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Electronic Market Use by Oklahoma Lamb Producers

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Socioeconomic and production system characteristics of a sample of Oklahoma sheep producers were employed to examine the decision to use or not use an electronic market for slaughter lambs. Producer attributes that influence electronic market use were identified with qualitative choice models. The results help identify characteristics of electronic markets which influence their success. The findings also have implications about educational opportunities for cooperative extension.

Key words: electronic markets, lambs, qualitative choice models, sample selection bias.

Introduction

Electronic marketing systems have been developed for many commodities including feeder pigs and cattle, slaughter lambs, hogs, cows, wholesale meat, cotton, eggs, and fresh fruits and vegetables [U.S. General Accounting Office (USGAO)]. Some of these systems, such as feeder pig teleauctions and computer auctions for cotton and slaughter lambs, were implemented successfully and have operated for years. However, the majority of electronic marketing systems were designed, pilot tested, and then ceased operating after a brief period of commercial trading (USGAO).

Primary objectives of electronic markets include exposing the commodity to more potential buyers, facilitating better access by buyers, and centralizing price discovery. Evaluations of electronic marketing systems reveal consistent observations about benefits to buyers, sellers, and the marketplace as a whole (Bell et al.; Schrader; Sporleder; Rhodus, Baldwin, and Henderson).

However, little research has identified the factors affecting producers' decisions to use electronic markets. A few studies have attempted to estimate acceptance and participation by sellers and buyers in proposed electronic markets. In three such studies, Russell and Purcell examined a potential slaughter cow market, Tilley and Dickey examined a proposed electronic grain market, and Turner, Epperson, and Fletcher assessed attitudes toward a multiple-commodity electronic market. All of these studies were intended to guide market development. However, none of the electronic markets were formed. In three additional studies (Ethridge on cotton, Glazener and Sporleder on feeder cattle, and VanSickle on fruits and vegetables), survey results were used to guide development of an electronic market, but no follow-up study was done to identify user characteristics. Sarhan and Nelson's evaluation of an electronic wholesale meat market pilot test is the only work found which provides insight as to why market participants use or do not use electronic markets.

Development and operation of an electronic market are costly. The market must have

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enough users and commissions to cover variable costs and make fixed cost payments. Assessments of electronic markets indicate costs are often prohibitively high compared to volumes (USGAO). Benefits to users and the marketing system will not occur if electronic systems cannot remain viable.

Computer marketing of slaughter lambs could be considered an electronic marketing success. One electronic market located in Wisconsin (Corn Belt Lamb Electronic Market, or CBLEM) markets slaughter lambs for producers in several midwestern states. In Oklahoma, a telephone auction for lambs began in 1979 (Ward 1980). In 1982, the first teleauction ceased operating and was replaced by the CBLEM computer auction (Russell and Ward). At the same time, a second teleauction began operating. At the present date, the CBLEM computer auction remains operational. The purpose of this research is to identify characteristics of Oklahoma lamb producers which influence their use of electronic markets.

Research reported here goes beyond previous work. We identify some of the linkages between socioeconomic and production system characteristics and a producer's decision to use an electronic market. A qualitative choice model is used to determine elements of this link. Further, the research focuses not on anticipated behavior, but on actual market choice.

Economics of Market Choice

Rational marketers of agricultural products compare marginal returns to marginal costs of market choice. Sheep producers recognize that marketing lambs through electronic media may not be convenient. However, choosing the most convenient method may not provide the best pricing opportunity. Optimal market choice involves weighing returns to market use against market costs and opportunity costs of not using alternative markets.

Oklahoma sheep producers who reported using electronic markets indicated selling price was an important factor affecting their decision to use an electronic market (Jones). Sheep producers benefit from higher prices when marketing lambs through electronic media (Ward, Jones, and White; Ward 1984). Price premiums received for products marketed are the direct marginal return associated with market use. Some producers also recognize indirect marginal returns of electronic market use. Lamb markets have exhibited increasing buyer concentration. Efforts to establish electronic markets are often the result of a concerted effort by producers to improve market structure. Improved market structure may improve prices received by producers.

Sheep producers using other marketing alternatives indicated convenience was an important factor (Jones). Some convenience is lost using an electronic market. When participating in a group marketing program such as an electronic market, producers transfer some marketing decision making to a group coordinator. Two aspects of decision making are most affected. First, many producers decide to sell lambs either a few days before or the day of the sale. Participating in an electronic market requires producers to plan sales and contact the coordinator several days in advance. Second, after a sale, the meatpacking firm determines when lambs are shipped. There may be some negotiation between coordinator and packer–buyer, but the producer will have to deliver lambs to the collection point on the day determined by the packer–buyer and coordinator.

A host of factors influence marginal costs associated with market use. The most important costs have to do with whether the producer resides in a location which can take advantage of the market, has adopted a production system which yields the type of lambs marketable through electronic outlets, has the management skills and knowledge to take advantage of the electronic market, and whether the producer has low enough opportunity costs to devote time and effort to using an electronic market. Producer location is important due to transportation and time costs associated with moving lambs to collection points after a sale. The type of production system employed is important in that meatpackers who procure livestock through electronic markets often look for a specific animal weight

Table 1. Definitions and Summary Statistics of Survey Variables Used in the Qualitative Choice Models

