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The Economic Impact of Services Provided by an Electronic Trade Platform: The Case of MarketMaker

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Despite the touted potential of e-commerce to improve agriculture profits, the literature on effectiveness of e-commerce is very limited. This paper assesses the economic impact of an electronic trade platform (i.e., MarketMaker) on agricultural producers. Contingent valuation techniques are employed to estimate the monetary value that producers placed on MarketMaker services. Results indicate that producers are willing to pay $47.02 annually for the services they receive. Registration type, amount of time registered, amount of time devoted to MarketMaker, type of user, number of marketing contacts received, and firm total annual sales have a significant effect on producers' willingness to pay.

Key words: contingent valuation, e-commerce, nonparametric methods, willingness to pay

Introduction

Agricultural producers' use of computers and the Internet has increased in recent years. In 2011, 62% of U.S. farms had Internet access and 65% had access to a computer compared to 29% and 47% in 1999, respectively (U.S. Department of Agriculture, National Agricultural Statistics Service, 1999, 2011). One of the potential applications of computers and the Internet in agriculture is e-commerce, which refers to the use of the Internet to market, buy, and sell goods and services; exchange information; and create and maintain web-based relationships among participants (Fruhling and Digman, 2000).

E-commerce has been said to have the potential to both increase sales revenues and significantly decrease costs through greater efficiencies of operation. Gains in efficiency could result from reducing inventory levels, transportation costs, information costs, and order and delivery times (Batte and Ernst, 2007; Montealegre, Thompson, and Eales, 2007).

In spite of the touted potential of e-commerce to improve profits in agriculture, the literature on its economic impact in agribusinesses is very limited. Most of the literature related to computer and Internet use has focused on describing and analyzing the extent of adoption and usage by agribusinesses (e.g., U.S. Department of Agriculture, National Agricultural Statistics Service, 2011; Batte, 2004). Moreover, studies evaluating e-commerce websites have focused on assessing users' perceptions of quality rather than on the economic impacts of these sites.

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This study extends the e-commerce impact literature by assessing the economic benefits of an electronic trade platform (i.e., MarketMaker) on agricultural producers.[1] Specifically, contingent valuation methods are employed to estimate the economic value (i.e., willingness to pay) that producers registered with MarketMaker place on the services received from this trade platform.[2] We also evaluate the effect of producers' characteristics and perceptions on their economic valuation of the site.

MarketMaker is a free electronic resource that allows producers to select consumer attributes and receive a geocoded response showing the location of consumers with those attributes. The site also includes business data, which allows producers to identify potential supply-chain partners. For consumers—households, processors, handlers, retail, and wholesale companies—MarketMaker provides useful information to help decide where to purchase products and to identify upstream opportunities for adding value before final sale. Registered producers can use the MarketMaker website as a free marketing tool to help identifying new customers and potential clientele can find detailed information about farmers' product portfolios, geographic locations, and contact information. To date, the site operates in eighteen states and has over 17,500 profiles—including 7,698 producers.[3] It receives about one million hits per month from over 86,000 food-industry entrepreneurs.

Literature Review

The majority of studies evaluating e-commerce platforms have focused on assessing users' perceptions of website quality based on design, usability, and performance rather than on the economic impacts that the e-commerce platforms generate for their users. For example, Agarwal and Venkatesh (2002) developed a method for measuring and rating specific components of e-commerce website usability from a user's perspective, including content quality and design, ease of use, and ability to tailor a website to fit individual users' needs. In addition to website usability, Aladwani and Palvia (2002) also considered the quality of websites' technical components, including security, availability, interactivity, speed of page loading, and customer service. More comprehensive studies have highlighted the importance of other dimensions of perceived web quality beyond those related to interactions with e-commerce sites. For example, Petre, Minocha, and Roberts (2006) developed an evaluation instrument that measures both purchase and post-purchase web capabilities. Post-purchase components include product delivery, post-sale support, and quality of products and services. These evaluation methodologies were used to measure the quality of different e-commerce websites, including banks, bookstores, car manufactures, electronic retailers, and travel-related services.

Other studies have documented the adoption and use of different electronic marketing technologies by farmers and manufacturers. For example, Sporleder (1984) and Henderson (1984) described the early stages of electronic marketing use in agricultural markets with a special emphasis on the adoption of commodity electronic trading. The main objectives of these early efforts were to define the concept of electronic marketing and to describe its potential applications to agricultural markets. A gain in pricing efficiency was envisioned by the adoption of electronic trading systems.

More recent studies have focused on identifying firm characteristics that are likely to lead to a success when adopting electronic marketing. In a survey of 379 Swedish manufacturing firms, Bengtsson, Boter, and Vanyushyn (2007) explored the differences between adopters and nonadopters

[1] Electronic trade platforms are electronic systems that support the marketing, selling, buying, and servicing of products by matching vendors and buyers, providing intermediate trading transactions up to contract conclusion, and/or by providing the legal and technical institutional infrastructure and environment that facilitates these interchanges (Fritz, Housen, and Schiefer, 2005).

[2] Agricultural producers include both farmers and fishermen.

[3] States that have launched MarketMaker sites including Illinois, Iowa, Nebraska, Kentucky, New York, Georgia, Mississippi, Michigan, Ohio, Indiana, South Carolina, Colorado, Arkansas, Florida, Pennsylvania, Louisiana, Alabama, and Washington D.C.

of advanced Internet-based operations in firms of different sizes. Firm size was found to be positively associated with the adoption of the advanced Internet-based marketing operations. In addition, the composition of factors that affect the adoption process differed for each firm size considered. Several factors were related to a positive adoption of e-commerce practices in small and medium-sized firms, including external pressure from customers and competitors (Bengtsson, Boter, and Vanyushyn, 2007), professional-services firms and consumer-oriented firms (Daniel, Wilson, and Myers, 2002), and entrepreneurial thinking (Fillis and Wagner, 2005).

Similar efforts have been made to understand the adoption of e-commerce by agribusinesses. In a study of 575 U.S. agribusiness firms, Henderson et al. (2005) concluded that larger firms with a global scope are more likely to adopt internet strategies. Baer and Brown (2007) examined factors influencing website adoption by direct-marketing farms in the northeastern United States. The number of advertising methods used, high-speed Internet connection, and gross farm sales were found to be positively related to website adoption. In a broader context, Bhaskaran (2006) studied and identified the relationship between seafood retailers' characteristics and their implementation of novel production practices, including marketing innovations in Australia.

