Net Gains from 'Net Purchases? Farmers' Preferences for Online and Local Input Purchases

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E-commerce represents both threats to and opportunities for rural communities. This study addresses one element of the issue: farmers' willingness to substitute online merchants or national farm input stores for local businesses. Results of a conjoint analysis of contingent choice experiments suggest that farmers are willing to purchase from online or national stores outside their communities if compensated with lower prices or greater services. Results also demonstrate that the context of the input purchase, such as time constraints, was very important not only in valuing these services, but, more broadly, in terms of the farmer's loyalty to a local merchant.

Key Words: e-commerce, farm input purchase, willingness to pay, contingent choice, rural communities

Over the past two decades, use of computers and the Internet by farmers, rural businesses, and rural residents has changed dramatically. In 1991 less than one-third of U.S. farmers were using computers, primarily to support intra-business decision making—business financial accounting, correspondence, and crop and livestock record keeping (Batte et al. 1995). By 2005, 56 percent of Ohio farmers had access to a computer, and 29 percent used that computer for business tasks (National Agricultural Statistics Service 2005). External information collection and reporting have become much more important tasks for the farm computer user. Batte (2004) found that nearly 85 percent of commercial Ohio farmers with computers also used the Internet, and 74 percent cited an Internet application as one of the three most important tasks for which the computer was used on that farm.

While online buying and selling (electronic commerce, or "e-commerce," activities) by farm businesses significantly lag behind other Internet uses and e-commerce adoption in other industries, e-commerce offers both threats to and opportunities for rural businesses and communities. Essentially, the Internet lowers the barriers to trade between urban and rural market participants by greatly reducing search costs for product alternatives, and holds important implications for the financial well-being of rural communities and their residents in a time when rural firms of all kinds are under increasing economic pressure. Castle (1998) recognizes two types of rural communities: those within commuting distance of urban and suburban developments, and those more distant from population centers. Rural communities near urban centers typically have leakage of sales from their retailers to firms in the urban areas where commuting workers are employed—opportunity costs for shopping in urban markets are decreased by their commute. The vitality of communities more distant from urban centers is more closely related to changes in agriculture and other local businesses. There was a 9.2 percent decline in the number of rural retailers between 1990 and 1995, a loss of some 40,000 businesses (U.S. Small Business Administration Office of Advocacy, 1999b). The number of the smallest firms—those with fewer than 20 employees—declined by 11.6 percent, threatening rural communities' economic stability, increasing costs of living due to the expense of obtaining goods no longer available locally, and lowering quality of

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life. Within the traditional farm input sales sector, continued consolidation of national franchises and declining margins brought by fewer traditional buyers has forced changes. The number of retail locations is down, thereby increasing transaction costs for remaining customers. For remaining farm input retailers, the pressure to "urbanize" their inventories and services may make them less relevant to traditional producer markets. Ohio rural retailers may be better situated than firms in other agricultural areas. With 16 Census-designated Metropolitan Statistical Areas (population of 50,000 or more, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties), the potential for both survival through commuting workers and high levels of invasive competition is great. These conditions increase the interest of some farmers and other rural businesses in using the Internet and offers businesses the opportunity to differentiate their products in terms of variety, timeliness, and convenience, to improve service, to retain existing customers, and potentially to sell products directly to distant consumers. All of these businesses may also use e-commerce to enhance efficiency by purchasing lower-priced inputs.

This study addresses potential changes in farmers' purchasing behavior as a result of expanded online commerce—specifically, we measure attitudes toward e-commerce, and farmers' willingness to pay to support local businesses over online or national farm input retail competitors.

Literature Review

Lyman and Varian (2003) call the Internet the fastest-growing communication medium of all time. Sixty-eight percent of U.S. adults, or about 137 million people, used the Internet in 2005, up from 63 percent a year earlier (Fox 2005). Although online sales currently account for only 2 to 3 percent of all retail sales in the United States, the annual growth rate of Internet sales is projected at 19 percent through 2008, when sales will reach $229 billion (Rush 2003). Small businesses, like those predominating in rural areas, that use the Internet have higher revenues (U.S. Small Business Administration Office of Advocacy, 1999a), and small-business Internet users have grown 46 percent faster than non-users (American City Business Journals 2003). Information that allows rural retailers to capitalize on the potential benefits of e-business strategy may be a step towards eliminating the decline in numbers of existing rural retailers.