Variable	Definition from Survey Information	Mean (SD)
Electronic Market	Dummy variable equal to 1 if survey participant uses computer auction or teleauction, 0 otherwise.	.2753 (.4479)
North Central Region	Dummy variable equal to 1 if participant resides in a north central Oklahoma county, 0 otherwise.	.4270 (.4960)
Northeastern Region	Dummy variable equal to 1 if participant resides in a northeastern Oklahoma county, 0 otherwise.	.1517 (.3597)
Female	Dummy variable equal to 1 if participant is female, 0 otherwise.	.1910 (.3942)
B.S. Degree	Dummy variable equal to 1 if participant has a B.S. degree, 0 otherwise.	.2697 (.4450)
Other Education	Dummy variable equal to 1 if participant has "other education," 0 otherwise.	.4157 (.4942)
Nonfarm Residency	Dummy variable equal to 1 if participant resides in a "small town" or "rural nonfarm," 0 otherwise.	.1517 (.3597)
Nonproduction	Dummy variable equal to 1 if participant is not involved in nonproduction agriculture, 0 otherwise.	.2697 (.4450)
Part-time Operation	Dummy variable equal to 1 if participant is a part-time sheep producer, 0 otherwise.	.3539 (.4795)
Purebred	Dummy variable equal to 1 if respondent's sheep operation is classified "purebred," 0 otherwise.	.0618 (.2415)
Purebred/Show	Dummy variable equal to 1 if respondent's sheep operation is classified "purebred/show," 0 otherwise.	.1573 (.3651)
Commercial/Purebred	Dummy variable equal to 1 if respondent's sheep operation is classified "commercial/purebred," 0 otherwise.	.3034 (.4610)
Fall Lambing	Dummy variable equal to 1 if participant has a fall lambing operation, 0 otherwise.	.4214 (.4952)
Spring Lambing	Dummy variable equal to 1 if participant has a spring lambing operation, 0 otherwise.	.1854 (.3897)
Other Pricing Basis	Dummy variable equal to 1 if participant markets lambs on a pricing basis other than liveweight, 0 otherwise.	.0393 (.1949)
Price Reason	Dummy variable equal to 1 if main factor influencing market preference is price, 0 otherwise.	.3483 (.4778)
Other Reason	Dummy variable equal to 1 if main factor influencing market preference is "other," 0 otherwise.	.0960 (.2947)
Age	Age of survey participant.	46.4610 (13.3880)
Sheep Years	Number of years participant has spent raising sheep.	14.9440 (12.9120)
Farm Size	Categorical variable for size of total farming operation: 1 = 25 acres and under, 2 = 26–50 acres, 3 = 51–100 acres, 4 = 101–160 acres, 5 = 161–320 acres, 6 = 321–640 acres, 7 = 641–1,000 acres, 8 = 1,001–2,000 acres, 9 = 2,001–3,000 acres, 10 = 3,001–5,000 acres, and 11 = greater than 5,000 acres.	5.1966 (2.7289)
Acre for Sheep	Categorical variable for percentage of total farm acres in sheep production: 1 = 10% or less, 2 = 11–25%, 3 = 26–50%, 4 = 51–75%, and 5 = 76–100%.	2.8764 (1.5646)
Number Slaughtered	Categorical variable for number of slaughter lambs marketed annually: 1 = none, 2 = 25 head or less, 3 = 26–50 head, 4 = 51–75 head, 5 = 76–100 head, 6 = 101–250 head, 7 = 251–500 head, 8 = 501–1,000 head, 9 = 1,001–3,000 head, 10 = 3,001–5,000 head, and 11 = greater than 5,000 head.	4.2416 (2.0455)
Lamb Weight	Categorical variable for weight of slaughter lambs marketed: 1 = 95 lbs. or less, 2 = 96–105 lbs., 3 = 106–115 lbs., 4 = 116–125 lbs., and 5 = greater than 125 lbs.	2.6180 (.9389)

Table 1. Continued

Variable	Definition from Survey Information	Mean (SD)
Income	Categorical variable for estimate of 1989 gross farm income: 1 = no response, 2 = $2,500 or less, 3 = $2,501–10,000, 4 = $10,001–20,000, 5 = $20,001–25,000, 6 = $25,001–50,000, 7 = $50,001–100,000, and 8 = greater than $100,000.	5.1000[a] (2.1040) 5.6067[b] (2.0426)
Income from Sheep	Categorical variable for percentage of gross farm income from sheep production: 1 = no response, 2 = less than 10%, 3 = 11–25%, 4 = 26–50%, 5 = 51–75%, and 6 = 76–100%.	3.8298[c] (1.5444) 3.8596[b] (1.5247)

[a] Mean and standard deviation based on the 120 observations nonmissing sample.
[b] Mean and standard deviation based on the 178 observations complete sample.
[c] Mean and standard deviation based on the 141 observations nonmissing sample.

and quality. If the production system used by a sheep producer does not yield the type of animal meatpackers value highly, the producer may choose other marketing outlets. Other marketing costs include commission charges and reputation of the marketing firm.

Socioeconomic characteristics are factors which may affect market choice. To be willing to use an electronic market, producers must be aware of the market, understand its procedures, trust the pooling arrangements, and perceive that additional management time invested is rewarded. In essence, the degree of human capital development plays a role in the acceptance and adoption of technology (Feder, Just, and Zilberman). Age, gender, education, farm or nonfarm residency, a commercial agriculture background, and the number of years spent raising sheep are all attributes which may reflect the degree of human capital development and should capture a portion of how producer preferences and abilities affect the willingness to use electronic markets.

Gross farm income, the proportion of income from sheep production, and off-farm income will also likely influence decision making. The higher the gross farm income, the less important marginal gains in income become. High income operations may not make the additional investment needed to market lambs through electronic media due to high opportunity costs. However, the larger the component of gross farm income from lamb sales and the smaller these opportunity costs become, the more likely a producer is to use an electronic market. Further, if the sheep enterprise is part of a diversified operation or if the producer has off-farm income, less time likely will be spent marketing lambs.[1]

Survey and Data Characteristics

A sample of 254 Oklahoma sheep producers were surveyed during December 1989. Names were drawn randomly from a population of 750 Oklahoma sheep producers who receive the *Sheep Update* newsletter from the Animal Science Department at Oklahoma State University. Producers were contacted by telephone. If the person contacted was not a sheep producer, an additional name was drawn from the population. Of the 254 producers contacted, two chose not to provide information. Producers were asked questions regarding socioeconomic attributes, aspects of their sheep and lamb operation, and factors influencing their choice of lamb marketing method. Producers who grew lambs solely to participate in 4-H and FFA contests or who marketed no lambs in 1989 were not included in the analysis. Forty-nine sheep producers, 27.5% of the 178 resulting respondents, had marketed slaughter lambs through an electronic market. Table 1 defines and summarizes data obtained from the survey and used in the modeling.