Subramaniam and Shaw (2002) conducted one of the few studies evaluating economic impacts of e-commerce platforms. The authors estimated the cost savings of a heavy-equipment manufacturer associated with the procurement of indirect inputs through electronic trade platforms. Specifically, the implementation of an electronic business-to-business collaboration system resulted in procurement cost savings between 33% and 68%.

Studies evaluating the effectiveness of specific agricultural e-commerce platforms such as MarketMaker are very limited. In fact, we are only aware of one national and two state-level efforts that have focused on the impact of MarketMaker on agribusiness operations. At the national level, Zapata et al. (2011) estimated the perceived benefits attributed to participation in MarketMaker. Surveyed producers reported that they received an average of 2.6 marketing contacts as a result of their participation in MarketMaker and have gained an average of 1.5 new customers. Additionally, MarketMaker has assisted registered farmers with increasing their annual sales by an average of $121. This study was based on the evaluation and implementation framework developed by Lamie et al. (2011) to measure the impacts of the MarketMaker project. Lamie et al. (2011) describe the development of tailored evaluation tools—including logic models, quantifiable evaluation indicators, and survey instruments—for the main groups of MarketMaker participants: producers, consumers, retailers, wholesalers, chefs/restaurants, and farmers' markets.

At the state level, Fox (2009) developed and implemented a survey of various representatives of Ohio's food chain including producers, processors, wineries, farmers' markets, and distributors. One of the project objectives was to explore changes in marketing practices and market access that resulted from the use of MarketMaker. The survey asked Ohio registered producers if they believed that the MarketMaker site was helping keep more food dollars in the regional economy; 63% of producers agreed with the statement. Cho and Tobias (2009) conducted a survey of New York farmers registered on MarketMaker. Survey results indicated that the average increase in annual sales attributed to MarketMaker was between $225 and $790. Additionally, about 12% of respondents reported receiving marketing contacts through MarketMaker and using the MarketMaker directory to contact other food industry business partners.

In short, the evaluation of e-commerce platforms has mainly focused on human-computer interactions rather than on the economic impacts associated with participating in e-commerce activities. Studies evaluating the economic impact of agricultural e-commerce platforms are very limited.

Methods and Procedures

Since the main goal of this study is to estimate the economic benefits of MarketMaker for registered producers, we employed contingent valuation methods to estimate these benefits. Contingent

valuation methods can be used to estimate the economic value of a novel input or a nonmarket input (such as MarketMaker services) because the amount of money a producer is willing to pay for an improvement in the quality of a production factor represents the difference in profits before and after the improvement (Zapata and Carpio, 2013). Moreover, the willingness-to-pay (WTP) measure has the potential to incorporate other benefits attributed to the use of MarketMaker beyond an increase in profits, such as networking and collaboration between participants.

Contingent valuation techniques have been widely used to estimate the economic value of nonmarket goods and services as well as to assess individuals' willingness to pay for environmental services for which market prices are not well defined (Carson et al., 1995; Boyle, 2003; Carson and Hanemann, 2005; Zapata et al., 2012). More recently, contingent valuation methods have been used in health economics (Diener, O'Brien, and Gafni, 1998; Krupnick et al., 2002), real estate appraising (Breffle, Morey, and Lodder, 1998; Banfi et al., 2008; Lipscomb, 2011), art valuation (Thompson et al., 2002), agricultural extension services (Whitehead, Hoban, and Clifford, 2001; Budak, Budak, and Kaçira, 2010), and agribusiness (Patrick, 1988; Kenkel and Norris, 1995; Hudson and Hite, 2003).

Theoretical Framework

The WTP model presented here is developed within the context of the neoclassical theories of utility maximization and profit maximization as shown in Zapata (2012). More specifically, the variation function (or producer's WTP for nonmarket inputs or technologies) is derived using the individual's indirect utility function in combination with the firm's profit function.

In the context of this study, the adoption of MarketMaker is treated as an improvement in the quality of an aggregate marketing input. In fact, a recent study by Zapata et al. (2011) found that the majority of producers registered in MarketMaker used the MarketMaker website to reach individual consumers. Another justification for assuming that adopting MarketMaker represents an upgrade in terms of the quality of aggregate marketing input, rather than an additional input, is the strict essentiality property of the production function, which states that the production of a positive amount of output requires the use of positive quantities of all inputs (Chambers, 1988, p. 9).

Suppose that an individual maximizes utility $U(\boldsymbol{Z})$, where $\boldsymbol{Z}$ is a vector of goods consumed subject to income constraint. It is further assumed that part of her income (i.e., nonlabor income) comes from the profits she generates in a production process independent of individual preferences. The solution to the problem yields the indirect utility function $V[\overline{m}(\Pi(p_y,\boldsymbol{r},\boldsymbol{q})),L,\boldsymbol{P}_z]$, where $\overline{m}$ and L are the individual's nonlabor and labor income, $\Pi(\cdot)$ is the profit function, p_y is the price of produced output, $\boldsymbol{r}$ is a vector of input prices, $\boldsymbol{q}$ is a vector of exogenous input quality levels, and $\boldsymbol{P}_z$ is the vector price of the goods or services consumed. Now consider a change in the input quality level $\boldsymbol{q}$ from $\boldsymbol{q}^0$ to $\boldsymbol{q}^1$. In this context, the producer's WTP is the amount of money needed to make her indifferent between the original inputs and the upgraded inputs. Specifically, this relationship can be represented by $V[\overline{m}(\Pi(p_y,\boldsymbol{r},\boldsymbol{q}^0)),L,\boldsymbol{P}_z] = V[\overline{m}(\Pi(p_y,\boldsymbol{r},\boldsymbol{q}^1)) - WTP,L,\boldsymbol{P}_z]$.