Farm business use of the Internet also is growing. Park and Mishra (2003) found that farmers are increasingly using the Internet for applications such as price tracking (83 percent), accessing agricultural information services (56 percent), and online record keeping and data transmission to clients. Results also suggest that the educational level of the farm operator, farm size, farm diversification, off-farm income, off-farm investments, and regional location of the farm significantly affect the number of Internet applications used. Batte (2004) found that about 80 percent of computer-adopting Ohio farmers also used the Internet for online business such as financial transactions, purchasing inputs, and marketing outputs. In fact, Internet tasks combined to be one of the three most important computer tasks identified by 73.5 percent of computer-adopting farmers. Results of a binomial probit analysis of farmers' adoption of online transactions (online purchasing or sales, banking, stock, bond, or commodity market transactions, etc.) found that farm size (sales) was not a significant explanatory variable, but that operator education level was positively associated with the likelihood of using the Internet for transactions and that operator age was negatively associated (Batte 2006).

Although currently a very small share of the agricultural input market, e-commerce has the potential to become quite important. Geographic isolation, supply chain inefficiency, and demand for unique and specialized inputs are obvious constraints. Bejjani (2000) estimated the near-term business-to-business (B2B) market size for various agricultural inputs and suggests that agriculture will be receptive to e-commerce because the market is fragmented, supply chains are inefficient, buyers change sellers regularly, and the value of the product can be volatile. Wheatley, Buhr, and DiPietre (2001) suggest that the input market (business-to-business) that farm firms compete in functions more like business-to-consumer (B2C) markets in other sectors. Farm agribusinesses, like many non-farm consumers, tend to be more passive, to have less market power, and to act as price takers. Porter (2001) says the Internet is useful to firms in two ways: (i) in improving operational effectiveness, and (ii) in improving strategic positioning. Firms use e-business to improve operational efficiencies and to improve their strategic position with customers seeking a specific product niche or having special needs or locational constraints. Lemoux, Wortman, and Mathias (2001) correctly observe that the complexity of the transaction will impact the likelihood of a successful Internet market. They imply that standardized commodities are most suited for Internet-based markets. These would include such farm input items as agricultural chemicals, crop seed, veterinary supplies and similar items, and especially brand-name products sold in their original packaging. At the same time, niche markets can be successful online because of the opportunity to expand the potential customer base. Many farm input markets, while certainly handling standardized commodity-like products, now essentially behave like "niche" markets thanks to increased concentration from declining numbers of players on both the demand and supply sides of their markets. Concentrated markets with dispersed and well-focused consumers are particularly suited to an e-commerce environment, making farm inputs a seemingly attractive market for e-commerce. However, farmers' willingness to operate in this less-than-personal market remains a question, which this research addresses using a willingness-to-pay approach.

Data and Methods

In September 2005, a survey and contingent choice experiment were conducted using an intercept survey of farmers at the Ohio State University Farm Science Review (FSR), one of the nation's largest agricultural trade shows. FSR runs on Tuesday, Wednesday, and Thursday in mid-September and attracts primarily farmers and others from production agriculture, with an emphasis on crop farming. Attendance in 2005 was 119,354 visitors from approximately 34 U.S. states, 4 Canadian provinces, and 6 other foreign countries, with the greatest concentration coming from Ohio and Indiana. Sampling was done all three days of the FSR. Farmers were stopped as they passed a central location at the show, and were asked a screening question—did they farm in 2004? Those who answered yes were interviewed, and asked to complete a series of choice experiments. They also completed a short questionnaire addressing farm business usage of information technology, attitudes toward and degree of use of e-commerce, and respondent demographic and economic measures. Approximately one-third of the farmers approached agreed to complete the interview and survey. Seventy-eight surveys were completed, with each respondent also completing six choice experiments.

The contingent choice approach is an especially appropriate method for evaluating farmers' preferences for online input purchase. Relatively few farmers currently are making online purchases, and we cannot readily observe the decision process that farmers use as they choose between online and traditional input suppliers. We asked farmers to state their preference for purchase of inputs from among alternative hypothetical input purchase options, allowing for standardization of selected product characteristics (brand, input specifications, etc.) but manipulating key information provided to the consumer (e.g., type of store, availability date, price, etc.). The literature suggests that lower prices, increased convenience and lower opportunity costs associated with input search, and lower direct costs for travel are likely to be key factors influencing online shoppers. Likewise, desire to support the local community and distrust of the online store format, payment mechanism, or input quality may be reasons that farmers select brick-and-mortar stores.