The electronic market in question has loading points in north central and northeastern Oklahoma. Dummy variables were constructed to identify survey participants located in

counties surrounding the two loading points. These participants have lower transaction costs. A dummy variable was constructed to identify female survey participants. Dummy variables were used to identify persons holding a B.S. degree or "other" levels of education.[2] Survey participants indicated whether their residence was a rural farm, rural nonfarm, in a small town, or in an urban area. There were no urban participants, and participants indicating small town or rural nonfarm were represented with one dummy variable because of the limited sample, 10.1% and 5.1%, respectively, in the categories. Both education and residency may reflect knowledge of electronic markets.

Participants were asked if their sheep operation was a full- or part-time activity. A dummy variable was used to identify part-time operators. Diversified participants or participants with off-farm income may view the convenience/price tradeoff differently than participants concentrating on sheep production. Survey participants were asked to identify their type of lamb operation. The choices were commercial, purebred, commercial/purebred, and purebred/show. Dummy variables were used to identify purebred, commercial/purebred, and purebred/show operations. Dummy variables also were used to identify operations lambing only in the spring and operations lambing only in the fall. A dummy variable was used to identify if lambs sold by participants were priced on a basis other than liveweight. Finally, participants were asked if their market choice was influenced primarily by price received, convenience or marketing costs, or if their market choice was influenced by "other" reasons.

Given the dummy variables constructed, the base comparison group includes male participants from counties not bordering a loading point, with high school educations, residing on a rural farm, operating commercial flocks full-time, following a combined spring and fall lambing season, and with a market choice primarily determined by convenience.

Continuous and categorical variables from survey questions also were used in the modeling.[3] The continuous variables were participant age and number of years in sheep production. Categorical variables included participant farm size, percentage of acres devoted to sheep production, number of slaughter lambs sold in the survey year, average weight of lambs sold, gross farm income, and percentage of income from sheep production. Details of the continuous and categorical survey data are provided in table 1.

Qualitative Choice Models

Qualitative choice models use a set of attributes which describe agents in order to explain discrete choices by those agents (Amemiya). The models described here examine lamb producers' decisions to use or not use an electronic market. As a preliminary step, the decision by survey participants to report or not report income is examined.

The structure of the qualitative choice model is that there is a set of attributes x_i for the ith participant which can be combined with different weights β to form an index z_i^*,

$$z_i^* = x_i\beta + \epsilon_i, \tag{1}$$

which is measured with error ϵ_i. The index used to assess the underlying choice is not observed. However, it is assumed the choice is observed if the index is greater than some threshold value, which can be scaled to zero, or

$$\begin{aligned} &z_i = 1 \text{ if the agent makes the choice whereby } z_i^* \geq 0 \text{ and} \\ &z_i = 0 \text{ if the agent does not make the choice whereby } z_i^* < 0. \end{aligned} \tag{2}$$

The probability the agent makes the choice is derived from the index through the standardized cumulative distribution function F,[4]

$$\text{Prob}\{z_i = 1\} = \text{Prob}\{z_i^* \geq 0\} = P_i = 1 - F(-x_i\beta). \tag{3}$$

If a change in an attribute results in a change in the index, it implies a change in the

probability of crossing the threshold and observing the choice. The two distribution functions used in applications are the standard normal, resulting in probit models, and the standardized logistic, used in logit models. Similarly, the probability the agent does not make the choice equals

$$\text{Prob}\{z_i = 0\} = \text{Prob}\{z_i^* < 0\} = 1 - P_i = F(-x_i\beta). \tag{4}$$

The observed market choices across agents in a sample are realizations of a binomial process, so that the qualitative choice model's likelihood function is

$$L = \prod_{z_i=1} [1 - F(-x_i\beta)] \prod_{z_i=0} F(-x_i\beta). \tag{5}$$

Nonlinear maximum likelihood techniques are used to calculate the attribute weights β.

Parameter estimates are used to interpret the influence of an attribute on the probability of making the underlying choice. A change in the probability of making the underlying choice given a one-unit *ceteris paribus* change in an attribute is

$$\partial P_i/\partial x_{ji} = \partial F(z_i)/\partial z \cdot \partial z/\partial x_{ji} = f(z_i)\cdot\beta_j, \tag{6}$$

where $f(z_i)$ denotes value of the index z_i through the density function of one of the distributions above, x_{ji} is the jth attribute for the ith agent, and β_j denotes the parameter for the jth attribute.[5] The value of the index z_i is obtained using mean values for each attribute. Thus, changes in probabilities are consistent with the survey respondent having average attributes.

Modeling Process

The structure of the market choice model is as follows:

$$z_i^* = x_i\beta + y_i\alpha + e_i, \tag{7}$$

where z_i^* is the index of market choice for the ith agent, x_i is a vector of agent attributes excluding gross farm income and income from sheep production, y_i is a vector of the income attributes, β and α are attribute weights, and e_i is the random error term.

