopian Highlands; and Charles Nicholson, who conceived the collection of the data while a postdoctoral fellow at the International Livestock Research Institute under a grant from the Rockefeller Foundation. The authors are especially grateful to Adugna Mekonnen, Head, North Shewa Zone Ministry of Agriculture; Fille Kedida, Head, Wouchale Woreda Ministry of Agriculture; Getachew Kebede, Supervisor, Wouchale Woreda; and Asgedech Eshete, Etenesh Seme, and Derrese Woyessa, Development Agents, Wouchale Woreda for information offered in an October 16 interview concerning extension activities in Wouchale Woreda.

This article is dedicated to U.C. Davis Extension Specialist Bees Butler.

Amer. J. Agr. Econ. 83(3) (August 2001): 764–768

herds, crossbred dairy-producing herds produce upwards of twice their indigenous counterparts (Kiwuwa et al.). To varying degrees this productivity gain has stemmed increases in marketable surpluses and brought with it the potential for market immersion by formerly subsistence households. In addition, the inauguration of cooperative selling has lowered significantly the remaining barrier to trading and has freed the time absorbed by producing transportable products from fluid milk (butter, cheese, yogurt) to other productive enterprises in the household.

With these issues in mind, a comprehensive survey of some sixty-eight households was undertaken in 1997 (Nicholson) with the view to assessing the significance of factors that impede or promote market participation. Each household was visited three times and at each visit sales of milk to the milk group in the preceding seven days were recorded. Thus, some $(68 \times 3 \times 7 =)$ 1428 observations are available for analysis.

Transactions Costs Mitigation and Willingness-To-Pay For Extension Visitation

Despite potential complications, the derivation of household-production willingness-to-pay estimates shares many similarities with its derivation in the more traditional consumer model. We focus most attention on the cash-income constraint,

$$z \leq \hat{p} y_s + w \ell_w + m \tag{1}$$

where z denotes a (numeraire) purchased good, $\hat{p}$ denotes the household's "effective price," w denotes the wage in off-farm employment, ℓ_w denotes labor allocation to off-farm employment and m denotes exogenous income. Per-unit transactions costs are conceptualized as the difference between the per-unit price received in the market, p, and a per-unit costs function $c(\mathbf{z})$ so that

$$\hat{p} = p - c(\mathbf{z}) \tag{2}$$

denotes the effective (net) return to the household and $\mathbf{z} \equiv (z_1, z_2, \ldots, z_k)'$ denotes a vector of potentially observable, household-specific characteristics, one of which we assume to be extension visitation. Implicit in what follows, is the assumption that the transactions costs function is monotonically decreasing in extension visitation. Transactions costs may involve the cost of acquiring transport equipment, of walking (time) or, possibly, learning a new production technique in order that the selling unit conforms to some market standard. Given estimates of the impact of extension visitation on the transactions costs function, the task of retrieving estimates of willingness-to-pay is simplified considerably. The quantity that we seek is the amount of income that the household is willing to forgo in order to have one additional unit of the service rendered or, the quantity ω that solves:

$$V(\hat{p} + \delta, m - \omega, \mathbf{q}) = V(\hat{p}, m, \mathbf{q}) \tag{3}$$

where $V(\cdot)$ denotes indirect utility, $\delta \equiv \Delta c(\mathbf{z}) = \partial c(\mathbf{z})/\partial z_x \Delta z_x$ represents the change in effective price afforded by the increase in extension visitation and $\mathbf{q}$ denotes other factors affecting producing and consuming decisions. Taking a Taylor-series approximation at an arbitrary expansion point on both sides of equation (3) an empirically observable (approximation to) the willingness-to-pay measure is

$$\omega \equiv \delta V_p / V_m. \tag{4}$$

Econometric interests focus on the extent to which the right-hand-side of this expression is observable and the location and scale of its posterior distribution. The term in the numerator is the product of the extension-service change (which is observable) and the marginal valuation of one additional unit of extension (which, in general, is not observable); the term in the denominator gives the marginal valuation of one additional unit of income (which, again and in general, is not observable). However, from a simple application of the envelope theorem, $V_p \equiv \lambda y_s$ and $V_m \equiv \lambda$, where λ denotes the Lagrange multiplier corresponding to the cash-income constraint and y_s denotes the amount of the food product that is sold in equilibrium. Hence, the right-hand-side of (4) is observable and provides the basis for the willingness-to-pay calculations that follow.