If nonlabor income ($\overline{m}$) is a linear function of profits (Π), then the producer's WTP is also a linear function of the difference in profits and can be simplified to:[4]

$$WTP = \Pi(p_y,\boldsymbol{r},\boldsymbol{q}^1) - \Pi(p_y,\boldsymbol{r},\boldsymbol{q}^0). \tag{1}$$

[4] Linear (in the arguments) indirect utility functions are frequently assumed in the analysis of several economic problems (e.g., Haab and McConnell, 2002, p. 201). Moreover, it can be shown that as long as total income I is the sum of labor and nonlabor income (i.e., $I = \overline{m}(\cdot) + L$), equation (1) also holds for several of the most commonly used nonlinear (in the arguments) indirect utility functions. including the indirect representations of the CES and Cobb-Douglas direct utility functions and Gorman Polar indirect utility functions (Cornes, 1992, p. 53–55; Jehle and Reny, 2000, p. 42). Furthermore, equation (1) also holds for the indirect utility functions corresponding to preferences exhibiting price-independent generalized linearity and log-linearity (Cornes, 1992, p. 197).

Consequently, the maximum amount of money a producer is willing to pay for improvements in input quality levels reduces to the difference between the firm's *ex post* (after adopting the new input) and *ex ante* (before adopting the new input) profit levels.

Survey Description

Agricultural producers registered on the MarketMaker site were surveyed using both online and mailed paper instruments during the months of May 2011 and February 2012. The survey instrument was developed in conjunction with MarketMaker administrators in each state. Final survey instruments were approved by the MarketMaker National Evaluation Committee and the MarketMaker Policy Advisory Committee. The questionnaire was also tested in a focus group of registered MarketMaker producers. The survey was initially distributed by email to 1,446 producers registered on MarketMaker websites in seven participant states: Arkansas, Florida, Georgia, Indiana, Iowa, Mississippi, and South Carolina.[5] In February 2012, a second round of surveys was mailed to a subsample of 592 producers with the purpose of increasing the number of responses.

The questionnaire consisted of four sections. The first section focused on users' experience with MarketMaker. The second section concentrated on participants' perceptions of the impact of MarketMaker on their business. The third section asked respondents about their demographic characteristics as well as business characteristics. Producers' WTP questions were included at the end of this section. Finally, the fourth section, which was only given to producers participating in direct-marketing channels, focused on the impact of MarketMaker on direct marketing.

An invitation email containing a brief description of the project and the link to the questionnaire was sent to all registered agricultural producers in the participating states. Two reminder emails (one and two weeks after the initial email) were sent to individuals who had not responded to the survey. To further encourage participation in the survey, respondents were offered the opportunity to enter a drawing to win $100. Typical completion time of the questionnaire was five to ten minutes.

The overall response rate for the email survey was 8.9%; there were 129 usable observations. As found in a meta-study of 199 online surveys by Hamilton (2009), online survey response rates tend to be low (their study found a 13.4% average response rate). With the aim of increasing the number of responses, a mail survey and two reminder letters were sent to a random sample of 45% of those producers who did not respond to the initial email survey. The mail survey generated ninety-eight additional responses and had an overall response rate of 16.6%. The aggregated response rate of the study was 15.7% with 227 usable observations.[6] The sample frame size, number of respondents, and response rate by MarketMaker participant state and survey type are shown in table 1. The states with the highest response rate were Arkansas (24.5%) and Florida (21.0%), and those with the lowest response rate were Mississippi (11.8%) and South Carolina (12.5%). The proportion of individuals from each state in the final sample closely follows the corresponding proportions in the population.

Since a shorter version of the survey, without the WTP question, was implemented in several other participating states, we also compared the characteristics of this sample with that of the sample of individuals responding to the survey with the WTP question. The comparison was carried out using regression analyses accounting for potential heteroskedasticity problems. The dependent variable in the models was the characteristic of interest (all the explanatory variables in the WTP model, table 7), and the explanatory variable was a dummy variable identifying the survey version. Retaining the overall error at $\alpha = 0.05$, the null hypothesis that the mean value of the characteristic of interest does not differ across sample groups was not rejected in any of the cases. Although this result is not conclusive with regard to potential nonresponse survey biases, it provides some evidence

[5] Of registered website producers, 97% are farmers, 1% are fishermen, and 2% are both farmers and fishermen.

[6] Low response rates have traditionally been linked to lack of representativeness and bias in surveys results. However, several recent empirical studies analyzing the links between low response rates and low survey accuracy suggest a very weak or nonexistent relation between the two (Keeter et al., 2000; Curtin, Presser, and Singer, 2000; Brick et al., 2003; Keeter et al., 2006; Holbrook, Krosnick, and Pfent, 2008).

Table 1. Survey Sample Frame Size, Number of Respondents, and Response Rate by State

	Sample Frame Size		Number of Respondents			Response Rate		
State	**Email**	**Mail**	**Email**	**Mail**	**Total**	**Email**	**Mail**	**Total**
Arkansas	45	25	3	8	11	6.67	32.00	24.44
Florida	143	51	27	3	30	18.88	5.88	20.98
Georgia	260	107	18	16	34	6.92	14.95	13.08
Indiana	323	129	34	25	59	10.53	19.38	18.27
Iowa	326	130	27	23	50	8.28	17.69	15.34
Mississippi	93	34	7	4	11	7.53	11.76	11.83
South Carolina	256	116	13	19	32	5.08	16.38	12.50
Total	1,446	592	129	98	227	8.92	16.55	15.70

that nonresponse biases (if any) in the survey with the WTP question did not differ from those of the survey without the WTP question. The rates of response for both survey types were also similar.

WTP Questions

The producers' WTP question was asked using a double-bounded (DB) elicitation format. Using an appropriate elicitation approach has always been a major concern. In recent years, the DB elicitation format has virtually supplanted single-bounded (SB) and open-ended (OE) formats, mainly because this format reduces the strategic bias present in the OE method (Hanemann, 1994; Boyle, 2003) and provides more efficient estimates of central tendency than the SB format (Hanemann, Loomis, and Kanninen, 1991).[7] Two rounds of questions were presented to each participant. The initial bid amount was randomly assigned among respondents, and the second bid amount depended on their answers to the first question (higher if participant responded "yes" to the initial bid and lower if participant responded "no" to the initial bid).