Nonreporting of income is a common problem with using socioeconomic characteristics gathered from survey data to model economic decisions. In this survey, 32.6% of the respondents did not report gross farm income, and 20.8% did not report the percentage of income from sheep production. This is consistent with the 30% nonreporting of income and income derivatives found by Capps and Cheng. Missing income data are not a serious problem if the nonreporting of income is uncorrelated with other attributes in the sample, although there is a loss of efficiency. If there are systematic relationships between income reporting and other attributes and if the missing observations are dropped from the sample, parameter estimates may suffer from sample selection bias (Lee; Maddala). The possibility of sample selection bias should be tested and not assumed, given that the same attributes which influence market choice may influence the respondent's decision to report income.

Qualitative choice models are used to examine if the socioeconomic and production system characteristics explain the willingness to report gross farm income and, separately, the willingness to report income from sheep production. The basic model structure is

$$w_i^* = x_i\gamma + u_i, \tag{8}$$

where w_i^* is the index of the choice to report income, x_i is a vector of agent attributes, γ are attribute weights, and u_i is the random error term. The index is not observed, but the choice is observed if the index is above the threshold,

$$\begin{aligned} &w_i = 1 \quad \text{and} \quad y_i = y_i \text{ if } w_i^* \geq 0 \quad \text{and} \\ &w_i = 0 \quad \text{and} \quad y_i^* = 0 \text{ if } w_i^* < 0, \end{aligned} \tag{9}$$

where y_i^* is reported income. Dependent variable observations of the first model equal one if gross farm income is reported and zero if it is not reported. Dependent variable observations of the second model equal one if income from sheep production is reported and zero if it is not reported. The choices are modeled as functions of socioeconomic and production system attributes without the marketing preference variables.

The next step in the modeling process is to use socioeconomic attributes and information from the models of income reporting to model reported income levels. Least squares models of reported gross farm income and the reported percentage of income from sheep production are estimated using survey respondent attributes as exogenous variables. The basic model is

$$y_i^* = x_i\psi + \lambda(x_i\hat{\gamma})\phi + v_i, \tag{10}$$

where y_i^* is reported income, x_i is the set of agent attributes excluding income, ψ and ϕ are parameters, and v_i is the random error term. Included in the regression is the inverse of Mills' ratio from the income reporting model. The inverse of Mills' ratio is defined as $\lambda(x_i\hat{\gamma}) = f(x_i\hat{\gamma})/F(x_i\hat{\gamma})$, where $x_i\hat{\gamma}$ are predicted values from model (8), and f and F are standardized density and distribution functions. This variable accounts for sample selection bias by incorporating information from the income reporting models. Results of the income level regressions are used with the attribute data and the Mills' ratio series to calculate implied income levels for the missing observations. The complete data set, with missing income attributes replaced with predicted values, is then used in the market choice model. Parameter estimates of the final qualitative choice model are consistent and asymptotically efficient (Maddala).

As a final step in the modeling process, quadratic terms were included on the continuous and categorical variables in income reporting, income level, and market choice models if doing so resulted in meaningful improvements in the likelihoods. Akaike's Information Criterion (AIC) was used to determine the set of quadratic terms that should be included (Judge et al.).

Empirical Results

Collinearity diagnostics were examined for linear probability model versions of the probit models and for the income level regression models (Belsley, Kuh, and Welsh). Diagnostics indicated that the levels of collinearity between almost all of the variables in all of the models were not degrading. Problematic levels of collinearity were found only between linear and quadratic terms of individual continuous and categorical variables.[6] However, in all cases, model performance was reduced if the quadratic terms suggested by the AIC were not included.

Income Reporting Models

Parameter estimates, model statistics, and the probabilities of observing income reporting given changes in attributes are reported in table 2. The qualitative interpretation of probabilities of change across the probit and logit models were identical; only probit results are reported. The models effectively capture the decision to report income. The models correctly predict 75% of the decisions to report gross farm income and 81% of the decisions to report income from sheep production.

Results indicate that lamb producers in north central Oklahoma are 26% more likely to report gross farm income than producers in the other portions of the state. Female survey participants are 30% less likely to report income than male counterparts. Survey participants holding a B.S. degree are 19% more likely to report than participants with high school or other levels of education. Older participants and participants who have been involved with producing sheep for more years are less likely to respond. Last,

participants who market a large number of lambs are less likely to report income, while participants who market heavier lambs are more likely to report.

The model examining the reporting of income from sheep production is similar to that of the gross farm income model. Participants in north central Oklahoma are more likely while female participants are less likely to respond to the question. Participants with nonfarm residencies and part-time operators are more likely to respond to the question. Participants with larger farms are more likely to respond; however, the response is increasing at a decreasing rate. Participants who market large numbers of lambs are less likely to respond. Participants who market larger lambs are more likely to respond given the interaction between the linear and quadratic terms on the lamb weight variable. In summary, the responses to the income questions in the survey are related to the region of the state in which the participant lives, the participant's gender, and some characteristics of the participant's sheep operation.

Income Level Models

Results of the income level regressions also are reported in table 2. If sample selection bias is present, the models are heteroskedastic by construction (Maddala). Standard errors reported are from a heteroskedasticity-consistent covariance matrix estimator (White). Socioeconomic characteristics of participants are effective in capturing the income level variations. The R^2 for the gross farm income model is 75% and is 67% for the income from sheep production model. Farm size and whether or not the participant's sheep operation is part-time are the primary determinants of gross farm income. Farm size, percentage of acres in sheep production, and number of slaughter lambs marketed are the primary determinants of income from sheep production.

The coefficient associated with the inverse of Mills' ratio is significant at the 10% level in the gross farm income model and is insignificant in the income from sheep production model. Results suggest the gross farm income model is mildly affected by sample selection bias but that the model of income from sheep is not. Regardless of the presence of sample selection bias, using the results of the income level models to input missing income observations will improve the efficiency of the market choice model (Kmenta).