The primary difference between the options presented to farmers in the choice experiment was the type of input retailer. Three store types were identified—a local farm input retailer, a national farm input retailer located outside the farmer's community (e.g., Tractor Supply Company), and an online (Internet) national retailer (e.g., www.the-co.com/Parts/). Price of the input, presence or absence of delivery to the farm, and distance to the brick-and-mortar businesses were also varied. All other characteristics were assumed equal.

The experiments were conducted for two input purchase scenarios which were studied using different samples of farmers. One scenario addressed herbicide purchase decisions made in January (implied low opportunity cost for purchase delays or travel time). The second was the purchase of a replacement planter part during planting season (implying high opportunity costs of delays).

Experiments were administered in face-to-face interviews with FSR attendees who were approached randomly. The survey began with the conjoint instrument. Specifically, the preface to the herbicide conjoint question (see box) asks the respondents to suppose that he or she were choosing between the purchase of this input at two different store formats. The respondent was instructed that the two herbicide products were equivalent in all aspects except those attributes subsequently described. Two product profiles, presented side-by-side, provided information for four attributes. The experiment was repeated six times for each respondent. The full listing of attributes and their experimental levels are listed in Table 1.

The machinery-part purchase experiment differed by implying that the decision was made in a period of much greater opportunity cost of time. Ohio farmers are typically aware of yield penalties from delayed planting. By implying that delays in receiving the replacement part would delay crop planting, potentially reducing profits, we expected that farmer purchase behavior would be different from the herbicide-purchase scenario. The prompt for the machinery-part purchase experiment read as follows:

> Imagine that it is May 1 and crop planting is only half completed. The planter breaks down—you need a replacement part. Three options are available. County Farm Machine Parts is located in your community. A second option is the National Farm Machine Parts store located in a larger city a bit further away. TractorParts.com (www.TractorParts.com) is an Internet store where you can purchase the part online and have it delivered to the farm within the week. Assume that the parts are identical at all three stores. Of course, any purchase that you make adds to operating costs and reduces farm profits. Please try to make your selection of purchase options just as you would in a similar real-life situation.

Again, respondents chose between paired purchase options and each completed six experiments.

We implemented our study using a full factorial experimental design. There are 30 ($2 \times 3 \times 5$) possible product profiles for each of the store types. We randomly sampled from these profiles for each store type; thus, each respondent viewed different product comparisons based entirely on chance. Comparison of identical product profiles was excluded. Also, if one product profile dominated another (e.g., the two were identical in all attributes except price), then that pair was excluded.

Willingness-to-pay (WTP) measurements are grounded in utility theory. Hanemann and Loomis (1991) outlines the theoretical underpinnings as a utility-maximization problem subject to a budget

Prompt, Stimulus, and Choice Question Used for Conjoint Experiment of Herbicide Purchase Experiment

Imagine it is time to purchase herbicides for this year's crop production. You will need 250 gallons of herbicide. You have identified three suppliers of glyphosate (generic Roundup): (i) County Farm Supply, which is located in your community, (ii) the National Farm Supply store located in a larger city a bit further away, and (iii) FarmInputs.com (www.farminputs.com), an Internet store where you can purchase the product online and have it delivered to the farm within the week. Assume that the herbicide product is identical at all three stores. Of course, any purchase that you make adds to operating costs and reduces farm profits. Please try to make your selection of purchase options just as you would in a similar real life situation.

Select Store 1 or Store 2. You may also indicate "neither" if you don't prefer either store.

	Store 1	**Store 2**
Store name / location	Farm Supply.com – online at www.FarmSupply.com	National Farm Supply – located in a nearby city
Distance from your farm (round trip miles)	0 miles	75 miles
Delivery?	Delivered to your farm within three days (cost is included in the price)	Delivered to your farm by noon tomorrow (cost is included in the price)
Price for a 250-gallon bulk container of Glyphosate (includes shipping)	$16.25 per gallon or $4,063 per 250 gallons	$18.00 per gallon or $4,500 per 250 gallons