The initial bids used were \$25, \$50, \$75, \$100, \$150, and \$200. The corresponding follow-up annual bids were \$15, \$25, \$50, \$75, \$100, and \$150 when the initial response was a "no," and \$50, \$75, \$100, \$150, \$200, and \$250 when the initial response was a "yes." The different bids used in the WTP questions were chosen based on responses to an OE question obtained in a focus group early in November 2010 (producers' mean WTP value was estimated at \$65), previous studies evaluating the website, and consultation with MarketMaker administrators in several states.

A brief statement that clearly described the current funding situation of MarketMaker and the possibility that it might become privately funded in the future preceded the WTP question. An annual participation fee was used as the payment vehicle. The wording and payment vehicle used in the survey and two alternative WTP question options had been previously tested in the focus group. The two WTP question alternatives involved more extensive descriptions of MarketMaker's current and future funding situation. The other payment vehicle considered was a voluntary annual donation. All participants agreed that the scenarios described in the different WTP questions were realistic and that the WTP question employed in the survey was the easiest to respond to. The specific initial and follow-up questions presented to the participants are listed in Appendix A.

The validity of using a bid process and contingent valuation techniques to value free goods has been a topic of discussion and research by economists for the past twenty years (Kling, Phaneuf, and Zhao, 2012). Even though the debate is still ongoing and further research is critical in this area, there is a consensus that certain conditions tend to improve the quality of the results (Arrow et al., 1993; Kling, Phaneuf, and Zhao, 2012). Specifically, the current state of the good or service under valuation needs to be well known by participants, the future and hypothetical state has to be feasible

[7] One limitation of the DB elicitation format is the use of predetermined bids, which could cause anchoring (Boyle, 2003). In addition, some studies have found a tendency among respondents to answer "yes" to any bid amount presented to them regardless of their true views (Berrens, Bohara, and Kerkvliet, 1997; Blamey, Bennett, and Morrison, 1999).

and well understood, and the political intervention considered needs to be realistic. We believe that the above conditions are true for this particular study.

Econometric Methods

Summary Statistics

In order to simplify the respondents' tasks and encourage responses, most of the outcome measures (e.g., the number of new contacts found through MarketMaker), as well as demographic and business information, were collected using a discrete number of categories; the calculation of the mean value of these variables therefore required using special statistical techniques (Bhat, 1994; Carpio, Wohlgenant, and Safley, 2008; Stewart, 1983).

Two alternative approaches were used to estimate the mean values: a parametric and a nonparametric approach. The parametric approach was adapted from the literature on estimating equations using data in which the dependent variable is only observed to fall in a certain interval (Stewart, 1983; Bhat, 1994). The nonparametric procedure was adapted from the survival statistical literature (Turnbull, 1976) and contingent valuation literature (Day, 2007). Point estimates of the means of categorical variables were estimated using the parametric approach, while the nonparametric approach was used to estimate upper and lower bounds of the means.

Estimation of WTP Models

Estimating producers' WTP for MarketMaker services followed from methods proposed by Cameron (1988). Let WTP_i be the unobserved true amount that respondent i is willing to pay. In the DB elicitation format, every respondent i is presented with an initial bid B_i and asked if she is willing to pay that amount. If the respondent answers "yes" to the first bid, a second WTP question is asked, using a higher bid amount B_i^u. If the respondent answers "no" to the first bid, the second WTP question uses a lower bid B_i^l. Respondents will answer "yes" to the initial amount if $WTP_i \geq B_i$ and "no" to the second bid amount if $WTP_i < B_i^u$. Similarly, respondents will answer "no" to the initial amount if $WTP_i < B_i$ and "yes" to the second bid amount if $WTP_i \geq B_i^l$. Using the same logic, it is easy to show that respondents will answer "yes" to both questions if $WTP_i \geq B_i^u$ and "no" to both questions if $WTP_i < B_i^l$. Therefore, the probability that a respondent answers "yes" to both questions (π^{yy}) can be represented by

$$\pi^{yy}(B_i, B_i^u) = Pr\{WTP_i \geq B_i \text{ and } WTP_i \geq B_i^u\} = Pr\{WTP_i \geq B_i^u\} = 1 - G(B_i^u; \boldsymbol{\theta}), \tag{2}$$

where $G(B_i^u; \boldsymbol{\theta})$ is the cumulative density function (CDF) of some statistical distribution with parameter vector $\boldsymbol{\theta}$. The probability that a respondent answers "no" to both questions (π^{nn}) is given by

$$\pi^{nn}(B_i, B_i^l) = Pr\{WTP_i < B_i \text{and } WTP_i < B_i^l\} = Pr\{WTP_i < B_i^l\} = G(B_i^l; \boldsymbol{\theta}). \tag{3}$$

Similarly, the probability that a respondent answers "yes" to the first question and "no" to the second question (π^{yn}) is given by

$$\pi^{yn}(B_i, B_i^u) = Pr\{B_i \leq WTP_i < B_i^u\} = G(B_i^u; \boldsymbol{\theta}) - G(B_i; \boldsymbol{\theta}). \tag{4}$$

Finally, the probability that a respondent answers "no" to the first question and "yes" to the second question (π^{ny}) is given by

$$\pi^{ny}(B_i, B_i^l) = Pr\{B_i^l \leq WTP_i < B_i\} = G(B_i; \theta) - G(B_i^l; \boldsymbol{\theta}). \tag{5}$$

Table 2. CDF, Parameterization, Conditional and Unconditional Mean, Median, and Marginal Effects of the Log-Logistic Distribution

Function/Characteristic		Formula
CDF	$G(B;\boldsymbol{\theta})$[a]	$\left\{1+exp\left[-\frac{\log(B)-\mu}{\sigma}\right]\right\}^{-1}$
Parameterization		$\mu=\boldsymbol{X}_i'\boldsymbol{\beta}$
Mean	Unconditional: $E(WTP)$	$exp(\mu)\Gamma(1+\sigma)\Gamma(1-\sigma)$
	Conditional: $E(WTP\|\boldsymbol{X}_i)$	$exp(\boldsymbol{X}_i'\boldsymbol{\beta})\Gamma(1+\sigma)\Gamma(1-\sigma)$
Median		$exp(\mu)$
Marginal Effect	Continuous	$B_j exp(\boldsymbol{X}_i'\boldsymbol{\beta})\Gamma(1+\sigma)\Gamma(1-\sigma)$
	Discrete	$exp(\boldsymbol{X}_i'\boldsymbol{\beta})\Gamma(1+\sigma)\Gamma(1-\sigma)[1-exp(-\beta_j)]\|_{x_{ij}=1}$

Notes: [a] μ and σ denote the location and scale parameter, respectively.