Estimating Willingness-To-Pay From Market Participation Data

In estimating the impact of extension on the transactions costs function we infer a direct

relationship between the household's effective price and the effect of extension visitation on this price. To this end, household i's decision about whether to participate can be expressed in terms of (indirect) utility differences

$$(5) \qquad G(\hat{p}_i, m_i, \mathbf{q}_i) \equiv V^p(\hat{p}_i, m_i, \mathbf{q}_i) - V^n(m_i, \mathbf{q}_i)$$

where $V^p(\cdot)$ denotes utility from participation, $V^n(\cdot)$ denotes utility from nonparticipation, $G(\cdot)$ denotes the utility difference and m_i and $\mathbf{q}_i$ are defined previously. Given the monotonicity of $G(\hat{p}_i, m_i, \mathbf{q}_i)$ in $\hat{p}_i$ we can reinterpret the entry condition (G(·) positive or negative) in terms of a critical price, say $\hat{p}_i^c$, such that entry occurs whenever the effective price, $\hat{p}_i$, exceeds the critical price and not conversely. Given the dependence of $G(\hat{p}_i, m_i, \mathbf{q}_i)$ on m_i and $\mathbf{q}_i$, it is natural to group these terms into a set of covariates, $\mathbf{x}_i \equiv (m_i, \mathbf{q}_i)$, and consider the price rule as a transformation of a standard-normal regression,

$$(6) \qquad \sigma_i(\hat{p}_i - \hat{p}_i^c) = \sigma_i \mathbf{x}_i \boldsymbol{\beta} + \sigma_i u_i$$

where σ_i is an arbitrary, positive scalar; $\mathbf{x}_i$ is a k-vector of observations on the covariates; $\boldsymbol{\beta}$ is a k-vector of unknown coefficients; and $u_i \sim N(0, 1)$ is a standard-normal random variable. Normalizing on the scale parameter, and assuming independence across households, we are able to derive estimates of the quantities we seek from the regression,

$$(7) \qquad \mathbf{y} = \mathbf{x}\boldsymbol{\beta} + \mathbf{u}$$

where $\mathbf{y} \equiv (y_1, y_2, \ldots, y_n)'$ denotes an n-vector of latent (unobserved) values corresponding to the price differences; $\mathbf{x} \equiv (\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n)'$, $\mathbf{x}_1 \equiv (x_{11}, x_{12}, \ldots, x_{1k})$, $\mathbf{x_2} \equiv (x_{21}, x_{22}, \ldots, x_{2k}), \ldots, \mathbf{x}_n \equiv (x_{n1}, x_{n2}, \ldots, x_{nk})$ are observations on the covariates; and $\mathbf{u} \sim N(\mathbf{0}_n, \mathbf{I}_n)$. We observe the participation choice but neither $\mathbf{y}$ nor $\boldsymbol{\beta}$. However, inferences about the locations and scales of the elements of $\boldsymbol{\beta}$ are easily obtained using a Markov-chain, Monte-Carlo algorithm (Albert and Chib). In short, an alternative interpretation of the probit regression leads to robust estimates of the impact of extension on the household's effective price and its willingness to pay for extension visitation.

Results

Table 1 reports results. The variables in question are "Distance" ≡ return time in minutes to walk to the milk group; "Education" ≡ years of formal schooling of the household head; "Crossbred" ≡ number of crossbred cows currently being milked; "Local" ≡ number of local-breed cows currently being milked; "Extension" ≡ number of visits by an extension agent discussing production or marketing activities in the twelve months prior to the survey; "Ilu-Kura" ≡ dummy variable (= 1 if from the Ilu-Kura peasant association); "Mirti" ≡ dummy variable (= 1 if from the Mirti peasant association). Numbers in parentheses are the ratios of posterior means to their standard deviations in the Gibbs sample. All of the covariates have a significant impact on the price differences. The price difference is decreasing in the distance that the household resides from the milk group and is increasing in each of the other covariates. Particular interest lies in the impacts of the extension-visitation covariate. The results suggest that for each unit increase in extension visitation the effective price increases (the transactions-costs function is lowered) by 0.62 Ethiopian birr (EB). (Currently, $US 1.0 = EB 8.24). Hence, extension visitation shows promise as a market-entry catalyst.