Table 1. Input Prices and Delivery Options by Store Type

Product and Delivery Method	Local	National	Online
	Likelihood		
Herbicide purchase			
Pickup	0.5	0.5	
Delivery to your farm	0.5	0.5	1.0
Machinery part purchase			
Pickup	0.5	0.5	
Delivery to your farm – by noon tomorrow	0.5	0.5	0.5
Delivery to your farm – within three days			0.5
Distance to store (round trip miles)			
0			1.0
15	0.33		
30	0.33		
75	0.33	0.33	
100		0.33	
150		0.33	
Input prices			
Herbicide \$/gal (\$11.60, \$12.75, \$16.25, \$18.00, \$20.00)	-------------------- Equally likely --------------------		
Machine Part \$ (\$150, \$175, \$200, \$225, \$250)	-------------------- Equally likely --------------------		

constraint. The consumer chooses the level of the good X that maximizes utility, producing the traditional Marshallian demand curve $X(p,y,q)$, where p is market price, y is income, and q is the quality of the good, fixed exogenously. The resulting indirect utility function is $V(p, y, q)$. Identifying a change in a good's quality from q_0 to q_1, the measurement of value is

$$V(p, y - \text{WTP}, q_1) = V(p, y, q_0), \quad (1)$$

where WTP is the amount the consumer would be willing to pay for the improved quality, maintaining constant utility.

Lusk and Hudson (2004) demonstrate that willingness to pay also can be used to study farmer acceptance of a new product or service. Assume that the farmer wishes to maximize profits subject to a given production function, and can choose the level of input usage, x, with one input level, q, fixed exogenously. q may be thought of as either a level of service or some measure of input quality. However, in our experiment, input quality will be held constant across all input purchase options, so q measures differences in the level of services associated with the various store options (e.g., convenience of purchase, delivery, and promptness in filling the order). The producer will choose the optimal level of inputs and outputs for the indirect restricted profit function, $\pi(p, w, q)$, where p and w are vectors of output and input prices, respectively. For a choice between two inputs of differing quality, $q_1 > q_0$, the willingness to pay for the higher quality input is

$$\text{WTP} = \pi(p, w, q_1) - \pi(p, w, q_0). \quad (2)$$

WTP represents the maximum amount of profit the producer would be willing to forgo in order to obtain the higher quality input, q_1, rather than q_0.

Observations for the choice experiments are analyzed using conjoint analysis methods. Producer utility is hypothesized to be a function of the market attributes, interaction of socioeconomic variables with the market attributes, and the price of the product (input):

$$V_{ij} = x_j\,\beta + s_{ij}\,\alpha + p_j\,\Phi + \varepsilon_{ij}, \quad (3)$$

where V_{ij} denotes the individual i's indirect utility from choosing market opportunity j; x_j is a vector of market attribute levels; s_{ij} is a vector of socioeconomic variables for individual i interacted with the jth market attribute level; p_j is price for input in market j; β, α, and Φ are conformable vectors of coefficients to be estimated; and ε_{ij} is a mean zero, constant variance error term that is independently and identically distributed for all i and j.

Given the utility function in (3), we can model the choice between two market opportunities as the relative differences in utility. The difference in utility for inputs purchased from markets A and B for individual i is

$$(4) \qquad \Delta V^i_{AB} = \Delta x\beta + \Delta s\alpha + \Delta p\Phi + \varepsilon_{AB},$$

where ΔV^i_{AB} equals the utility difference between paired comparison of market opportunities A and B, Δx equals $(x^j_A - x^j_B)$, Δs equals $s^i * (x^j_A - x^j_B)$, Δp equals $(p^j_A - p^i_B)$, and ε^i_{AB} equals $(e^i_A - e^i_B)$, a normally distributed error term.

Results

Of the 78 farmers surveyed in the study, 39 completed the experiment related to herbicide purchase and 39 completed the planter-part scenario (Table 2). The mean age of participants in both groups was about 48 years, below the state and regional average for farmers. The mean cropped acreage was 552, producing average gross sales of nearly $176,000. Although the two subsamples differed substantially in these measures, the difference was not statistically significant at the 0.05 probability level. Farm computers were used by two-thirds of the total sample, and about half of these computer users indicated that they had previously purchased inputs online, although we have no indication of how often they use the Internet for e-commerce. Thirteen percent of those who used a business computer also had sold farm products online, in line with the national average.