Given a sample of N individuals, the log-likelihood function can be represented by

$$
\begin{aligned}
\ln L(\boldsymbol{\theta}) \quad = \quad & \sum_{i=1}^{N}\{(I_{1i})(I_{2i})\ln\pi^{yy}(B_i,B_i^u) \\
& +(1-I_{1i})(1-I_{2i})\ln\pi^{nn}(B_i,B_i^l) \\
& +(I_{1i})(1-I_{2i})\ln\pi^{yn}(B_i,B_i^u) \\
& +(1-I_{1i})(I_{2i})\ln\pi^{ny}(B_i,B_i^l)\},
\end{aligned} \tag{6}
$$

where I_{ji}, $j=1,2$, are indicator variables such that I_{ji} is equal to 1 if the ith respondent answers "yes" to the jth question and equal to 0 otherwise.

Explanatory variables can be introduced to the maximum likelihood estimation by modeling some elements of the parameter vector $\boldsymbol{\theta}$ as a function of specific covariates. For example, under the log-logistic distribution the parameter μ can be expressed as $\mu=\boldsymbol{X}_i'\boldsymbol{\beta}$, where $\boldsymbol{X}_i$ is a vector of covariates (including 1 for the intercept) and $\boldsymbol{\beta}$ the corresponding vector of parameters. Moreover, the inclusion of explanatory variables and additional parameters in the modeling process allows the estimation of the conditional mean WTP ($E(WTP|\boldsymbol{X}_i)$) and corresponding marginal effects (see table 2).

The marginal effects for continuous variables are estimated by taking the partial derivative of the conditional mean function with regard to the covariate of interest (i.e., $\frac{\partial E(WTP|\boldsymbol{X}_i)}{\partial x_j}$). For discrete variables (with values of 0 or 1), the marginal effects are given by the change in the conditional mean WTP as a result of a change in the discrete variable form 0 to 1, holding all other variables fixed as suggested by (Cameron and Trivedi, 2005, p. 124) (i.e., $E(WTP|\boldsymbol{X}_i,x_{ij}=1)-E(WTP|\boldsymbol{X}_i,x_{ij}=0)$). The marginal effects were calculated as the average marginal effects across the N producers in the sample. The standard errors of the mean WTP, coefficient estimates ($\boldsymbol{\beta}$), and marginal effects were estimated using the bootstrapping procedure outlined by (Cameron and Trivedi, 2005, p. 362). A total of 1000 replications were used to generate the standard errors.

It was assumed that producers' WTP for MarketMaker services could be explained by producers' characteristics and perceptions. To this end, registration type, the amount of time producers had been registered on the site, amount of time spent on MarketMaker activities, type of user based on usage frequency, number of marketing contacts received as a result of MarketMaker participation, total number of new customers gained, increase in annual sales attributed to MarketMaker, size of operation in terms of total annual sales, respondents' age and gender, share of family income from

farming, and farm location (South vs. Midwest) were included in the producers' WTP maximum likelihood modeling process. In particular, variables measuring participation characteristics (i.e., amount of time registered on the site, amount of time spent on MarketMaker activities and type of user) and perceived impacts of MarketMaker (i.e., number of marketing contacts received, new customers gained, and increase in annual sales) were considered as covariates in the modeling process because they were identified as quantifiable indicators of effective participation in MarketMaker based on the producers' logic model developed by Lamie et al. (2011). The other variables—registration type, total annual sales, respondent's age and gender, share of family income, and farm location—were included in the maximum likelihood estimation to relate the benefits generated by MarketMaker to specific producer characteristics. An indicator variable (i.e., survey type) was also included in the estimation to control for differences between email and mail survey responses. The categorical variables—time registered on MarketMaker, amount of time spent on MarketMaker activities, marketing contacts received, new customers gained, increase in annual sales attributed to MarketMaker, total annual sales, and share of family income from farming—were transformed to "continuous" by using the midpoint of each range. The explanatory variables—registration, user type, farm location, and respondent gender—were included as dummy variables. Producers who reported that they used at least one feature of MarketMaker frequently or sometimes were coded as active users and those who rarely or never used any feature of MarketMaker were coded as passive users.

Six statistical distributions were considered when modeling the producers' WTP for MarketMaker services, including the normal, Weibull, log-normal, exponential, log-logistic, and gamma distributions. The model that "best fitted" the data was selected using the Akaike information criterion corrected for finite sample sizes (AICC) (Hurvich and Tsai, 1989). The AICC is a log-likelihood-based model-selection criterion with degrees of freedom adjustment. Given a data set and several candidate models, the model with the smallest AICC is preferred.[8]

Results

Summary Statistics

Table 3 presents a complete description of the key variables describing respondent and business characteristics. Survey results indicate that nearly 97% of the respondents were the owners or the managers of the business. This finding gives more credibility to their answers concerning the characteristics of the operation and MarketMaker's impact on their business performance. Regarding business characteristics, survey respondents indicated that their operations generate, on average, about $100,090 in total annual sales. Therefore, the farms surveyed are smaller than the average U.S. farm ($134,000) (U.S. Department of Agriculture, National Agricultural Statistics Service, 2009). The average age of respondents was 54.4 years, and 39% were female. The average age is similar to the average age of U.S. farm operators (54.9 years), but the proportion of females in the sample is higher than the reported proportion of female operators in the country (30%) (U.S. Department of Agriculture, National Agricultural Statistics Service, 2009). The demographic/business characteristics of the sample are similar to those of the population of farmers and farms in the regions considered in this study.

In terms of MarketMaker registration and use, 75% of respondents indicated that they had registered on the site by themselves, 8% indicated that someone else had registered for them, and 17% did not know how they had become enrolled in MarketMaker. This finding may be explained by the fact that sometimes producer lists provided by State Departments of Agriculture were used to initially populate the MarketMaker database in some states.

[8] Even though the Akaike information criterion is not a formal test to discriminate between different models, it is commonly used to compare the type of parametric models employed in this study (e.g., Baghestani, Hajizadeh, and Fatemi, 2010; Shauly et al., 2011; Garcia-Aristizabal, Marzocchi, and Fujita, 2012).

