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Willingness to Pay for Broadband Access by Kentucky Farmers

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Since the Internet's inception its impact has been felt across the United States, but the distribution and adoption of the Internet has not necessarily been uniform geographically. As more consumers and businesses rely on the Internet to access information, the data transmission requirements have also increased. Consequently, access to broadband has become increasingly more important since dial-up cannot realistically handle the increased requirements. The use of broadband in agriculture can provide better access to price, weather, and management information while also opening new markets. However, many rural communities lag behind urban areas in broadband access and adoption rates. This study evaluates, through the use of a producer survey, the level of broadband Internet use, motivations for its use, degree of access to broadband, and willingness-to-pay (WTP) to fund broadband infrastructure investments. Results from the producer survey suggested farmers utilize the Internet primarily for accessing weather reports, e-mail, market reports, and agricultural news. Notably, the survey's WTP questions allowed for the use of an interval regression to calculate producer WTP for varying demographics. The results suggested that producers who were younger, farmed larger farms, and those who currently use the Internet but do not have broadband access were WTP more in property taxes to support broadband infrastructure investments than those of a differing demographic. Because WTP levels varied drastically depending on the underlying demographics, it becomes difficult to pinpoint a WTP level for a one-time payment in property taxes that would be acceptable from a policy standpoint.

Key Words: broadband, rural community, willingness-to-pay

JEL Classifications: Q13, Q31, Q38

The Internet has increasingly become more important to individuals and industries as a means to facilitate transactions and disseminate information. The Internet's increasing importance has impacted the agricultural industry, like many other industries, by improving management and marketing decisions. Decisions are enhanced by providing access to instantaneous weather reports, market prices, input prices, and potential marketing opportunities. As the Internet has progressed over the last decade its applications and graphics have become more complex, which increases the data transmission and speed requirements. Consequently, broadband technology has become more important since it can transmit greater amounts of data at faster speeds than traditional dial-up Internet service. Therefore, availability to broadband Internet for farmers has become important for them to fully benefit from the Internet's wide array of uses on the farm.

Availability to broadband Internet, though, has been unevenly distributed across rural and urban communities, with significantly lower access to broadband in rural communities. The

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lower population in rural communities increases the cost to deploy broadband on a per household basis compared with urban communities (Federal Register, 2011). These higher costs per household deter private providers in the most rural areas from investing in the necessary infrastructure to support broadband because subscriber revenue may not be high enough to recuperate the initial investment and support the maintenance requirements (Federal Register, 2011). Limited access to broadband in rural communities can lead to asymmetric information for farms and agricultural businesses, as well as diminished network economies. Asymmetric information can potentially impede the decision-making process for farms and rural agribusinesses, which may negatively impact their profitability and long-term viability. Subsequently, network capabilities for the transfer of information or the sale of products can also be hindered when fewer people are utilizing the Internet's capabilities.

Agriculture remains a cornerstone for many rural communities and their local economy. A previous study (Jeffcoat, 2011) initially evaluated the impact of broadband Internet availability on total gross farm sales for counties in Kentucky. It was theorized that gross farm sales increase in response to higher broadband Internet availability. The author utilized a modified growth model, but broadband Internet availability was not a significant influence in the growth of farm sales over a period from 1997–2007. These insignificant results provided motivation to better understand the difference between access to and adoption of broadband as well as the extent of Internet use, type of Internet use, motivations for its use, and reasons for not using broadband. To help understand these issues the authors created and distributed a survey to Kentucky farmers to evaluate these questions and gain a better understanding of farmer willingness-to-pay (WTP) for broadband access. The results from this survey provide important information for local policymakers considering broadband infrastructure investments as an economic development strategy as well as for the private telecommunications industry. In addition these results should be useful to the Cooperative Extension Service when planning educational programs and methods to disseminate information.

Agricultural Broadband Importance

Rural areas are at a disadvantage in accessing Internet information since it increasingly relies on transmitting complex signals at faster speeds (Cowan, 2008). Lower broadband availability in rural areas can potentially lead to the condition of asymmetric information for farms and agribusinesses. Broadband can provide access to immediate information on weather, input and output pricing, and management practices or access to online marketing options. Instantaneous weather updates can be extremely important to producers since the quality of a crop and many tasks depend in large part on the weather. Additionally, broadband users may access price information allowing them to gain bargaining power and make more educated marketing or purchasing decisions. Consumers' purchase decisions can be facilitated through price discovery or information attainment even when the purchase is not consummated online (Stenberg et al., 2009). Broadband Internet's potential to facilitate price discovery can increase market efficiency while also increasing the network capabilities. Broadband users can also access management information to improve their farm's profitability. General farm management tools and information are available from online sources such as the Cooperative Extension Service or United States Department of Agriculture (USDA). Expeditious and improved access to research-based information can improve and allow for more efficient management decisions.

