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This paper examines the use of market consultants and market information systems by grain and cotton producers. A model of producer demand for marketing information and consultants is proposed that decomposes price received into exogenous and endogenous components. The analysis is based on a survey of over 1,600 producers. The results suggest that expenditures on market information systems and market consultants are not independent and, more specifically, expenditures on marketing consultants substitute for expenditures on market information systems.

Key words: expected utility, market information, marketing, risk, Tobit

Introduction

The information needs of agricultural producers are increasing as technology becomes more complex, farms get larger, and market alternatives become more sophisticated. A particular area of interest in the literature is price and income risk. In a survey of Midwest grain producers, studies by Patrick and Ullerich (1996) and Coble et al. (1999) both found that price variability was rated as having the most potential to affect farm income. As such, considerable interest has been generated in risk management programs, and this interest is not limited to commercial producers (Vergara et al., 2001). Traditionally, commercial-sized producers rely on production and marketing contracts, vertical integration, futures contracts and hedging, financial reserves, and crop insurance as means to manage farm risk (Harwood et al., 1999). While producers value and use these tools, they are placing an increasingly higher value on market advisory services as a source of price risk management, information, and advice (Pennings et al., 2001).

A significant body of literature has emerged which investigates producers' decisions regarding marketing advisory services (Patrick and Ullerich, 1996; Schroeder et al., 1998; Jirik et al., 2000; Martines-Filho et al., 2000, 2001; Norvell and Lattz, 1999; and Pennings et al., 2004). For example, Pennings et al. (2004) estimate the perceived impact of market advisory service recommendations on pricing decisions. This body of literature has also included many analytical models that attempt to predict optimal behavior

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under assumptions of risk aversion (Lapan and Moschini, 1994). There is another body of literature associated with efforts to understand marketing behavior, which investigates producers' demand for market information systems and computer technology (Batte, Jones, and Schnitkey, 1990; Baker, 1991, 1992; Ortmann et al., 1993; Ortmann, Patrick, and Musser, 1994; Amponsah, 1995; Hoag, Ascough, and Marshall, 1999; Gloy, Akridge, and Whipker, 2000).

Many studies have identified the importance of risk preferences and technology to information systems adoption, while other studies focus on producers' educational level as the driving force behind technology adoption. A limitation of this literature is the assumption that producers consider the adoption of market advisory and information systems independently. Lack of independence in these adoption decisions, however, could result in biased estimates of adoption. Nevertheless, there has been no attempt to jointly examine these related components of producers' risk management decisions.

We argue that the demand for marketing advisory services and the adoption of market information systems are potentially interrelated. We model these adoption decisions jointly and attempt to relate both bodies of literature to construct an econometric model that partitions price into two components—the typical exogenous component and an endogenous or marketing-induced component—in order to explain the joint adoption process under an expected utility maximization framework.

We further argue that producers' expenditures on marketing information and market consultants are best explained as a process where producers believe collecting and analyzing additional information will allow them to market their output at better prices than those obtained otherwise. This investigation not only provides insight as to how much producers value market information, but it also offers empirical evidence of producers' preferences for marketing choices by examining the relationship between the demand for marketing advisory services and the use of market information systems. Finally, this study examines the factors determining producers' level of adoption.

Previous Research

Several empirical studies have related farm and nonfarm characteristics with the adoption of marketing advisory services among grain producers. In a survey of Midwest grain producers, Patrick and Ullerich (1996) found that producers rate market advisors and market information systems as the most important sources of information, surpassed only by farm records. Similar findings were reported by Schroeder et al. (1998) in their survey of Kansas grain and cattle producers. They note that producers rank marketing advisory services as the number one source of information for developing price expectations. Norvell and Lattz (1999) found that 21% of Illinois producers use marketing consultants and consider them to be most important to their business in the future. Reporting the results of a survey of Midwest, Great Plains, and Southeast producers, Pennings et al. (2001) identify market information systems and market advisory services as producers' first and second most important sources of market information, respectively. Most of the producers surveyed also indicated they use market advisory systems as sources of market information and market analysis.

Previous research on producer adoption of market information systems relies on farm and producer characteristics. Several studies link producer educational level to the likelihood of adoption of new technologies (Feder and Zilberman, 1985; Putler and Zilberman, 1988; Schnitkey et al., 1992; Lin, 1991; Zepeda, 1994). In a survey of computer adoption by Ohio commercial producers, Schnitkey et al. (1992) found age, education level, and farm size were factors that predicted computer adoption. They suggested there is a complementary relationship between expenditure in farm information systems and computer usage. Similarly, in a survey of large Corn Belt producers, Ortmann, Patrick, and Musser (1994) observed a positive relationship between expenditure on consultant services and computer use. In a survey of computer adoption by Great Plains producers, Hoag, Ascough, and Marshall (1999) concluded that farm size, livestock production, farm tenure, off-farm employment, and farming experience were factors shown to predict computer adoption, whereas education appeared to have no impact.