Figures 1 and 2 are histograms of the gross farm income data and income from sheep production data before and after missing values are replaced. The means and standard deviations of the nonmissing and complete income series also are reported in table 1. Figure 2 reveals there is little change in the percentage of sample in each of the income from sheep categories between the nonmissing and complete samples. The means reported in table 1 are very similar. This is consistent with the sample selection bias model result which suggests there is no bias. Figure 1 suggests that most of the survey participants who do not respond to the gross farm income question are lamb producers with relatively high incomes. The mean of the complete series is slightly larger than the nonmissing series. This is consistent with the result of the sample selection bias model which suggests there is some bias. The result is also intuitive; higher income producers may be expected to withhold income information.

Market Choice Model

Table 3 reports parametric results, model statistics, and probabilities of change for the market choice model.[7] The probabilities from probit and logit models are identical for interpretive purposes. Only the probit results are reported. The model explains 82% of the actions correctly. The majority of the model parameters suggest relatively small probabilities of observing electronic market use given a change in an attribute. Contrary to the studies of ex ante electronic market adoption, this examination of ex post market use has more conservative findings as to the number and extent of impact that socioeconomic and production system attributes have on electronic market use. However, several of the

Table 2. Probit Results for the Models of Gross Farm Income Reporting and Income from Sheep Production Reporting, and Regression Results for the Models of Gross Farm Income Level and Income from Sheep Production Level

	Probit Model Results				Regression Model Results	
	Gross Farm Income		Income from Sheep		Gross Farm Income	Income from Sheep
Independent Variables	Estimate (SE)	Probability of Change	Estimate (SE)	Probability of Change	Estimate (SE)	Estimate (SE)
North Central Region	.7510** (.2625)	.2551	.7971** (.3071)	.1771	.0959 (.3612)	−.3327* (.2072)
Northeastern Region	.1713 (.3305)	.0582	.4623 (.3803)	.0993	−.6403** (.2771)	.1094 (.2411)
Female	−.8832** (.3030)	−.3000	−.6821** (.3226)	−.1465	.5248 (.4209)	.2482 (.2402)
B.S. Degree	.5494** (.3136)	.1866	.4356 (.3571)	.0935	.0258 (.3653)	.4652** (.2509)
Other Education	.2753 (.2627)	.0935	.3141 (.2939)	.0674	−.0149 (.3068)	.2220 (.2261)
Nonfarm Residency	.1387 (.3295)	.0471	.5657* (.4014)	.1215	−.4634** (.2310)	.0446 (.2643)
Nonproduction	.1847 (.3192)	.0627	.3033 (.3914)	.0651	−.2907 (.2738)	.4245* (.2632)
Part-time Operation	−.2245 (.2754)	−.0763	.5469** (.3172)	.1174	.6098** (.2319)	−.2838* (.1922)
Purebred	.3171 (.5443)	.1077	.2737 (.5599)	.0588	.2459 (.3960)	−.2209 (.3141)
Purebred/Show	.4328 (.3703)	.1470	.3967 (.4148)	.0852	−.4425 (.4503)	.5573** (.2977)
Commercial/Purebred	.1834 (.3313)	.0623	.0913 (.3702)	.0196	−.0735 (.3016)	.4358** (.2229)
Fall Lambing	−.3358 (.3069)	−.1140	−.0579 (.3429)	−.0124	.6123* (.3703)	−.3302* (.2083)
Spring Lambing	.3697 (.3300)	.1256	.4924* (.3544)	.1057	.0701 (.3228)	−.0180 (.2171)
Other Pricing Basis	−.4480 (.3617)	−.1522	−.3090 (.3769)	−.0663	.5169* (.3487)	.3565* (.2604)
Age	.0780* (.0549)	−.0045	−.0117 (.0112)	−.0025	.0098 (.0110)	−.0555** (.0331)
Age^2	−.0010** (.0006)					.0006** (.0004)
Sheep Years	−.0580** (.0300)	−.0102	−.0132 (.0106)	−.0028	.0203* (.0126)	.0399** (.0225)
Sheep Years^2	.0009** (.0006)					−.0009** (.0004)
Farm Size	.0404 (.0741)	.0137	.6993** (.2520)	.0427	.4450** (.0694)	−.6439** (.1687)
Farm Size^2			−.0482** (.0188)			.0343** (.0120)
Acres for Sheep	.0081 (.1207)	.0028	.1898* (.1389)	.0407	−.0931 (.0995)	.2891** (.0897)
Number Slaughtered	−.1417* (.0835)	−.0481	−.1711** (.0969)	−.0367	−.4046* (.2694)	.1512** (.0579)
Number Slaughtered^2					.0731** (.0255)	
Lamb Weight	.2339* (.1394)	.0794	−1.4447** (.7898)	.0899	−.0642 (.1502)	−.1419* (.0994)

Table 2. Continued

Independent Variables	Probit Model Results				Regression Model Results	
	Gross Farm Income		Income from Sheep		Gross Farm Income	Income from Sheep
	Estimate (SE)	Probability of Change	Estimate (SE)	Probability of Change	Estimate (SE)	Estimate (SE)
Lamb Weight[2]			.3559** (.1667)			
Inverse Mills' Ratio					−1.4020* (.8996)	−.0034 (.5502)
Intercept	−.9926 (1.4413)		.0149 (1.3837)		2.8365** (1.0507)	5.6197** (1.0911)
Log-Likelihood	−90.495		−71.037			
Likelihood Ratio	43.7163**		39.8831**			
% Correct Predictions	.7472		.8146			
Density Value $f(z)$	.3397		.2147			
R^2					.7501	.6722
Error Variance					1.3571	.9437

* Denotes significance at the 10% level; ** denotes significance at the 5% level.

parameters are statistically significant and suggest there is a set of attributes which influence whether or not sheep producers use electronic markets. Further, significant and insignificant variables identify what are and are not the important attributes that make sheep producers potential electronic market users. The results help identify target groups of sheep producers for electronic market educational programs.