Broadband may also allow for an expansion of the farm into direct marketing to the consumer with network capabilities assisting in the opening of new markets to farmers that may be local, statewide, or national in scope. Those farms that already direct market locally can also increase their market range and gain access to potential customers. Direct marketing may also encourage diversification or production of value added products that may command higher prices in the marketplace. In rural communities, home businesses are more common and 81% of households with home businesses have Internet access, while only 62% of total households have Internet access (Stenberg et al., 2009). Without broadband access, direct marketing by farm households may be hindered and therefore not reach its full potential.

Broadband facilitates many functions when utilized to its fullest extent, which can reduce the occurrence of asymmetric information and improve marketing decisions through network economies therefore allowing farms to operate more efficiently. Broadband is viewed as a critical component of the United States national communications infrastructure and future economic well-being because adoption can increase overall productivity (Lehr et al., 2005).

Broadband Availability

The broadband Internet market reveals locational differences that lead to variances in the level of broadband availability between rural and urban communities. These variances can be observed particularly for rural areas located outside the proximity of towns, where most rural farms are located. Availability varies because of the fixed cost of investing in broadband infrastructure, which is higher on a per subscriber basis in rural areas (Kandilov and Renkow, 2010). Costs per subscriber are higher for rural areas primarily because the population is lower and more dispersed, but additional factors such as a demanding terrain, aging population, and education also play a role in the amount of broadband supplied to and demanded by residents (Federal Register, 2011).

The fixed cost of installing broadband infrastructure in rural communities decreases provider profitability therefore constraining private investment (Federal Register, 2011). Revenue from subscribers to the broadband company must be high enough to recover the infrastructure investment and provide for maintenance. In a 2005 Office of Management and Budget study, it was determined that the broadband investment cost for rural areas is $2,921 per subscriber, while the cost in urban areas is $1,920 per subscriber (Kandilov and Renkow, 2010). The variation reflects the population and terrain differences between rural and urban areas, but it is fundamental in understanding why urban areas realize economies of scale.

Population size and concentration are the primary drivers in broadband availability throughout the United States (Stenberg et al., 2009) and because rural areas have a lower and less concentrated population, broadband is likely to be less available. Fewer customers share in the fixed costs of the initial infrastructure investment and annual infrastructure maintenance and there are fewer large businesses or government operations that indirectly subsidize household use (Stenberg et al., 2009). However, controlling for population, areas with higher employment in agriculture had greater levels of broadband support (Stenberg et al., 2009). This may occur because farmers recognize the benefit of broadband to their operation and adopt its applications to improve production. It is more likely in the farming sector that broadband becomes embedded into productivity since the basic inputs of farming are more fixed than other sectors (Stenberg et al., 2009).

Review of the Literature

When considering rural and urban household basic Internet access, including dial-up and broadband, 62% of all households had access in 2007 with the rural and urban difference nonexistent (Stenberg et al., 2009). However, when exploring broadband adoption data exclusively, 84% of urban and 70% of rural households had broadband in 2007 (Stenberg et al., 2009). In a different study, PEW conducted a survey in 2008 to collect general Internet and broadband use data and found that 69% of all adults had dial-up or broadband in their home (Stenberg et al., 2009). The same PEW survey revealed that 55% of all households had broadband, but only 41% of rural households had broadband (Stenberg et al., 2009). The rural and urban household broadband adoption differences in these studies may reflect both fewer broadband providers and/or a lower broadband demand by rural consumers.

An analysis of 2005 and 2007 USDA Agricultural Survey data displayed differences in broadband adoption among farmers across the

United States. In 2005, USDA Agricultural Survey data revealed that 24% of all farms had adopted broadband Internet (Stenberg et al., 2009). More recently, in a 2007 USDA Agricultural Resources Management Survey, data revealed that 63% of farms reported using the Internet for farming operations and 60% of these Internet adopters utilized broadband (Stenberg et al., 2009). When observing the conversion of dial-up to broadband Internet access from 2005–2007 it was found that farms were less likely to directly jump from no Internet use to broadband Internet use, however, farms that already had dial-up service were more likely to adopt broadband Internet (Stenberg et al., 2009).