Putler and Zilberman (1988) found California producers were more likely to use computers in relation to the size of the farm, education, and age of the operator—findings consistent with those of Jarvis (1990) for Texas rice producers. However, Jarvis determined there was an inverse relationship between computer technology adoption and the use of consultants. Based on conclusions by Shapiro, Brorsen, and Doster (1992), risk perceptions are important factors in the decision to adopt new technologies by grain producers.

Several empirical studies have addressed the relationship between management and information systems. Schnitkey et al. (1992) argued that managerial style might influence information preferences. Ortmann et al. (1993) agreed, noting that their finding of a relationship between self-assessments of different types of business skills and expenditure on consultants supported this proposition. Their results show that producers used production consultants as a complement to their production skills, while marketing consultants tended to substitute for producers' marketing skills. Verstegen and Huirne (2001) also report a positive relationship between high management levels and increased value added from information systems.

With these past results in mind, we model expenditures on market advisory services and market information systems as a joint decision, which is novel in the literature. First, the expenditures are modeled on marketing consultants and market information systems using a bivariate Tobit model to assess whether they are jointly determined. Second, in order to define the degree of substitutability or complementarity between agricultural consultants and market information systems, a two-stage univariate Tobit is estimated. Modeling the decision in this fashion will provide a more complete picture of the producers' decision-making process. Finally, a multinomial logit model allows us to develop "customer profiles" of adoption based on producers' likelihood of adopting both marketing consultants and information systems, either one, or neither.

The Market Information Model

Assuming a completely exogenous output market implicitly eliminates the incentive to purchase market information because any expenditure on market information would not affect the price received. Nevertheless, most studies of producer marketing activities show that producers actively engage in obtaining market information (Batte, Jones, and Schnitkey, 1990; Baker, 1991, 1992; Ortmann et al., 1993; Ortmann, Patrick, and Musser, 1994; Amponsah, 1995; Hoag, Ascough, and Marshall, 1999; Gloy, Akridge, and Whipker, 2000).

We argue that producer expenditures on marketing information and market consultants are best explained as a process where producers, within the limitations imposed by their own human capital (Z), believe collecting and analyzing additional information will allow them to market their output at better prices than those obtained otherwise. Examples of additional marketing information evaluated by producers in order to maximize expected utility include product quality differences, costs of transport and storage, basis, and government programs.

Empirical research supports the efficient market hypothesis in agricultural commodity futures markets (Garcia, Hudson, and Waller, 1988; Kastens and Schroeder, 1996; Kolb, 1992). However, there is also evidence that many producers perceive they can obtain abnormal profits by trying to "beat" the market using futures and options contracts (Schroeder et al., 1998; Isengildina and Hudson, 2001). The activities assumed here would not necessarily violate the efficient market hypothesis. Producers might purchase market information for a number of reasons consistent with efficient futures markets. For example, information on price movements which affects basis allows producers to analyze whether they are better off storing their grain or selling it on the cash market.

Under these assumptions, we propose a conceptual model where the overall price P is partitioned into two components: an exogenous part (P_E)[1] and an endogenous or marketing-induced part (P_M), so that:[2]

(1) $$P = P_E + P_M(I_1, I_2, Z),$$

where P_E and P_M are both random variables, I_i represent the market information sources (marketing consultants and market information systems), and Z is the level of human capital. By differentiating equation (1) with respect to I_i and Z, the signs of the following partial derivatives with respect to P_M are assumed:

(2) $$\frac{\partial P_M}{\partial I_i} > 0, \quad \frac{\partial P_M^2}{\partial^2 I_i} < 0, \quad \text{and} \quad \frac{\partial^2 P_M}{\partial I_i \partial Z} > 0.$$

The positive sign on the first derivative implies that producers believe information increases P_M. This must hold for there to be a positive expected marginal value product for market information. The negative sign on the second derivative imposes concavity. A positive interaction between human capital and information is also assumed—i.e., producers with greater human capital will derive greater benefits from information. These assumptions are tested in the empirical model [see equation (5)].

The optimization behavior of a producer considering the adoption level between alternative sources of market information is modeled as follows. The producer is assumed to maximize expected utility according to a Von Neumann-Morgenstern utility function defined over end-of-season wealth (W), which is strictly increasing, concave, and twice continuously differentiable. Initial wealth is represented by W_0, crop acres by A, and yield by Y. Production cost is denoted as $C(Y)$. The variable market information costs associated with market information source i are denoted α_i. P_E and P_M are defined over the range $[\underline{P_E}\,\overline{P_E}]$ and $[\underline{P_M}\,\overline{P_M}]$, respectively. Thus, there is a joint distribution $f(P_E, P_M)$.

[1] The exogenous part includes factors outside of the farmer's control such as farm policy and weather effects.

[2] While we present the price effect additively, a multiplicative effect (or other form) may be possible as well.