The location of a producer relative to collection points is crucial. Producers in north central and northeastern Oklahoma are, respectively, 32% and 35% more likely to use electronic markets than producers in other regions of the state. Transportation costs, manager time, and inconvenience are strong determinants of electronic market use. Efforts to increase the number of collection points or improve pooling convenience likely will increase market use.

Producers who choose their marketing method based on prices received are 26% more likely to use an electronic market. Informing producers about price opportunities in an electronic market may improve market viability. Factors other than price or cost also appear to influence market choice. Producers whose market choice is influenced by "other" reasons are 16% more likely to use an electronic market.[8] Results here support studies which found that producers concerned about prices or buyer competition were most apt to use electronic markets (Tilley and Dickey; Turner, Epperson, and Fletcher). Similarly, inconvenience was an important reason why participants in CATS, a Computer-Assisted Trading System for wholesale meat, did not use the system (Sarhan and Nelson).

To some degree, survey participant age influences market choice. Based on coefficients of the linear and quadratic age variables, middle-aged producers are more likely to use the electronic market for lambs than older or younger producers. Studies of proposed electronic markets consistently suggest targeting younger producers (Turner, Epperson, and Fletcher; Tilley and Dickey; VanSickle). However, our results suggest otherwise and indicate other factors supersede age in determining electronic market use.

The weight of lambs sold is an important determinant of whether a producer uses an electronic market. Most Oklahoma sheep producers sell lambs in the 96–105 pound or 106–115 pound category. If producers sell lambs one weight category higher, they are 14% more likely to use an electronic market. Producers selling lambs which weigh between 116–125 pounds are the most likely to use an electronic market. It is not possible to determine if producers marketing lambs in this weight category do so through electronic media because of advantages due to the lamb breed, or whether these more efficient