Business operator attitudes toward e-commerce are useful measures of adoption trends for these technologies. A 5-point Likert psychometric scale was used to specify respondents' level of agreement to each of seven statements. Possible responses ranged from "strongly disagree" to "strongly agree." One-third of the respondents (33.87 percent) would agree to buy farm inputs online if the price was lower, and another 53.23 percent were undecided (Table 3). Nearly 43 percent believed that Internet purchases are safe, and 54.1 percent agreed or strongly agreed that online purchases save time—29.51 percent were undecided. More than 60 percent of the farmers in our study followed a typical general consumer trend of shopping for a product online, then buying it at a local store. This practice further supports the apparent concern with retailer trust shown by the more than 77 percent of respondents who stated that they would buy only from online companies they know and trust. Not surprisingly, participants were quite divided on whether or not they wanted their local farm supply store to sell online so they could order inputs from home—3.33 percent strongly agreed with the statement that they would like their local input supplier to have online sales, 48.33 percent agreed with the statement, and 31.67 percent were undecided.

Conjoint Model Estimation

Each respondent was asked to cast six decisions during the conjoint questioning for a potential of 456 usable responses. Due to non-reported demographic information, 38 conjoint choices were dropped from estimation. This leaves 418 usable conjoint choices for analysis—208 for the herbicide model and 210 for the machinery-part model. We model the probability that the respondent chooses the store format shown on the left side in the box displayed on page 87. The model's parameters are estimated via maximum likelihood procedures for a probit model.

Separate models were estimated for the herbicide and machine-part experiments (Table 4). The primary attribute of interest—whether the purchase is made in a local, national, or online supply store—is represented by two binary variables. OnlineStore (NationalStore) takes on the value of one if the input is offered at an online (national) store, and is zero otherwise. The local store is the referent category.

About one-third of the sampled farmers do not use an office computer in the management of their farm business. Because e-commerce requires access to a computer, one might question whether the computer-using and non–computer-using farmers might make different choices during the conjoint experiment. To test the regularity of preferences between these sub-samples, models were estimated and a log-likelihood ratio test was used

Table 2. Descriptive Statistics for the Sample

	Full Sample		Herbicide Sub-Sample[a]		Machinery Parts Sub-Sample[a]	
Variable	Mean or %	Std. Dev.	Mean or %	Std. Dev.	Mean or %	Std. Dev.
Number of respondents	78		39		39	
Cropped acreage	551.8	687.2	397.1	523.5	706.4	796.9
Percentage with livestock	54.9	50.1	54.1	50.5	55.9	50.4
Percentage who use a farm computer	66.2	47.7	75.8	43.5	56.3	50.4
Percentage of computer users who have purchased inputs from the Internet	51.3	50.6	45.5	51.0	58.8	50.7
Percentage of computer users who have sold farm products using the Internet	13.2	34.3	9.5	30.1	17.6	39.3
Percentage with post high school education	56.9	49.9	51.4	50.7	62.9	49.0
Respondent age (years)	48.6	12.4	48.9	11.0	48.2	13.9
Percentage working off-farm seasonally	16.7	37.5	18.9	39.7	14.3	35.5
Percentage working off-farm year-round	58.3	49.6	62.2	49.2	54.3	50.5
Mean farm gross sales	175,986	270,816	156,622	288,131	197,059	253,234
Median farm gross sales	75,000		75,000		75,000	

[a] Although there is substantial variation in mean values between sub-samples, these differences were not statistically significant at the 0.05 probability level.

Table 3. Farmer Attitudes Regarding E-Commerce

	Response Percentage				
Statement	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I am willing to purchase farm inputs from the Internet if the price is lower.	8.06	4.84	53.23	33.87	0.00
Purchasing from the Internet is safe.	6.35	11.11	39.68	36.51	6.35
Purchasing from the Internet saves time.	4.92	11.48	29.51	47.54	6.56
I like to shop for prices online but make my purchases at a local store.	5.26	8.77	24.56	47.37	14.04
I will only purchase from the Internet if I know and trust the company.	4.92	4.92	13.11	55.74	21.31
I will only purchase from the Internet if the firm has good return policies.	8.20	1.64	34.43	45.9	9.84
I would like my local farm supply store to have online sales so that I can purchase from home.	3.33	13.33	31.67	48.33	3.33

to test for differences based on computer adoption. The log-likelihood ratio test statistic was not statistically significant at a 0.05 probability level; hence, we conclude that there is no systematic difference in response between these groups.