Table 3. Description and Summary Statistics of Respondents Characteristics and Perceptions

Variable and Category	Category Percentage			Mean	
	Email	Mail	Total	Nonparametric Lower and Upper Bounds	Parametric (Standard Error)
Ownership					
1=Business owner/manager	96.12	97.96	96.92		0.97
0=Employee	3.88	2.04	3.08		(0.01)
Total annual sales ($1,000)					
Less than $10	42.64	40.82	41.85	(72.73, 144.71)	100.09
$10 to $50	26.36	32.65	29.07		(14.52)
$50 to $100	13.95	8.16	11.45		
$100 to $250	5.43	11.22	7.93		
$250 to $500	5.43	2.04	3.96		
Gender					
1=Female	41.09	36.76	39.20		0.39
0=Male	58.91	63.24	60.80		(0.03)
Age					54.43
					(0.82)
Share of total family income from farming (%)					
Less than 10	37.93	39.08	38.42	(30.10, 40.10)	35.38
10 to 20	11.21	12.64	11.82		(2.29)
21 to 30	9.48	12.64	10.84		
31 to 40	4.31	6.90	5.42		
41 to 50	8.62	0.00	4.93		
51 to 60	1.72	1.15	1.48		
61 to 70	2.59	1.15	1.97		
71 to 80	5.17	3.45	4.43		
81 to 90	3.45	6.90	4.93		
91 to 100	15.52	16.09	15.76		
Farm location					
1= South	52.59	51.90	52.30		0.52
0=Midwest	47.41	48.10	47.70		(0.04)
Registration type					
1=Self-registered	82.95	64.30	74.89		0.75
0=Otherwise	17.05	35.70	25.11		(0.03)
Time registered on MarketMaker (months)					
Less than 1	1.55	0.00	0.88	(16.70, 28.08)	22.02
1 to 6	10.08	1.02	6.17		(0.79)
7 to 12	10.85	4.08	7.93		
13 to 24	55.81	52.04	54.19		
25 to 36	13.95	20.41	16.74		
37 to 48	5.43	16.33	10.13		
More than 48	2.33	6.12	3.96		
Time spent on MarketMaker activities (min/month)					
Less than 30	79.84	86.73	82.82	(11.02, 46.75)	21.99
30 to 60	14.73	8.16	11.89		(1.35)
61 to 120	2.33	4.08	3.08		
121 to 300	2.33	0.00	1.32		
301 to 600	0.00	1.02	0.44		
More than 600	0.78	0.00	0.44		
Marketing contacts[a]					
0	66.38	69.39	67.76	(1.30, 4.00)	2.65
1 to 9	25.86	24.49	25.23		(0.39)
10 to 20	5.17	4.08	4.67		
21 to 30	2.59	0.00	1.40		
31 to 40	0.00	2.04	0.93		

Continued on next page. . .

Table 3. – continued from previous page

Variable and Category	Category Percentage			Mean	
	Email	Mail	Total	Nonparametric Lower and Upper Bounds	Parametric (Standard Error)
New customers					
0	69.72	71.43	70.53	(1.04, 2.44)	1.65
1 to 5	19.27	18.37	18.84		(0.24)
6 to 10	9.17	7.14	8.21		
11 to 20	0.92	2.04	1.45		
More than 20	0.92	1.02	0.97		
Increase in annual sales due to MarketMaker ($)					
Under $25	73.79	80.61	77.11	(148.05, 393.87)	221.30
$25 to $50	5.83	4.08	4.98		(73.80)
$51 to $75	1.94	1.02	1.49		
$76 to $99	4.85	1.02	2.99		
$100 to $499	7.77	6.12	6.97		
$500 to $999	3.88	3.06	3.48		
$1,000 to $4,999	0.97	3.06	1.99		
$5,000 to $9,999	0.00	0.00	0.00		
More than $10,000	0.97	1.02	1.00		

Notes: [a] Marketing contacts and new customers refer to the total contacts received and customers gained since the producer became registered on the MarketMaker website.

On average, respondents had been registered on the site for twenty-two months. About 15% of respondents had been registered for less than twelve months, 54% had been registered between twelve and twenty-four months, and 31% had been registered for more than twenty-four months. In relation to the time devoted to the website, producers registered on MarketMaker spent about twenty-two minutes per month managing their accounts, with nearly 83% of producers devoting less than thirty minutes per month to MarketMaker-related activities.

Survey questions related to the impact of MarketMaker asked respondents about the perceived impact of MarketMaker on the total number of contacts received due to their participation in the site, total number of new customers gained, and the increase in annual sales since producers became registered in the website (table 3). Producers indicated that they had been contacted, on average, about 2.7 times by customers, input suppliers, and other producers as a result of their participation with MarketMaker. At the same time, nearly 68% of producers in the sample had not received any contacts due to MarketMaker. However, the proportion of producers who received marketing contacts through MarketMaker in the sample (32%) is greater than the 12% reported by registered New York producers in 2009 (Cho and Tobias, 2009). Therefore, although the number of contacts received due to MarketMaker seems to be low, there seems to be an increasing proportion of users who find the site useful for pointing customers to their businesses.

In terms of the number of new customers gained, respondents indicated that their participation had helped them obtain an average of 1.6 new customers, even though 71% of the respondents indicated that they have gained no new customers through the site. Lastly, survey respondents perceived an average annual increase in sales of about $221 as a result of MarketMaker, with 77% of the participants indicating that the increase in annual sales was less than $25. The overall increase in annual sales due to MarketMaker in the sample was lower than that found by Cho and Tobias (2009), where New York producers reported average increases in annual sales between $225 and $790 as a result of assistance from MarketMaker.

Producers reported various degrees of intensity with respect to using MarketMaker features (see table 4).[9] The most commonly used features (sometimes or frequently) are "search for products"

[9] As a reviewer pointed out, the "rarely," "sometimes," and "frequently" options used to rate the frequency of site feature use can have differing interpretations. In this case, these variables measure the perceived degree of intensity of MarketMaker usage.