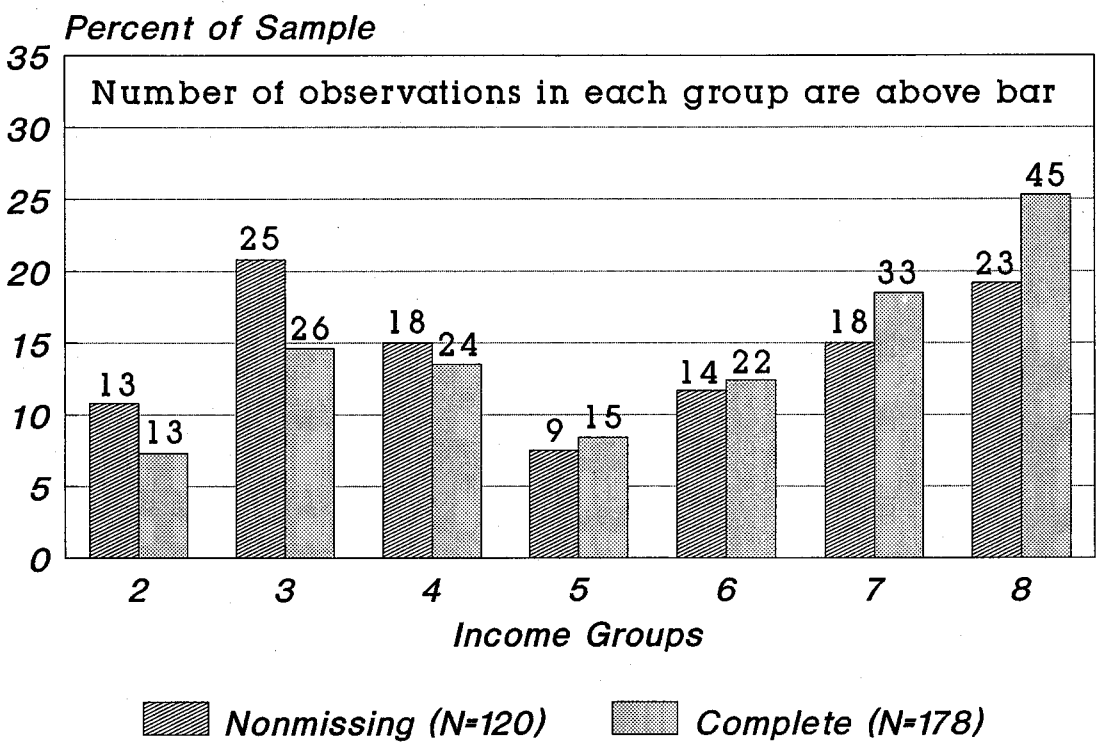

Figure 1. Gross farm income sample distribution

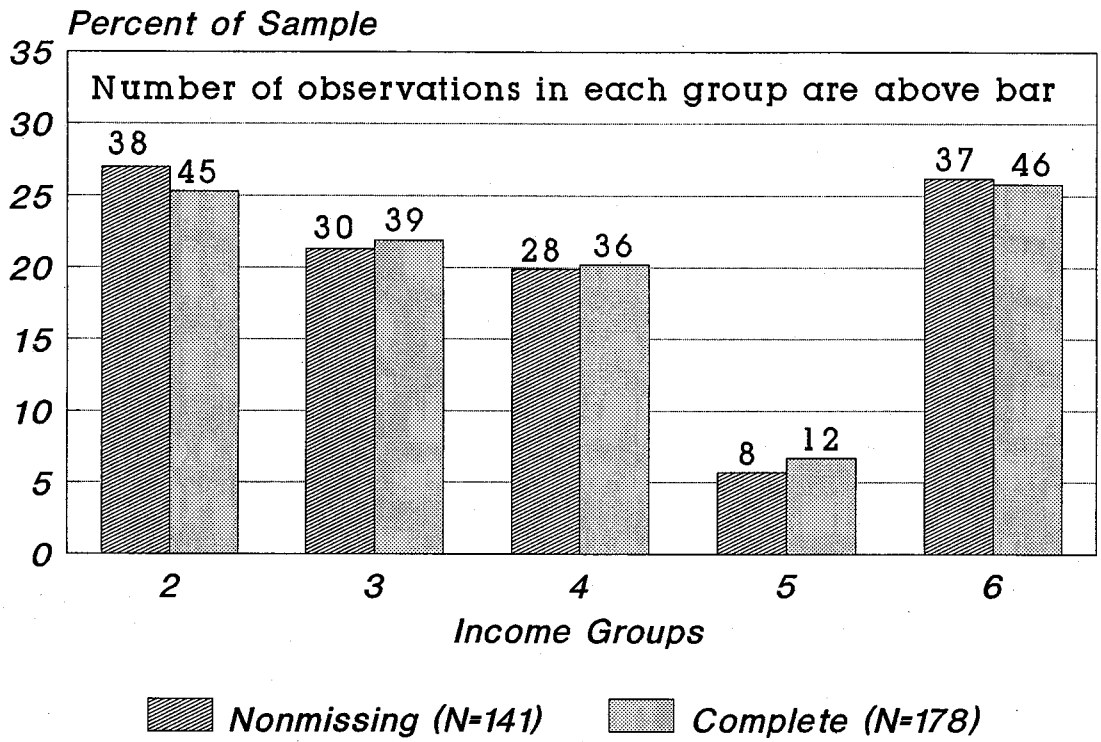

Figure 2. Income from sheep production sample distribution

Table 3. Probit Results for the Model of Electronic Market Use

Independent Variables	Parameter Estimate	Standard Error	Probability of Change
North Central Region	1.4054**	(.3520)	.3234
Northeastern Region	1.5186**	(.4617)	.3494
Female	.1664	(.3844)	.0383
B.S. Degree	−.7137**	(.4172)	−.1642
Other Education	−.2418	(.3394)	−.0556
Nonfarm Residency	−.8573**	(.4253)	−.1973
Nonproduction	−.5414*	(.3895)	−.1246
Part-time Operation	.2171	(.3437)	.0500
Purebred	−.3703	(.7581)	−.0852
Purebred/Show	−.2963	(.4971)	−.0682
Commercial/Purebred	−.5876*	(.4182)	−.1352
Fall Lambing	−.0012	(.3722)	−.0003
Spring Lambing	−.7896**	(.3964)	−.1817
Price Reason	1.1346**	(.3141)	.2611
Other Reason	.6975*	(.4658)	.1605
Age	.1109*	(.0706)	.0035
Age^2	−.0010*	(.0007)	
Sheep Years	.0001	(.0124)	.0000
Farm Size	.0766	(.1058)	.0176
Acres for Sheep	.0196	(.1641)	.0045
Number Slaughtered	.0969	(.1178)	.0223
Lamb Weight	2.3828*	(.9166)	.1440
Lamb Weight^2	−.3356**	(.1613)	
Income	−.2023**	(.0998)	−.0466
Income from Sheep	.2674**	(.1609)	.0615
Intercept	−8.6867**	(2.3130)	
Log-Likelihood	−65.365		
Likelihood Ratio	78.7559**		
% Correct Predictions	.8202		
Density Value $f(z)$	.2301		

* Denotes significance at the 10% level; ** denotes significance at the 5% level.

producers are also better informed and thus take advantage of markets with better prices. In any case, the results indicate that a producer's decision to use an electronic market is influenced by the production system followed.

The portion of gross farm income from sheep production is an important factor determining electronic market use. The more important the sheep enterprise is to a survey participant's income, the more likely that producer is to use an electronic market. A one-category increase in income from sheep suggests a producer will be 6% more likely to use an electronic market. More diversified sheep producers are less likely to use an electronic market. Our findings that an increased proportion of income from sheep increased the probability of using an electronic market somewhat support results by Tilley and Dickey but conflict with those of VanSickle. Tilley and Dickey found firm size was important in determining anticipated use of an electronic market for grains, while VanSickle found that firm size was not important in estimating use of an electronic market for fruits and vegetables. While our farm size variable was insignificant, the income from sheep results support the argument that when a producer's marginal gain from using an electronic market is relatively large, that producer is more likely to use the market.

The main factors which imply a producer will not use markets with electronic media are as follows. Lamb producers not living on a farm or not directly associated with production agriculture are, respectively, 20% and 12% less likely to use an electronic market. These sheep producers may lack knowledge about the availability of the market or may not have available technical assistance to make using an electronic market worth the opportunity costs.

Sheep producers operating combined commercial and purebred flocks are 14% less likely to use an electronic market than commercial operators. All coefficients on the type of sheep operation dummy variables are negative, although two are statistically insignificant. This suggests a reluctance by noncommercial sheep producers to use electronic markets. Their marketing efforts may be focused in other outlets or on products other than slaughter lambs. Producers who market lambs exclusively in the spring are 18% less likely to use an electronic market. Operations following the traditional lambing season do not use an electronic market. This may be due to the reluctance to use nontraditional markets or because time and labor opportunity costs are excessive.

Producers with a B.S. degree are 16% less likely to use an electronic market. Producers with higher gross farm incomes are also less likely to use an electronic market. Our results also conflict with the ex ante finding of Turner, Epperson, and Fletcher that gross income was not an important determinant of market choice. Better educated, higher income sheep producers appear to view the opportunity costs of using an electronic market as prohibitive.

Implications for Firms Sponsoring Electronic Markets and Cooperative Extension

Results from the market choice model have implications for firms sponsoring electronic markets and cooperative extension. Both groups can use results from this study to target current and potential electronic market users. Clearly, the number and location of collection points are important. Sponsoring firms might consider multiple collection locations to achieve truckload lots of slaughter lambs. Pooling convenience might be enhanced by scheduling weekend collection and temporarily holding lambs at a collection point for later loading and shipping to buyers. Nonrural and part-time sheep producers also might be better able to use electronic markets if convenience is increased.