Obviously, assuming a random output price P_E without P_M would imply that an increase (reduction) in market information cost α_i would create a reduction (increase) in expected utility derived from market information source I_i.[3] Assuming two sources of information, expected utility can be written as:

(3)
$$E(U) = \int_{\underline{P_E}}^{\overline{P_E}} \int_{\underline{P_M}}^{\overline{P_M}} U\Big(W_0 + A\Big[\big[P_E + P_M(I_1, I_2, Z)\big]Y - \alpha_1 I_1 - \alpha_2 I_2 - C(Y)\Big] f(P_E, P_M)\, dP_E\, dP_M.$$

The expected utility-maximizing strategy will be the choice of levels of market information source I_i^*, which maximizes $E(U)$. Specifically, the first-order condition for expected utility maximization is:

(4)
$$\int_{\underline{P_E}}^{\overline{P_E}} \int_{\underline{P_M}}^{\overline{P_M}} U'(\cdot) \left[\frac{\partial P_M}{\partial I_i} AY - \alpha_i \right] f(P_E, P_M)\, dP_E\, dP_M = 0.$$

Given this model, the choice of market information source will be conditioned on the parameters of the decisions problem: W_0, A, Z, α, the mean and higher moments of P_E and P_M, along with the correlation ρ between P_E and P_M. Since expected utility maximization is assumed, the optimal strategy is also conditioned on the degree of risk aversion θ. The market information derived demand can be shown as a function of the following inputs, whereby:

(5)
$$I_i^* = f\big(\alpha_1, \alpha_2, W_0, A, E(P_E), E(P_M), \sigma_{P_E}, \sigma_{P_M}, \rho, Z, \theta\big).$$

Thus, under these assumptions, we expect the demand for a particular marketing technology to be a function of both its own price and the price of other marketing technologies, suggesting a joint relationship. As is common in empirical applications, the potential joint adoption decision is investigated by estimating expenditure equations for the two marketing technologies in the following section.

Econometric Procedure

Any analysis of producer demand for marketing advisory services and market information systems needs to take into consideration that, in some cases, the expenditure on technological inputs is zero, thus raising the issue of censored samples. A standard approach to deal with censoring is the use of Tobit models (Tobin, 1958).

Previous research has suggested that when a production process requires two related inputs, the farm operator may choose to upgrade them at different dates in an asynchronous schedule (Jovanovic and Stolyarov, 2000). This close relationship implies the operator's decision to purchase marketing services may be made jointly with the decision to hire additional market information systems. Specifically, producers' expenditures on marketing advisory services may be influenced by expenditures on information systems, and vice versa. Therefore, an empirical model should take into consideration that the

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[3] We assume that an increase or reduction in market information cost α has no impact on output price. For example, an increase in the cost of DTN would decrease the expected utility derived from this marketing information source with no impact on the output price P_E.

demand for marketing services and information systems is jointly determined, and thus simultaneous equation estimators need to be adopted.

The econometric model consists of a structural bivariate Tobit model of marketing consulting and market information services demand, which is fitted to the whole sample. The basic Tobit model may be embedded in a simultaneous equations model (Greene, 2000) by:

$$(6) \qquad I_1^* = X_1\beta + \gamma I_2^* + \varepsilon_1,$$

$$(7) \qquad I_2^* = X_2\beta + \gamma I_1^* + \varepsilon_2, \quad \text{and}$$

$$\text{Correlation } (\varepsilon_1, \varepsilon_2) = \rho_{12}.$$

From equation (5), the expected value of I, and the expression for the covariance matrix, is given by:

$$(8) \qquad E(I_i | I_2, X_1, \varepsilon_2) = \beta X_1 + \gamma I_2 + (\sigma_{12}/\sigma_2^2)\varepsilon_2, \quad \text{and}$$

$$\text{Covariance } (\varepsilon_1, \varepsilon_2) = \begin{vmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{vmatrix}.$$

The estimated cross-equation coefficient of the disturbances (correlation coefficient ρ_{12}) in the bivariate Tobit model indicates the degree of dependence between these two equations. Whether this coefficient is significant would lead to conclusions relating to the degree of interdependence between producers' marketing choices. Other computations and retrievable results are the same as for the univariate Tobit model (Greene, 2000). Parameter estimates for Tobit models do not directly correspond to changes in the expected value of the observed dependent variable brought about by changes in the independent variables. As shown by McDonald and Moffitt (1980), in the Tobit model this effect is given by:

$$(9) \qquad \frac{\partial E(I)}{\partial X} = F(Z)(X\beta/\sigma)\beta,$$

where $Z = X\beta/\sigma$ is the unit normal density, and $F(Z)$ is the cumulative normal distribution function. Note that this marginal effect is distinct from the effect on the latent variable.