For both models, the estimated coefficients for ΔOnlineStore are negative and statistically significant, indicating that, with all other attributes equal, farmers were less likely to purchase online than at a local farm supply store. Marginal effect estimates suggest that farmers, with distance to store and all other attributes held constant, were 21.7 percent less likely to purchase herbicides online relative to a local supply store, and were about 40 percent less likely to purchase the machinery part online. For the purchase of herbicides, farmers were significantly less likely (36 percent) to choose the national supply store relative to the local store. However, for the time-sensitive machine-part purchase decision, there was

Table 4. Parameter Estimates and Marginal Effects for Conjoint Model

	Herbicides			Machine Parts		
Product Specific Attribute	Coefficient	Marginal Effects	p-value	Coefficient	Marginal Effects	p-value
Intercept	0.2058	0.0821	0.108	0.1998	0.0788	0.070
ΔPrice	-0.0014	-0.0005	0.000	-0.0108	-0.0043	0.000
ΔOnlineStore	-0.5448	-0.2174	0.098	-1.0097	-0.3983	0.002
ΔNationalStore	-0.9026	-0.3601	0.009	-0.1589	-0.0627	0.607
ΔDistance to Store	0.0043	0.0017	0.233	-0.0109	-0.0043	0.001
ΔDelivery (within one week)	0.6452	0.2574	0.004			
ΔDelivery (noon tomorrow)				-0.0662	-0.0261	0.708
ΔDelivery (3 days)				-1.2894	-0.5086	0.000
PostHS*ΔOnlineStore	-0.8732	-0.3484	0.019	-0.1115	-0.0440	0.720
PostHS*ΔNationalStore	-0.5646	-0.2252	0.121	0.4919	0.1940	0.102
N		208			210	
Log likelihood function		-67.5			-94.3	
Restricted log likelihood		-144.2			-145.2	
Chi-squared		153.2	0.000		101.9	0.000
Percentage of observations correctly predicted		86.5			75.7	

no statistically significant difference between the national and local supply options.

The two attributes—distance to store and whether or not the store will deliver the inputs—were expected to be interrelated. Clearly, larger travel distances increase both the direct cost of travel and the opportunity cost of time. On the other hand, delivery to the farm eliminates the travel cost but requires additional delay in receiving the part. In our experiment, the delivery option was expressed as a free service—delivery cost was included in the price of the commodity. The online store does not require travel, but imposes the same delay for herbicides, and may include an even longer delay (3 days) in receiving the machinery part. Table 1 displays the delivery options for each of the store types as well as the travel distances for each store type.

For the herbicide model, ΔDistance was not significant, but ΔDelivery was significant and positive in sign, indicating that the presence of delivery increased (by nearly 26 percentage points) the likelihood of a farmer selecting a particular purchase option. This suggests that in the non-urgent herbicide purchase scenario, the delay for delivery is not important enough to offset the convenience and cost savings of the delivery option. For the machine-part purchase model, where greater urgency is implied, distance to store was statistically significant and negative in sign (an additional 100 miles of travel distance decreased the likelihood of selecting a purchase option by 43 percent). ΔDelivery (by noon tomorrow) was not statistically different from zero, indicating that farmers were indifferent between options that required travel for pickup today and options without travel but where receipt of the machine part was delayed by one day. However, ΔDelivery (3 days) was statistically significant and negative in sign—farmers were nearly 51 percent less likely to select a purchase option if delivery was delayed to this extent. Because delivery helps to offset the travel cost of distant store locations, we included an interaction term for ΔDistance and ΔDelivery; however, this term was not statistically significant in either model and was excluded in the final models.

In addition to the main effects of product characteristics, we also hypothesized that farmer economic and demographic variables might be important determinants of purchase option selection. The literature on technology adoption suggests that operators of larger farms and farmers with greater formal education are more likely to be early adopters (Rogers 1983). For high technology such as computers and information technologies, younger farmers also are often found to be early adopters (Batte, Jones, and Schnitkey 1990, Putler and Zilberman 1988). We included interactions of operator age, education (post-high school = 1), and farm size (gross sales) with both ΔOnlineStore and ΔNationalStore. In preliminary models, only the education interaction was significant, and thus it is included in the final model. Contrary to our expectations, the PostHS*ΔOnlineStore coefficient was negative in sign in the herbicide model, indicating that farmers with post high school education were 35 percentage points less likely to choose the online store than those with lesser education levels. For the machine-part model, the estimated coefficient for PostHS*ΔNationalStore was significant and positive in sign, indicating that farmers with post high school education were 19 percentage points more likely to choose the national store than those with less education.