Early research on general Internet use has revealed that education, age, income, and the number of children in a household are demographic determinants for whether households adopt Internet use (Stenberg et al., 2009). Using maximum-likelihood methods a multinomial logit model yielded results that suggested larger farm businesses who hired more workers, farm households with greater than $50,000 in income, farm households with school-age children, and operators with at least a college degree had a higher probability of broadband access (Stenberg et al., 2009). When considering the location of the farm their results suggested that farms in mixed urban-rural areas were less likely to use dial-up or broadband than urban areas, which may be due to its cost or availability (Stenberg et al., 2009). However, there were insignificant results when analyzing more isolated farms suggesting the need for further analysis.

In 2008 a PEW survey of all Internet users revealed 89% use an online search engine, 80% check weather forecasts, and 73% get news online (Stenberg et al., 2009). Specific to agriculture, Hopkins and Morehart (2001) analyzed 2000 survey data from farm operators and found that 98% of farm businesses used broadband for information gathering and 82% used it for price tracking (Stenberg et al., 2009). Using self-reported survey data from Great Plains' farmers in 2000, it was suggested that 27% reported financial improvements of $3,800 on average and 42% reported cost savings of 14% (Carter et al., 2005). However, calculations based upon objective economic measures may be more appropriate than estimates from farmers when attempting to determine financial gains from Internet use (Kandilov et al., 2011). Additionally, it's important to not extrapolate strong conclusions regarding broadband availability or financial improvements based upon early adopters since the benefits of adoption to them may be higher and there may be a higher opportunity cost for them to not adopt broadband.

Recent research analyzing the impact of the Pilot Broadband Loan Program and the Broadband Loan Program suggested that counties who received broadband loans increased their farm revenues by approximately 6%, as well as their production expenditures by 3%, and farm profits by 3% (Kandilov et al., 2011). The increase in total commodity sales was primarily due to crop sales, whereas livestock and animal product sales were less sensitive (Kandilov et al., 2011). The increase in farm expenditures suggests that broadband loans influenced the increase in farm expenditures (Kandilov et al., 2011).

In a working paper, Jeffcoat (2011) utilized a modified growth model to analyze the influence of broadband Internet availability on Kentucky gross farm sales from 1997–2007. The model failed to detect significance for broadband availability using the Federal Communications Commission's zip code level data on the number of providers. The results may suggest that broadband availability is not a driver of gross farm sales or that a better approach might involve utilizing actual broadband adoption rates in counties. Unfortunately, data on actual adoption rates for this time period are not available. The ambiguity of the results also raised several important questions regarding the level of broadband use, motivations for use, and reasons for not using broadband by Kentucky farmers.

Research focusing on the impact of broadband access and adoption on farm profitability is relatively recent. Thus, there are opportunities to better understand farmer adoption and use of the Internet, specifically broadband Internet. To assist in this understanding and to expand the literature, the authors created a survey to gain a better perspective into these issues related to use and motivations for use of broadband. In addition, the purpose of the survey was to elicit a WTP for supporting future broadband infrastructure investments. The results can provide insight about the value of broadband access and adoption beyond what has been previously studied.

Farmer Use of Broadband Survey

Data were collected by distributing surveys through the Cooperative Extension Service in Kentucky and placing a survey insert in the Cow Country News (CCN). The Cooperative Extension Service has offices in each of Kentucky's 120 counties. The CCN is a monthly publication by the Kentucky Cattlemen's Association. There were 7,425 farm households who received the survey as an insert through the CCN. Surveys were sent in the September 2011 issue with a follow-up survey sent again in the October 2011 issue. Respondents could either return their completed surveys using an enclosed postage paid envelope or by submitting their responses through a website link provided in the survey instructions. Less than 2% of the respondents, though, submitted their responses through the online option.

Responses were limited to only Kentucky farmers who were 18 years or older and farmed at least one acre. A total of 1,311 surveys were returned and used for this analysis with 1,117 received from the CCN mailing, which represents about a 15% response rate. The remaining 194 surveys were received through the distribution of surveys by the Cooperative Extension Service. Respondents represented 110 of the 120 total counties in Kentucky. Summary statistics are provided in Table 1.

All respondents were instructed to answer questions related to household demographics, gross farm sales, and the production of crops or livestock. The gross farm sales categories followed those employed in the 2007 Census of Agriculture with the exception of less than $9,999. This category was further disaggregated in the Census of Agriculture, but was consolidated into one category for the survey.