Table 4. MarketMaker Features and their Perceived Intensity of Use by Producers (%)

Feature	Never	Rarely	Sometimes	Frequently
Log on to check or update profile (such as adding new information, photos, social media links, business contacts, alerts, etc.)	27.80	54.26	15.70	2.24
Search for products	44.59	34.68	18.02	2.70
Search for business partnerships (e.g., to find other companies to sell products)	59.19	30.04	9.87	0.90
Search for buyers and sales opportunities	48.66	31.70	17.86	1.79
Find a target market for your products (e.g., using demographic data, food consumption data)	58.30	30.94	9.87	0.90
Use the buy/sell forum	64.29	22.32	11.16	2.23

Table 5. Response Frequency by Initial Bid Amount

		Decision			
Initial Amount	N	No, No	No, Yes	Yes, No	Yes, Yes
25	46	29	4	10	3
50	34	23	6	4	1
75	43	34	4	5	0
100	46	39	1	5	1
150	24	21	2	0	1
200	34	30	2	2	0

(20.72% of users), "search for buyers and sales opportunities" (19.65%), and "log on to check or update profile" (17.94%). Less commonly used features include "search for business partnerships" and "find target market for your products," both used by 10.77% of users, and "use the buy/sell Forum" (13.39%). Based on reported intensity of use, 33% of registered producers were considered active users and 67% were passive users.

Participants' responses to the initial and follow-up WTP question are presented in table 5, which suggests that producers' WTP for MarketMaker services is less than $200 for 96% of respondents. As expected, the share of individuals willing to pay a particular bid amount decreases as the bid asked increases (table 5). For example, as the initial bid amount increases from $25 to $200, the "yes" responses to the first contingent question fall from 28% to 6%. When a second, higher bid is asked, the "yes" responses fall from 7% to 0% at $250.

WTP Estimation Results

The different statistical distributions considered in this study and their corresponding maximized log-likelihoods and AICC are presented in table 6. This table suggests that the preferred distribution is the log-logistic distribution.[10] Therefore, the log-logistic distribution was employed to estimate producers' mean WTP for MarketMaker services and the marginal effects of each covariate in the model. The explanatory variables for total number of new customers gained and increase in annual sales due to MarketMaker were excluded from the final model because they were found to be highly correlated with the total number of contacts received due to MarketMaker. The variables for respondents' age and gender, farm location, and share of family income from farming were also excluded from the final model because they were not statistically significant. Estimated parameter values and marginal effects of the remaining explanatory variables were robust to the exclusion of these four variables from the model. Mean WTP and the marginal effect of each explanatory variable

[10] In general, the mean and marginal effect estimates were robust across the different candidate models considered in this study.

Table 6. AICC by Statistical Distribution

Distribution	Log-Likelihood	AICC
Normal	-166.1	351.6
Weibull	-163.6	345.9
Log-normal	-160.3	339.4
Exponential	-170.1	356.8
Log-logistic	-159.4	337.6
Gamma	-165.2	349.1

Table 7. Coefficient and Marginal Effect Estimates

Variable	Coefficient	Standard Error	Marginal Effect	Standard Error
Constant	2.6964***[a]	0.3620		
Registration type (Self-registered=1, Otherwise=0)	−0.5872**	0.2811	−26.5184**	15.5569
Time registered on MarketMaker (Months)	0.0146**	0.0084	0.5528**	0.3183
Time spent on MarketMaker activities (Min/month)	0.0028**	0.0014	0.1048**	0.0609
Type of user (Active user =1, Passive user=0)	0.6300***	0.2531	24.9529**	11.5420
Marketing contacts	0.0336**	0.0202	1.2685*	0.8511
Total annual sales ($1,000)	0.0006**	0.0003	0.0232**	0.0129
Survey type (Mail=1, Email=0)	−0.7655***	0.2671	−26.3297***	8.5284
σ[b]	0.6020***	0.0651		

Notes: [a] Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.
[b] σ corresponds to the shape parameter of the log-logistic model (see table 2).

were estimated using the specific formulas presented in table 2. Maximum likelihood estimation results of the final models are reported in table 7.

In order to assess the overall significance of the final model, we used a likelihood ratio test to test the null hypothesis that all the coefficients except for the intercept and the parameter σ are 0. The overall model is statistically significant with a Chi-squared statistic of 37.1, which is well beyond the critical value of 18.48 ($\chi^2_{7,0.01}$). We also assessed the goodness of fit of the model by calculating the percentage of estimated mean WTP values that fell within the observed WTP intervals. We found that 64.8% of the estimated WTP values were enclosed in the corresponding observed intervals.

Registration type, amount of time registered on MarketMaker, amount of time devoted to the website, type of user, number of marketing contacts received, and firm total annual sales had a significant effect on producers' WTP for MarketMaker services (table 7). The estimated marginal effects of explanatory variables indicate that producers who registered themselves on MarketMaker were willing to pay $26.52 per year less for MarketMaker services than those who were registered by someone else or do not know how they were enrolled in the site. This may reflect the fact that the benefits producers obtain from MarketMaker are the same regardless of how they were registered at the site. Therefore, self-registered producers will have a lower WTP for MarketMaker services given that they have put more effort into registering for the site as compared to those who were registered by someone else or do not know how they were registered in MarketMaker.

Results also suggest that producers' WTP increases by $0.55 for each additional month that the producer has been registered on the site, suggesting that the benefits associated with participating in MarketMaker are positively related to the time registered in the site.

Other variables used to measure MarketMaker usage by participants after registration were also found to be related to producers' valuation of the site. Specifically, each additional minute per month

spent on the MarketMaker website increased annual WTP by $0.10. Active users of the site were willing to pay $24.95 more per year than their passive counterparts.

As expected, the number of marketing contacts received due to participation with MarketMaker has a positive effect on producers' WTP for MarketMaker services. Each additional marketing contact received increased annual WTP by $1.27. Since marketing contacts are potential sales, the more contacts received due to MarketMaker, the higher the chance that at least some of them result in actual sales, which might translate to higher WTP.

In terms of the effects of business characteristics on producers' valuation of MarketMaker, results indicate that a $1,000 increase in total annual sales is expected to increase annual WTP by only $0.02. Thus the difference in annual WTP between a producer who generates $100,000 in total annual sales and one who generates $50,000 in total annual sales is just $1, suggesting that producers' WTP for MarketMaker services is nearly constant across producers' annual sales levels.