Finally, ΔPrice is included to estimate the impact of price on the input purchase decision. As suggested by theory, the regression coefficients for price are statistically significant and negative in sign. Thus, with all other parameters constant, higher prices reduce the likelihood that the alternative will be selected.

Estimates of farmer willingness-to-pay for various purchase attributes are presented in Table 5. These estimates are calculated by dividing the estimated coefficient (part worth utility) by the negative of the price coefficient (marginal utility of income). Because the input prices differed substantially between the herbicide and machine-part models, the WTP estimates vary greatly in size between the models. For the herbicide model, farmers were willing to accept the online purchase option only if prices were $400 (10.18 percent) lower than in the local store. For the machinery purchase scenario, where opportunity cost of time was much greater, farmers were willing to accept the online purchase option only if prices were nearly $94 (47 percent) lower than for the local store. The sensitivity of choice between local and national store also differs depending on the scenario—for the non-urgent herbicide choice model, farmers are willing to accept the national store relative to the local store only if prices are 17 percent lower, but are indifferent between local and national stores when there is urgency to buy, as in the machine-part scenario. Distance to store was not important in either model, but delivery options are important. Farmers are willing to pay 12 percent higher prices for delivery for the herbicide purchase, but are willing to accept the three-day delayed delivery for the time-critical machine part purchase only if prices are reduced by 60 percent.

Conclusions

E-commerce represents both threats to and opportunities for rural communities. This study provides an insight into one element of this issue—how willing farmers are to substitute online merchants or national farm input stores for local agricultural businesses. For our sample, about half of the computer-using respondents indicated that they had previously purchased inputs from online sources, but there is no indication of whether this is a frequent or infrequent activity on their part.

Results of a conjoint analysis of contingent choice experiments suggest that farmers are willing to purchase from online or national stores outside their communities if compensated with lower prices or if the national store is able to provide other services (ready availability or delivery). Still, the farmers sampled gave several indications that they are willing to support local businesses when possible, including about 60 percent who agreed with the statement that they would "purchase farm inputs from local businesses even if it costs more than the Internet." However, results for the herbicide purchase model, where time and other constraints were minimal, indicated that farmers who received price discounts of just over 10 percent tended to choose an online or national store over the local store, all else equal. Thus, rural merchants will need to be price competitive in their products and services relative to online or national competitors, or they may lose customers to these extra-community vendors. One might also speculate that migration of farm suppliers away from smaller, local retail outlets into regional enterprises further offsets this desire to "buy local," intensifying the need for rural retailers to understand their online competition's pricing schemes.

Table 5. Comparison of Direct WTP Estimates for Farmer Purchase of Herbicides and Machine Parts

	Herbicide[a]	Machine Parts[a]
Online store	-400.12	-93.66
	[-37.82, 838.05]	[32.90, 154.42]
National store	-662.87	14.74
	[186.82, 1138.91]	[-45.95,75.43]
Distance to store	-3.18	-1.02
	[-8.55, 2.20]	[0.30, 1.72]
Delivery (within one week)	473.80	
	[-810.51, -137.08]	
Delivery (noon tomorrow)		6.14
		[-28.62, 40.90]
Delivery (3 days)		-119.60
		[33.24,205.96]

[a] Figures on top are point estimates of compensating variation (willingness-to-pay) for the listed attribute. In brackets below the point estimates are 95 percent confidence intervals. Due to the nonlinearity of the compensating variation expression in the estimated parameters, the confidence intervals are constructed by bootstrapping from the original data. Specifically, 500 data sets are drawn with replacement from the original data, and the underlying model parameters are estimated for each synthetic data set. The adjustment factors are then calculated from each set of 500 estimated parameters, with the 2.5 and 97.5 percentile of these factors listed in the table.

There is evidence that local merchants may be able to profit by establishing an online presence. About 52 percent of surveyed farmers agreed that they would like to see their local farm supply store offer online sales. Another 54 percent agreed that e-commerce saved time relative to purchasing through conventional channels, and 61 percent indicated that they "shopped for prices online" before purchasing conventionally. The conjoint models demonstrated that services such as delivery do have value, but also made it very clear that the context of the purchase—specifically, time pressure to quickly fill the order—was very important not only in valuing these services, but, more broadly, in terms of the consumer's loyalty to the local merchant.