Survey Procedure and Data

A survey conducted in the spring of 1999 elicited grain and cotton producers' expenditures on marketing consultants and market information systems. The survey was conducted in four states in which corn, soybeans, cotton, and sorghum production are important: Mississippi (cotton, soybeans), Texas (cotton, sorghum), Indiana (corn, soybeans), and Nebraska (corn, soybeans). These states were chosen to reflect differing production regions and crops. Each state's Agricultural Statistics Service was contracted to sample from their pool of commercial farms. After excluding small, noncommercial farms generating less than \$25,000 in gross income, the sample was stratified across four categories of gross farm income. A Dillman (1979) three-wave survey design was used to mitigate nonresponse bias. A total of 6,810 mail surveys were sent to producers prior to planting in the spring of 1999. A follow-up reminder card was sent two weeks following the first mailing, and a second mailing was sent to those who had not returned a survey two weeks after the postcard reminder. This study utilizes 1,617 completed questionnaires returned by grain and cotton producers, for a usable response rate of 24%.[4]

Table 1 provides a description of the variables used in this study, and table 2 reports summary statistics of the dependent and independent variables. Producers were asked to quantify their dollar expenditure on marketing consultants, and their dollar expenditure in market information services. Specifically, they were asked, "In 1998, how much did you spend on hiring marketing consultants?" and "In 1998, how much did you spend on market information systems such as ACRES, DTN, etc.?"[5] These variables represent the variables of interest in this analysis. Because information on prices paid for marketing services or quantities purchased is not available, expenditures are used as dependent variables.[6]

As seen from table 2, 15% of the producers indicated they hired a marketing consultant, and those who hired a consultant paid, on average, $411.81 per year. With respect to market information systems, 37% of the producers reported they had made an expenditure for market information services. Those who purchased information systems paid an average of $291 per year. Based on the high percentage of zero expenditures in marketing consultants and information systems, the choice of an econometric model that takes into consideration censoring in the dependent variable is appropriate.

The remaining variables described in table 1 are independent explanatory variables included in the analysis. Total acres represent a measure of farm size (A) in equation (5). On average, producers in our sample had 1,450 acres of farmland (table 2). It is expected that increased expenditures in marketing consultants and market information systems are related to larger farm size. A quadratic term was included to capture a possible nonlinear effect of increased farmland on expenditures.

The percentage of crops priced before harvest is an indicator of producers' use of marketing tools. This variable is a measure of producers' human capital (Z) in equation (5). On average, approximately 19% of the producers in the sample priced their crops before harvest. It is expected that increased use of pricing before harvest would be correlated with increased expenditures in marketing consultants and information systems. Producers who are active rather than passive in marketing are more likely to seek outside advice and information.

Price variability is derived from a five-point Likert scale question asking the producers to quantify the perceived price variability. This variable is represented by (σ_{P_E}) in equation (5). Ninety-one percent of the producers in the sample reported perceiving high price variability.

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[4] A response rate of 24% is somewhat low, but is consistent with response rates in mail surveys (Dillman, 1979) of this magnitude. Respondents to this survey were slightly older and farms slightly larger as compared to statistics reported in the *1997 Census of Agriculture* (USDA, 1999) for farms greater than $10,000 in sales. This is especially true for Indiana and Mississippi. Direct comparisons with the *Census* are difficult because this sample was restricted to those farms with more than $25,000 in sales. However, given the similarity of the respondents to population estimates, the sample is deemed reasonably representative, with the caveat that the sample may be slightly biased toward larger farms.

[5] In 1998, grain and cotton producers did not have access to market consultants through DTN, thus eliminating the risk of having a biased sample. According to DTN, this service was first offered in 2000, and discontinued in 2002.

[6] Because prices paid for marketing information services tend to be similar in a cross-sectional sample (i.e., the cost of DTN is fairly similar across the four states considered in this study), econometrically there is little gain from modeling prices per se. There are also quality attributes (i.e., differences in services rendered by market consultants) influencing the price paid by the producers which are also difficult to quantify. Therefore, expenditures on marketing services can be used as a proxy for prices and quantities.

Table 1. Target Markets for Consultants and Market Information Systems: Description of Variables (N = 1,617 producers)

Variable	Description
Dependent Variables:	
Expenditure in Marketing Consultants	Dollar amount paid by producer to hired marketing consultants ($)
Expenditure in Information Systems	Dollar amount paid by producer for market information systems ($)
Independent Variables:	
Total Acres	Total acres available in the farming operation (acres)
Total Acres Squared	Total acres available in the farming operation squared (acres squared)
Percent Crops Priced Before Harvest	Weighted variable constructed by adding the share of each crop with respect to total crop acres multiplied by the percentage of each crop priced before harvest (%)
Price Variability	Dummy variable = 1 if producer perceives price variability as having a high potential effect in affecting farm income; 0 otherwise
Producer Marketing Knowledge	Dummy variable = 1 if producer is highly knowledgeable about forward pricing, and futures and options; 0 otherwise
Risk Aversion	Dummy variable = 1 if producer is highly risk averse; 0 otherwise
Education	Dummy variable = 1 if producer has some college education; 0 otherwise
Marketing Plan	Dummy variable = 1 if producer has a written marketing plan for the farm's major crop commodities; 0 otherwise
Age	Age of the farm operator (years)
Wealth	Dummy variable = 1 if gross farm assets are $2,000,000 or more; 0 otherwise
Cotton Acres	Acres planted to cotton with respect to total acres (%)
Soybean Acres	Acres planted to soybeans with respect to total acres (%)
Corn Acres	Acres planted to corn with respect to total acres (%)
Sorghum Acres	Acres planted to sorghum with respect to total acres (%)