Finally, producers who were surveyed using the online questionnaire were willing to pay $26.33 more than those who responded to the mail survey. This finding could reflect the fact that producers who responded to the email survey were more exposed to or conscious of electronic technologies such as MarketMaker than those who preferred to respond to the traditional survey form.

Results from the unconditional maximum likelihood model (when no regressors are included in the model) in conjunction with the formulas for the unconditional log-logistic mean and median presented in table 2 were used to calculate mean and median annual WTP for MarketMaker services.[11] Producers' average annual WTP for MarketMaker services was estimated at $47.02 with a standard error of $16.94. Producers' median annual WTP for MarketMaker services is $15.23. As expected, both the mean and the median WTP values are lower than the reported increase in revenues associated with MarketMaker ($221.30).

Producers' estimated average annual WTP can be used to estimate the aggregate value that registered producers place on MarketMaker services by multiplying the estimated mean annual WTP by the 7,698 producers currently registered at the national level. Thus, the estimated annual aggregate producer' WTP is $361,960 (standard error of $130,404). Calculating aggregate benefits implicitly assumes that the sample of farmers is representative of the population of interest. Although some preliminary analyses did not show evidence of nonresponse biases, data limitations preclude us from conducting a more in-depth analysis of this issue.

Summary and Conclusions

Despite the touted potential of e-commerce to improve agricultural profits, the literature on the economic impact of e-commerce in agribusinesses is very limited. This study assessed the economic benefits of MarketMarket, an electronic trade platform, on registered producers. Contingent valuation methods using online and mail surveys were employed to estimate the economic value that registered producers place on MarketMaker services. Estimation of the WTP model used parametric maximum likelihood estimation procedures.

The WTP estimation results indicate that producers are willing to pay an average of $47.02 annually for MarketMaker services. This value is a measure of the increase in annual profits attributed to using MarketMaker. The estimated aggregate annual economic value that registered producers place on MarketMaker services is $361,960. It is important to emphasize that the aggregate estimate of MarketMaker's economic impact might represent only a portion of the total benefits generated by MarketMaker, given that other site users were not considered in the analysis, including consumers, retailers, wholesalers, chefs/restaurants, and farmers' markets.

Understanding producers' valuation of MarketMaker is necessary for ensuring that the resources dedicated to its support and development are allocated efficiently. This information could also be

[11] The estimated location and scale parameters (standard error) from the unconditional maximum likelihood estimation are $\mu = 2.7231(0.1589)$ and $\sigma = 0.7324(0.0844)$, respectively.

useful to government officials and MarketMaker's administrators to justify the expenditure of public funds on the operational and development costs associated with the MarketMaker website. Since its creation in 2000, MarketMaker has offered its electronic infrastructure and resources to registered users at no cost. Currently, the website is entirely funded by federal and state governments. Hence, the estimated WTP function and its features (e.g., mean and median) could also be used as a guide if a participation fee is imposed in the future.

Empirical results indicate that registration type, amount of time registered on MarketMaker, amount of time devoted to the website, type of user, number of marketing contacts received, and firms' total annual sales have a significant effect on producers' WTP for MarketMaker services. In particular, producers who registered by themselves are willing to pay nearly $26 less per year than their counterparts. This lower WTP could be attributed to the fact that the benefits associated with participation are similar regardless of how producers registered on the site; thus a self-registered producer who has put more time and effort registering for the site is expected to have a lower WTP. Empirical results also show that the effectiveness of MarketMaker is strongly linked with how producers use it after registration. For example, a higher WTP is positively related to the time devoted to MarketMaker activities after registration, suggesting that MarketMaker leaders should encourage producers to become more active users of the site to achieve the desired participation benefits. Another interesting result is the positive relationship between the amount of time producers have been registered on the site and stated WTP, implying that the benefits associated with MarketMaker tend to become higher as users become more familiar with the functioning of the site.

Results also indicate that each additional marketing contact received due to participation with MarketMaker was expected to increase annual WTP by $1.27. Hence, with the aim of increasing the number of marketing contacts received, MarketMaker website development should focus on encouraging producers to update their site profiles frequently, specifically their contact information (phone number, email address, website URL) and attributes and availability of their products. Although statistically significant, the benefits generated by MarketMaker are nearly constant across firms of different sizes as measured by annual sales levels.

Lastly, producers who were surveyed using the mail questionnaire had a lower WTP for MarketMaker services than those who replied to the email version, which may imply that producers who preferred to respond to the mail survey were less aware and familiar with electronic technologies. Hence, MarketMaker administrators should consider devoting additional time and effort not only to site development and maintenance but also to delivering tailored training and promotion.

Some caveats regarding the results of the study are also in order. The overall survey response rate was relatively low, even though every effort was made to obtain the highest possible response rate: the use of economic incentives, inclusion of the invitation letters signed by MarketMaker administrators from the local Land Grant University, the use of the shortest possible surveys instruments pretested using focus groups, the use of the Dillman, Smyth, and Christian (2009) survey method, and the use of a follow-up mail survey. This low response rate could potentially introduce nonresponse biases. A more in-depth analysis of nonresponse biases requires more information about the characteristics of the population of interest that are not available at this time. Therefore, we recommend that MarketMaker administrators collect more information about the demographic characteristics of farmers and businesses registering on the site (e.g., age of the operator, farm size, etc.). Administrative records would be very valuable for evaluating the representativeness of future survey research results of MarketMaker users.

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Appendix A: Willingness-to-Pay Questions Used in the Survey

The initial question presented to participants was:

"Since its creation in 2000, MarketMaker has offered its electronic infrastructure and resources to consumers, farmers, processors, retailers, chefs/restaurants, farmer markets, and other users at no cost. Currently, MarketMaker is entirely funded by federal and state government institutions, but may become a privately funded organization in the future. If MarketMaker becomes privately funded, while retaining all the features and services it currently provides, would you be willing to pay an annual participation fee of \$B for the services you receive from MarketMaker?"

☐ Yes ☐ No.

The follow-up question asked:

"Would you be willing to pay an annual participation fee of \$$B^f$ for the services you receive from MarketMaker?"

☐ Yes ☐ No.

Where B^f is equal to B^l or B^u depending on the answer given to the initial question.