References

American City Business Journals. 2003. "The Internet Economic Indicators Facts and Figures." Available online at www.internetindicators.com/facts/html (accessed July 18, 2003).

Batte, M.T. 2004. "Computer Adoption and Use by Ohio Farmers." *Journal of the American Society of Farm Managers and Rural Appraisers* 67(1): 108–111.

____. 2006. "Shopping at the Farm Office: What Is the Future of Farm E-commerce?" *Journal of the American Society of Farm Managers and Rural Appraisers* 69(1): 100–105.

Batte, M.T., E. Jones, and G.D. Schnitkey. 1990 "Computer Use by Ohio Commercial Farmers." *American Journal of Agricultural Economics* 72(4): 935–945.

Batte, M.T., G.D. Schnitkey, M.E. Rister, and G. Frank. 1995 "Farm Information Systems' Design and Use." In M.T. Batte, ed., *Adoption and Use of Farm Information Systems*. North Central Regional Research Publication No. 339, OARDC (Ohio Agricultural Research and Development Center) Special Circular No. 149 (November).

Bejjani, G. 2000. "Venture Capital Perspectives on the Ag.com Industry." Presentation at the CARD 2000 Agricultural Forum entitled "E-commerce: The Net Effect on Agribusiness" at the Center for Agricultural and Rural Development (CARD) in Ames, Iowa, February 28, 2000. Available online at www.agforum.org/2000/home.html (accessed May 1, 2001).

Castle, E.N. 1998. "Agricultural Industrialization in the American Countryside." Henry A. Wallace Institute for Alternative Agriculture Policy Studies Report No. 11 (October).

Fox, S. 2005. "Digital Divisions." Pew Internet & American Life Project, Washington, D.C. Available online at www.pewinternet.org/PPF/r/165/report_display.asp (accessed January 15, 2006).

Hanemann, M., and J. Loomis. 1991. "Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation." *American Journal of Agricultural Economics* 73(4): 1255–1263.

Lemoux, N., M.S. Wortman, Jr., and E.D. Mathias. 2001. "Dominant Factors Impacting the Development of Business-to-Business (B2B) E-commerce in Agriculture." *International Food and Agribusiness Management Review* 4(2):

205–218.

Lusk, J.L., and D. Hudson. 2004. "Willingness-to-Pay Estimates and Agribusiness Decision Making." *Review of Agricultural Economics* 26(2): 152–169.

Lyman, P., and H.R. Varian. 2003. "How Much Information." Available online at www.sims.berkeley.edu/how-much-info-2003/ (accessed January 15, 2006).

National Agricultural Statistics Service (NASS). 2005. "Farm Computer Usage and Ownership." U.S. Department of Agriculture, Washington, D.C. Available online at usda.mann[-]lib.cornell.edu/usda/current/FarmComp/FarmComp-08-12-2005.pdf (accessed November 22, 2006).

Park, T., and A. Mishra. 2003. "Internet Usage by Farmers: Evidence from a National Survey." Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27–30, 2003.

Porter, M.E. 2001. "Strategy and the Internet." *Harvard Business Review* 79(3): 63–78.

Putler, D.S., and D. Zilberman. 1988. "Computer Use in Agriculture: Evidence from Tulare County, California." *American Journal of Agricultural Economics* 70(4): 790–802.

Rogers, E. 1983. *Diffusion of Innovations*. New York: McMillan Publishing Company.

Rush, L. 2003. "U.S. E-commerce to See Significant Growth by 2008." *Cyberatlas* (August 7). Available online at cyberatlas.internet.com/markets/retailing/print/0,,6061_2246041,00.html (accessed November 13, 2003).

U.S. Small Business Administration Office of Advocacy. 1999a. *E-commerce: Small Businesses Venture Online* (July). Washington, D.C.

____. 1999b. *Rural and Urban Areas by Firm Size, 1990–1995* (March). Washington, D.C.

Wheatley, W.P., B. Buhr, and D. DiPietre. 2001. "E-Commerce in Agriculture: Development, Strategy and Market Implications." Staff Paper No. P01-6, Department of Applied Economics, University of Minnesota (July).