Producers' marketing knowledge measures how comfortable producers are with their knowledge on forward contracting tools as a risk management strategy. This variable is another measure of producers' human capital (Z) in equation (5). They were asked to rank their comfort level on a five-point Likert-type scale. This variable takes a value of one if producers feel comfortable (4) or very comfortable (5) with their knowledge on the subject. Thirty-eight percent of the producers indicated a comfortable knowledge of forward contracts. The expected relationship between this variable and expenditures in marketing consultants and information systems is not clear. Marketing consultants and information systems may assist a knowledgeable producer in making better marketing decisions. However, a knowledgeable producer may believe it is no longer necessary to hire the services of marketing consultants.

Producers' risk aversion measures a producer's willingness to accept a lower crop price in order to reduce price variability. This variable is represented by (θ) in equation (5). Producers were asked to rank their agreement on a five-point Likert-type scale for the following statement: "I am willing to accept a lower price to reduce price risk." This variable takes a value of one if the producer agrees (4) or strongly agrees (5) with the statement. Forty-two percent of the producers indicated agreement with the statement.

Table 2. Target Markets for Consultants and Market Information Systems: Summary Statistics of Variables (N = 1,617 producers)

Variable	Mean	Standard Deviation	Minimum	Maximum
Expenditure in Marketing Consultants [a]	411.8169	1,964.239	0.00	40,000
Expenditure in Information Systems [b]	291.0259	562.256	0.00	7,000
Total Acres	1,450.4545	1,559.264	25	18,000
Total Acres Squared	4,533,620.33	14,883,770.2	625	324,000,000
Percent Crops Priced Before Harvest	18.9558	27.322	0.00	100
Price Variability	0.91094	0.28490	0.00	1.00
Producer Marketing Knowledge	0.38651	0.48710	0.00	1.00
Risk Aversion	0.42053	0.49379	0.00	1.00
Education	0.64935	0.47732	0.00	1.00
Marketing Plan	0.15460	0.36164	0.00	1.00
Age	51.9826	12.113	19	90
Wealth	0.15831	0.36515	0.00	1.00
Cotton Acres	0.21433	0.32248	0.00	1.00
Soybean Acres	0.30214	0.27450	0.00	1.00
Corn Acres	0.26515	0.26842	0.00	1.00
Sorghum Acres	0.06097	0.16359	0.00	1.00

[a] Fifteen percent of the producers in the sample indicated they hired marketing consultants.
[b] Thirty-seven percent of the producers in the sample reported that they purchased market information systems.

Education indicates whether the producer has some college education. Sixty-five percent of the producers indicated having at least some college education. This variable is another measure of producers' human capital (Z) in equation (5). College-educated producers may be inclined toward more complicated marketing strategies that require the hiring of marketing consultants and market information services.

The marketing plan variable indicates whether the producer has a preexisting written marketing plan for the farm. This previous effort on the part of a producer would potentially affect the value of new market information. On average, 15% of the producers in the sample had a written marketing plan. The expected relationship between this variable and expenditures on marketing consultants and information systems is unclear. Marketing consultants and information systems may aid a producer in developing a better marketing plan. In contrast, however, the use of a marketing plan may suggest the producer is well equipped for marketing, and may reduce his/her demand for marketing consultants or marketing information systems.

Age is included as a variable, assuming that producers evaluate the discounted value of their expected returns from different levels of expenditure in marketing consultants and information systems to decide whether they should participate. Therefore, expenditures on marketing consultants and information systems should be inversely related to older age. This variable is another measure of producers' human capital (Z) in equation (5). The average producer in our sample was 52 years old.

Wealth measures gross farm assets. This variable is a measure of producers' initial wealth (W_0) in equation (5). It takes a value of one if the producer's assets are in excess of $2,000,000, which is the highest asset value category on the survey. This variable is included because the producers' risk evaluation is conditional on wealth. Slightly less than 16% of the producers stated that they belong to the highest asset value group.

The last four explanatory variables measure the percentage of acres planted to grain crops (corn, soybeans, sorghum) and cotton with respect to total acres. These variables are another measure of farm size (A) in equation (5). On average, the share of farmland devoted to cotton, soybeans, corn, and sorghum is 21%, 30%, 26%, and 6%, respectively. These percentages reveal that most of the farms included in this analysis rely on some sort of crop mix, especially corn-soybeans in the Corn Belt, cotton-soybeans in Mississippi, and cotton-sorghum in Texas. It is theorized that increased complexity of the farming system may require the hiring of marketing consultants and may result in increased expenditures in market information systems.