Combining the probit regression results with the willingness-to-pay calculation in

Table 1. Probit Regression Results

Distance	−0.06
	(−9.27)
Education	0.56
	(9.94)
Crossbred	2.87
	(14.78)
Local	1.14
	(7.22)
Extension	0.62
	(10.66)
Ilu-Kura	−6.67
	(−13.82)
Mirti	−11.31
	(−18.53)
Participants	168
Pos. Predict.	74
Neg. Predict.	94
Non-Participants	1260
Pos. Predict.	24
Neg. Predict.	1236

equation (4), we can estimate the quantities of interest in terms of the Ethiopian birr that the households are willing to give up for one additional extension visit. Figure 1 presents the estimates across the 168 participating households. The point estimates are virtually indistinguishable from their 95% highest-posterior-density values (confidence intervals) and the estimates appear credible in terms of the operations under consideration. Average sales in the sample are 3.9 l milk per day and the prices received are EB 1.00 and EB 1.25 per liter, respectively, at the Ilu-Kura and Mirti milk groups. The maximum (standard deviation) willingness-to-pay estimate is 6.77 (0.50) EB and the minimum (standard deviation) willingness-to-pay estimate is 0.62 (0.05) EB. These estimates provide relatively precise information to which supply considerations should be targeted.

Complicating supply estimates are problems arising in the allocation of fixed costs (educating field representatives, housing a base of personnel and equipment, updating and revising communication techniques) and estimating the variable costs of visitation (wages and variable expenditures incurred in travel). However, rough estimates about the per-unit costs can be made by dividing the annual extension budget of the local administrative unit by the number of visits made to each household. During the "peak season" for visitation (April–August) extension agents typically visit with 180 farmers per week; during the "slack seasons" (September–October and January–March) average visits amount to 18 per week per agent; and during the seasons in which there is "normal demand" (November–December) average visits amount to about 100 per week per agent. The extension department of the administrative unit in question has a total of 29 Development Agents and in the production year 1998–99 (Ethiopian calendar year 1991) incurred running costs amounting to EB 294,748 (Wouchale Woreda Extension Personnel). Dividing this amount by the total number of visits, which is $((180 \times 20) + (18 \times 20) + (100 \times 8)) \times 29 = 138{,}040$ visits per year, we arrive at a rough estimate of the marginal cost of each visit—EB 2.14 per visit. Using the willingness to pay estimates in figure 1, it appears that some sixty-five "households" (observations in the sample) would be willing to purchase extension services. Hence, net of fixed costs, and in the context of milk-market development in the Ethiopian highlands, the privatization of extension services is an intriguing possibility.

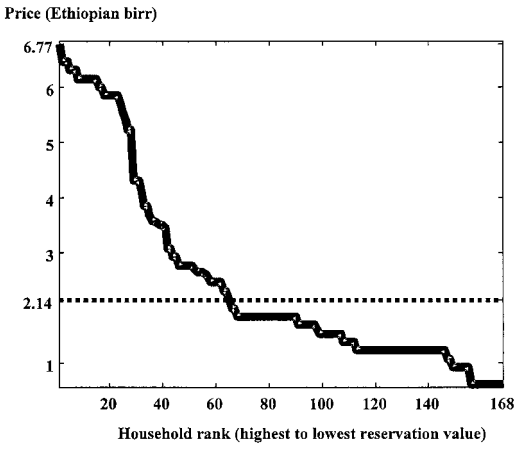

Figure 1. Willingness-to-pay estimates for a one unit increase in extension visitation

Conclusions

Extension visitation is a potent catalyst stimulating entry into emerging milk-markets. This article has analyzed willingness to pay for extension visitation in the context of data collected from two sites close to Addis Ababa and has assessed the conditions necessary for a private market to prevail. Although a precise response must hinge on the magnitude of any fixed costs, variables costs cannot preclude the possibility that privatization may be currently possible. Future work should aim at strengthening confidence in our estimates by overcoming limitations of the analysis, including the assumption of unit variance in the pricing model, the assumption of independence across time periods and the arbitrary assignment of covariates to the transactions costs function.

References

Albert, J., and S. Chib. "Bayesian Analysis of Binary and Polychotomous Data." *J. Amer. Stat. Assoc.* 88(1993):669–79.

Holloway, G., C. Nicholson, C. Delgado, S. Ehui, and S. Staal. "Agroindustrialization Through Institutional Innovation: Transactions Costs, Cooperatives and Milk-Market Development in the East African Highlands." *Agric. Econ.* 23(2000):279–88.

Kiwuwa, G.H., J.C.M. Trail, M.Y. Kurtu, G. Worku, F.M. Anderson, and J. Durkin. *Cross-Breed Dairy Cattle Productivity in Arsi Region, Ethiopia*. International Livestock Center for Africa (ILCA) Research Report No. 11, Addis Ababa: ILCA, 1983.

Nicholson, C.F. "The Impact of Milk Groups in the Shewa and Arsi Regions of Ethiopia: Project Description, Survey Methodology, and Collection Procedures." Mimeograph, Livestock Policy Analysis Project, International Livestock Research Institute, Addis Ababa, 1997.

Wouchale Woreda Extension Personnel. Personal communication, October 14, 2000.