When communicated to producers, documented price differences favoring electronic markets should increase market use. Extension education programs should emphasize the actual, not just conceptual, price advantages associated with marketing slaughter lambs through electronic media. If sponsoring firms add collection points and reduce inconvenience barriers to using an electronic market and if extension programs better educate producers about realized price premiums in an electronic market, market use should increase.

The type of production system followed is an important determinant of electronic market use. Producers operating strictly commercial flocks appear more likely to use an electronic market. The more efficient and advanced producers who sell lambs at larger weights are also more apt to use an electronic market. Cooperative extension and firms sponsoring electronic markets should target these producers with educational programs about specific benefits of electronic market use. In addition, extension and sponsoring firms might target other types of producers with education programs about packer–buyer preferences in lamb weight and quality; this may lead to their eventual use of electronic markets.

Producers whose sheep operation is an important part of gross farm income are more likely to use an electronic market than other producers. Producer education programs need to be targeted such that the cost/benefit tradeoff is recognized. Programs encouraging electronic market use will be more effective if they are targeted at sheep producers with less formal education, lower gross farm income, and a higher proportion of gross farm income from sheep production. Appropriately targeted programs should increase the volume of trade in electronic lamb markets, which should improve both operational and pricing efficiency.

Summary and Conclusions

A qualitative choice model was used to identify factors affecting Oklahoma sheep producers' decisions to market slaughter lambs through electronic media. Due to missing

data on income derivative variables, two intermediate stages were modeled before the model of market choice. The first stage models the choice of reporting income in the survey. Information from these models is used in second stage models, regressions of income levels from those participants who did report on their attributes, to test for sample selection bias.

Empirical results from these two stages can be summarized as follows:

(1) Factors explaining the reporting of gross farm income and income from sheep production include: producer location, gender, education level, age, and selected characteristics of sheep production systems.
(2) Factors explaining gross farm income levels include: producer location, residency, farm size, whether or not sheep production is a full- or part-time enterprise, and selected characteristics of sheep production systems. Sample selection bias was mildly present in the reporting of gross farm income.
(3) Factors explaining income from sheep production include: education, age, farm size, and almost all of the characteristics describing the production system. Sample selection bias was not present in the reporting of income from sheep production.

The income level regressions then are used to predict gross farm income and income from sheep production for the nonreporting survey participants. The complete attribute data set then is used in a model of market choice.

Empirical results from the market choice model are summarized as follows:

(1) Factors positively related to the use of an electronic market include: location of the producer relative to collection points, prices received, weight of lambs sold, and the importance of income from sheep in total income.
(2) Factors negatively related to the use of an electronic market include: nonfarm residency, spring lambing operations, noncommercial sheep operations, higher education, and gross farm income.

Results from the market choice model have implications for cooperative extension and firms sponsoring electronic markets. The number and location of collection points are important. Additional, and more convenient, collection points will increase electronic market use. Documented price differences favoring electronic markets, when communicated to producers, also should increase electronic market use. Commercial producers whose sheep operation is an important part of their gross farm income appear to be more apt to use electronic lamb markets than other sheep producers. Thus, extension education programs should target those producers. Similarly, collection points should be selected which make marketing more convenient for commercial sheep operations and for producers who rely relatively heavily on income from their sheep operations.

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Notes

[1] There is a large contingency of survey participants in the data used who do not reside on a farm, yet are involved in commercial agriculture. Gross farm income level for these sheep producers is relatively large, and the proportion of income from sheep is relatively small. For sheep producers who are not involved in commercial agriculture, gross farm income is small, reflecting income from only sheep and lamb sales.

[2] The "other" education category applies both to persons with less than high school education and persons with more education than a B.S. degree (Jones). This diverse grouping is a limitation of the survey.

[3] Two alternative approaches to handling the categorical variables also were examined. The first used a dummy variable for each group within a categorical variable, and the second used the midpoint of the range of the underlying data from which the categories are constructed. Both of these approaches are approximately equivalent to using the categorical data directly, and both have statistical and interpretive problems similar to or greater than use of the categorical data directly.

[4] In order for the model parameters to be identified, the error term must be from a standardized distribution. If the distribution is not standardized, the vector of weights (β) is not identified and the estimable parameter vector is the attribute weights (β) divided by the root error variance (σ), e.g., β/σ.

[5] Quadratic terms on the continuous and categorical data variables were examined. Including a quadratic term

changes the formula for calculating the change in probability. Denoting the parameter for the jth attribute as β_{1j} and the parameter for the jth attribute squared as β_{2j}, the change in probability is

$$\partial P_i/\partial x_{ji} = \partial F(z_i)/\partial z \cdot \partial z/\partial x_{ji} = f(z_i)\cdot(\beta_{1j} + 2\cdot\beta_{2j}\cdot x_{ji}).$$

[6] Most condition indices were below 30, with the majority below 10. Where condition indices were greater than 30, only the variance proportions associated with linear and quadratic terms of individual continuous or categorical variables were greater than .5.

[7] The market choice models also were estimated with the nonmissing portion of the sample. Changes in results are consistent with expectations, given econometric properties of models with missing data and models where missing data are replaced using good instruments. Given the size of the standard errors, the parametric results are not all that different between models using the nonmissing and complete data. Some sample selection bias is present but mild. The most bias appears in dummy variable parameters which identify characteristics not largely prevalent in the nonmissing sample and in the gross farm income variable parameter. The most noticeable change in the results between the full and reduced samples is the substantial loss of efficiency (standard errors increase 20–35%). This can be expected when one-third of the sample is ignored.

[8] Our interpretation of the use of an electronic market for "other" reasons, based on discussions with sheep producers, is that this variable captures actions by producers who are concerned about lamb market structure.

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