Results

This section presents the results obtained from three econometric analyses. First, we report the results obtained from the bivariate Tobit model on producers' expenditures for marketing advisory services and market information systems. Results from this analysis guided the second econometric model consisting of a two-stage univariate Tobit model on predicted values for expenditures in marketing advisory services and market information systems. Finally, the third econometric model is a multinomial logit model on the probability of adoption of different levels of marketing advisory services and market information systems.

The Bivariate Tobit Model

The statistical significance of ρ_{12} in the bivariate Tobit model indicates that the expenditures on marketing consultants and market information systems are jointly determined (table 3, columns [A]). This result suggests expenditures on marketing consultants and market information systems are similarly influenced and should be modeled jointly. Given this result, interpretation will focus on the two-stage univariate Tobit model, discussed below.

The Two-Stage Univariate Tobit Model

A two-stage econometric estimation is conducted in order to define the degree of substitutability or complementarity between agricultural consultants and market information systems. First, each equation was estimated separately as a univariate Tobit model, and the expected value of the dependent variable was saved for a second-stage estimation. Second, each equation was reestimated using the predicted values of the dependent variable in the first equation as another independent variable in the second equation, and vice versa. For example, the predicted values for marketing consultant expenditure were used as an independent variable in the market information systems equation, and vice versa.

Results from the two-stage model suggest that expenditures on marketing consultants substitute for expenditures on market information systems (table 3, columns [B]). This result is not surprising because marketing advisory services provide producers with a broad range of services, such as specific marketing recommendations, market-related data, USDA reports, market and price analysis and outlook, and general marketing strategy (Pennings et al., 2004). These additional services compete with the services

Table 3. Target Markets for Consultants and Market Information Systems: Bivariate Tobit and Two-Stage Univariate Tobit Model Results

	[A] Bivariate Tobit Maximum Likelihood Coefficient		[B] Two-Stage Univariate Maximum Likelihood Coefficient	
Variable	Consultant	Information System	Consultant	Information System
Intercept	-426.19 (363.89)	51.82 (124.05)	-12,802.24 (2,165.52)	-1,082.19 (254.49)
Predicted Consultant Expenditure				-0.2255** (0.1022)
Predicted Information System Expenditure			1.2866 (2.446)	
Total Acres	0.2454*** (0.0607)	0.1404*** (0.0183)	1.2307** (0.5429)	0.4275*** (0.0478)
Total Acres Squared	-0.00029*** (0.00005)	-0.00006*** (0.00001)	-0.00065** (0.00036)	-0.00022*** (0.00003)
Percent Crops Priced Before Harvest	9.918*** (1.56)	1.20** (0.52)	49.845*** (9.296)	5.431*** (1.658)
Price Variability	-228.14 (166.61)	35.267 (75.49)	-435.16 (954.72)	241.33** (126.10)
Producer Marketing Knowledge	298.78** (101.22)	184.57*** (32.09)	2,889.37*** (775.11)	628.02*** (81.31)
Risk Aversion	55.80 (89.59)	-29.615 (29.98)	317.89 (495.79)	-62.367 (61.88)
Education	87.43 (115.12)	47.77 (38.44)	393.90 (614.11)	194.55** (71.43)
Marketing Plan	94.49 (113.54)	89.02** (36.55)	996.06 (661.38)	257.73** (85.45)
Age	-1.462 (3.97)	-2.62** (1.35)	-16.225 (25.34)	-118.83*** (2.85)
Wealth	310.49*** (116.05)	136.85*** (30.86)	-39.701 (768.40)	261.26*** (83.44)
Cotton Acres	497.76** (253.9)	-127.77* (71.89)	2,376.20* (1,400.56)	-364.41** (165.45)
Soybean Acres	553.304** (275.76)	13.59 (80.46)	1,994.14* (1,418.20)	90.857 (167.08)
Corn Acres	248.48 (263.05)	176.89*** (68.45)	3,730.31** (1,582.29)	731.95*** (175.47)
Sorghum Acres	114.19 (452.9)	-70.36 (147.06)	-3,200.00 (2,867.14)	-732.28 (307.12)
	ρ_{12} = 1,869.97***, (9.168) Log Likelihood Func. = 12,326.225 Adjusted R^2 = 0.218		Log Likelihood Func. = 12,320.376 Adjusted R^2 = 0.223	

Notes: Single, double, and triple asterisks (*) denote statistical significance at the α = 0.1, 0.05, and 0.01 levels, respectively. Numbers in parentheses are standard errors.

offered by market information systems. However, the reverse does not appear to be true (i.e., market information does not substitute for marketing consultants), which also is reasonable. Specifically, market information presents a general knowledge base for producers, but is not likely to compete with more specialized services and information provided by consultants.

Total acres and acres squared are both statistically significant in the two-stage univariate model. Taken together, these results show that expenditures increase at a decreasing rate in farm size, a finding consistent with prior research (Hoag, Ascough, and Marshall, 1999; Gloy, Akridge, and Whipker, 2000; Daberkow and McBride, 2001). Expenditure on marketing consultants is maximized at 953 acres, while expenditure on market information systems is maximized at 963 acres, suggesting similar scale economies of the two marketing inputs. Again, the degree of specialization in information affects this result. Because market information systems provide general information, their cost can be spread across more acres.

The percentage of crops priced before harvest is significant and directly related to producers' purchases of marketing services and market information systems, as expected. Producers more actively engaged in marketing appear to purchase more of both services. Price variability is significant and directly related to producers' purchases of market information systems only, suggesting price variability has the effect of inducing producers to seek out information to manage that risk. From a farm policy perspective, this result indicates price variability creates an externality that is managed by the producer through an additional expenditure on market information systems.

Producers' marketing knowledge is significant and directly related to producers' purchases of marketing services and market information systems. Previous knowledge may increase the producers' efficiency and/or interest in using those services. Similarly, education is significant and directly related to producers' purchases of market information systems. Thus, increases in knowledge/human capital, in general, increase expenditures on these services.

Having a marketing plan is significant and directly related to producers' purchases of market information systems. This result lends support to the notion that if a producer has a written marketing plan, the farm may be less dependent on the services of a hired marketing consultant, while a marketing plan does not replace the need for information systems. In fact, a written marketing plan may actually increase the need for market information systems. Encouraging written marketing plans could increase demand for market information systems. An example marketing strategy for information service providers would be to offer assistance to producers in designing a written marketing plan in exchange for subscribing to their service.

Age is significant and inversely related to producers' purchases of market information systems. This result is consistent with the work of Putler and Zilberman (1988), Jarvis (1990), Schnitkey et al. (1992), and Baker (1991), and suggests older producers are less likely to use advanced technologies. As turnover in farm operators occurs and younger producers take over, a natural increase in market information use is likely to occur. The coefficient for wealth is significant and directly related to producers' purchases of market information systems. This finding is consistent with the work of Amponsah (1995). Again, as farms grow larger, this result points to a natural growth in demand for these types of services/products.

Most of the commodity acreage percentage variables were statistically significant in explaining producers' demand for marketing services and market information systems. Cotton acres are significant and directly related to producers' purchases of marketing services, but inversely related to producers' purchases of market information systems. Due to the popularity of pooled marketing among cotton producers (Isengildina and Hudson, 2001), most of the marketing decisions are made by professional marketers, thus reducing the need by producers to use sophisticated information systems to track market movements. Percentage of soybean acres is significant and directly related to producers' purchases of marketing services. This result is in agreement with the work of Eckman, Patrick, and Musser (1996), who noted the importance of the role of marketing consultants in assisting producers in making soybean-pricing decisions. Percentage of corn acres is significant and directly related to both producers' purchases of marketing services and market information services. This result supports the findings of Goodwin and Schroeder (1994) that showed the intensive use of futures hedging among corn producers, thus requiring accurate information systems to track market price movements.

Collectively, the above results reveal some important implications. For crops where producers make the majority of marketing decisions (corn and soybeans), a heavier emphasis is placed on market information. For crops where production management is more intensive (cotton), heavier emphasis is on market consulting services. Although not directly examined here, these results suggest that higher per acre values for the crop tend to be associated with greater employment of marketing consulting services.

The Multinomial Logit Model

In order to identify what factors motivate producers to use different combinations of marketing services and market information systems, a multinomial logit model was estimated to predict producers' adoption of different levels of technology. Results are presented in table 4. The adoption levels were (*a*) no adoption, (*b*) adoption of agricultural consultants only, (*c*) adoption of market information systems only, and (*d*) simultaneous adoption of both agricultural consultants and market information systems. The likelihood ratio χ^2 value of the model was 676.23, indicating statistical significance at the < 0.001 level.

A second measure of overall model performance is percentage of concordance, which identifies the percentage of observations where the predicted and observed response agrees (table 5). The model is 68% concordant. As is typical of multinomial models, not all categories were predicted equally well. The model predicted nonadoption and simultaneous adoption quite well. However, the model failed to predict any cases of adoption of agricultural consultants only. Marginal effects, calculated at the sample means of the data, are reported in table 4. The marginal effects provide a measure of the percentage change in the probability of adoption. The results indicate several significant economic factors influencing marketing technology adoption.

Overall, the results of this analysis suggest total acres, the percentage of crops priced before harvest, previous marketing knowledge, perception of price variability, education, the existence of a marketing plan, wealth, and the percentage of total acres planted to corn are factors shown to increase the likelihood that producers will adopt marketing advisory services, market information systems, or both. On the other hand, age, the percentage of total acres planted to cotton, and the percentage of total acres planted to sorghum are factors found to decrease the likelihood that producers will adopt marketing advisory services, market information systems, or both. Generally, the results are consistent with the two-stage univariate Tobit model.

Table 4. Target Markets for Consultants and Market Information Systems: Multinomial Logit Model Results

	[A] Adopt Neither Consultants Nor Market Information Systems		[B] Adopt Consultants Only	
Variable	Max. Likelihood Coefficient	Marginal Effect Coefficient	Max. Likelihood Coefficient	Marginal Effect Coefficient
Intercept		0.6135***	-4.2020	-0.1452***
Total Acres		-0.0015***	0.0039	0.000070
Total Acres Squared		0.00000008***	-0.00000018	-0.0000000023
Percent Crops Priced Before Harvest		-0.0160**	0.1677	0.0063***
Price Variability		-0.1255**	0.2029	0.0017
Producer Marketing Knowledge		-0.2659***	0.9966	0.2584**
Risk Aversion		-0.0199	0.2267	0.1005
Education		-0.6670**	-0.1890	-0.1328
Marketing Plan		-0.1469***	0.5059	0.1227
Age		0.0509***	-0.0770	0.00013
Wealth		-0.8809**	-0.3550	-0.2220
Cotton Acres		0.1353*	0.7286	0.4240
Soybean Acres		-0.0319	0.7770	0.0121
Corn Acres		-0.3892***	1.6567	0.4673
Sorghum Acres		0.2759**	-0.4452	-0.0034

	[C] Adopt Market Information Systems Only		[D] Adopt Both Consultants and Market Information Systems	
Variable	Max. Likelihood Coefficient	Marginal Effect Coefficient	Max. Likelihood Coefficient	Marginal Effect Coefficient
Intercept	-1.9590	-0.2687**	-4.8130	-0.1995***
Total Acres	0.0062	0.0010***	0.0096	0.00037***
Total Acres Squared	-0.00000032	-0.000000054***	-0.0000006	-0.000000024***
Percent Crops Priced Before Harvest	0.0335	0.0022	0.1688	0.0074***
Price Variability	0.6400	0.1201**	0.2995	0.0522
Producer Marketing Knowledge	1.0293	0.1655***	1.8570	0.7459***
Risk Aversion	-0.4251	-0.1244	0.8737	0.0437
Education	0.3110	0.5591**	0.5696	0.2410**
Marketing Plan	0.5869	0.9642**	0.9685	0.3822***
Age	-0.2305	-0.0408***	-0.2773	-0.0102**
Wealth	0.5139	0.1019***	0.3007	0.8368
Cotton Acres	-0.8100	-0.1622**	-0.5129	-0.1550
Soybean Acres	0.3671	-0.0370	0.7142	0.3448
Corn Acres	1.4890	0.2375***	2.6360	0.1049***
Sorghum Acres	-1.2450	-0.2201*	-1.5040	-0.5544

Log Likelihood Function = -1,335.555
Restricted Log Likelihood = -1,673.671
χ^2 = 676.2327

Note: Single, double, and triple asterisks (*) denote statistical significance at the α = 0.1, 0.05, and 0.01 levels, respectively.

Table 5. Concordance Results of Multinomial Logit Model: Frequency of Actual and Predicted Outcomes

		Predicted				
		0	1	2	3	Total
Actual	0	852	0	91	6	949
	1	46	0	17	6	69
	2	214	0	193	24	431
	3	48	0	77	43	168
	Total	1,160	0	378	79	1,617

Conclusions

This paper examines the determinants of the demand for marketing advisory services and market information systems by grain and cotton producers. Unlike prior research in which these purchase decisions are considered as independent, this study first determines whether these decisions are interrelated, and then examines whether market consultants and marketing information systems are complements or substitutes. Finally, the factors affecting different levels of adoption are examined.

The results indicate that the producer decision to purchase market consulting services and marketing information systems is a joint decision. Implications of this finding are twofold. First, the decision to purchase different levels of market consulting services and market information systems is not made in isolation. Therefore, an economic evaluation of the producers' choice for these marketing tools made in isolation may lead to biased results. Second, it was found that for cotton and grain producers, market consultants are substitutes for market information systems.

Interestingly, risk-averse producers did not show a direct relationship with the demand for marketing advisory services or market information systems. A logical follow-up to this study would include a measure of how much producers know about risk management tools in order to better assess the relationship between risk and the demand for marketing consultants and market information systems.

This analysis provides an insight into grain and cotton producers' demand for marketing advisory services and market information systems at a time when the agricultural sector faces changes in federal support programs, and vertical and horizontal integration is common among the marketing channels. It is expected that successful producers are those who will make better use of these marketing services to help them cope with the uncertainty of farming.

This study is unique in that its focus is not on computer adoption, but rather on specific marketing information application packages. Also, producers from the major crop commodities and producing areas are included—permitting examination of the demand for marketing services and information systems that smaller studies have not allowed. A natural extension of this work would investigate the role of speculative reasons in the choice process.

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