In addition, respondents were asked whether they used the Internet for their farming operation. Only respondents answering "Yes" to using the Internet for farming operations answered questions related to the type of Internet, location of Internet use, and reasons for Internet use questions.

The survey was constructed in a manner to reveal farmers' adoption of and purposes for Internet use, availability to broadband, and WTP for broadband infrastructure investments. This format also allowed for a comparison of WTP data across various demographics. WTP data, along with the demographics, were analyzed to estimate farmers' WTP for a one-time increase in property taxes to support broadband infrastructure investments. Table 2 provides an overview of how Kentucky farmers use the Internet and an overview of their WTP for broadband.

The initial WTP question asked farmers whether they would be willing to pay an additional one-time payment in property taxes to fund the necessary infrastructure investment to support broadband (high-speed) Internet in their area. The payment vehicle in this approach used property taxes since a majority of Kentucky counties already have specialized local taxing districts to generate property tax revenue that is devoted specifically to the Cooperative Extension Service of their respective county. In this aspect producers already understand how the local property taxes operate for taxing districts such as the Cooperative Extension Service. It is also possible, though, that some producers would view the question negatively since property taxes are used as the payment vehicle.

To elicit respondent WTP for accessing broadband, we followed and modified the general form of a one-and-half-bound contingent valuation question suggested by Cooper, Hanemann, and Signorello (2002). In our design, we incorporated three WTP amounts in the initial question to ensure the correct baseline value for WTP was achieved. The values for the initial WTP question were $100, $200, and $300. The WTP variations were equally and randomly distributed through the survey insert in CCN. The version distributed through the Cooperative Extension Service solely represented the $300 variation.

Respondents answering "No" to the initial WTP amount were then asked their maximum WTP. Utilizing a payment card approach with

Table 1. Summary Statistics Demographic Variables

Variable	Variable Description	N	Mean	Standard Deviation
Male	1 if respondent is a male producer	1,311	0.895	0.307
Fulltime	1 if respondent is a fulltime producer (more than 50% household income from farming)	1,311	0.372	0.484
Age	Age of producer (continuous variable)	1,307	59.213	13.338
Acres	Acres farmed that are owned and rented (continuous variable)	1,260	366.965	490.349
Gross Farm Sales				
Less_9999	1 if gross farm sales are $9,999 or less	1,257	0.181	0.385
Btwn10000_24999	1 if gross farm sales are $10,000 to $24,999	1,257	0.302	0.459
Btwn25000_49999	1 if gross farm sales are $25,000 to $49,999	1,257	0.185	0.389
Btwn50000_99999	1 if gross farm sales are $50,000 to $99,999	1,257	0.161	0.368
Greater_100000	1 if gross farm sales are $100,000 or greater	1,257	0.169	0.375
Farms Producing the Following Crops and Livestock				
Tobacco	1 if respondent's farm produces tobacco	1,311	0.149	0.357
Corn	1 if respondent's farm produces corn	1,311	0.286	0.452
Soybeans	1 if respondent's farm produces soybeans	1,311	0.166	0.372
Hay	1 if respondent's farm produces hay	1,311	0.796	0.403
Fruit	1 if respondent's farm produces fruit	1,311	0.052	0.222
Vegetables	1 if respondent's farm produces vegetables	1,311	0.105	0.307
Other crops	1 if respondent's farm produces other crops	1,311	0.058	0.234
Cattle	1 if respondent's farm produces cattle	1,311	0.941	0.235
Hogs	1 if respondent's farm produces hogs	1,311	0.028	0.166
Poultry	1 if respondent's farm produces poultry/eggs	1,311	0.069	0.254
Equine	1 if respondent's farm produces equine	1,311	0.101	0.300
Other livestock	1 if respondent's farm produces other livestock	1,311	0.079	0.269
Internet Use for Faming				
Use_Internet	1 if respondent uses the Internet for farming	1,311	0.702	0.487
Use_Dialup	1 if respondent's type of Internet use is dial-up	920	0.099	0.299
Use_Broadband	1 if respondent's type of Internet use is broadband	920	0.899	0.302
Location of Internet Use				
Home	1 if respondent uses the Internet at home	920	0.939	0.239
Farm_Office	1 if respondent uses the Internet at farm office	920	0.079	0.270
Job_Location	1 if respondent uses the Internet at off farm job location	920	0.128	0.335
Other	1 if respondent uses the Internet at other location	920	0.034	0.180

descending $25 increments from the WTP amount in the initial question to the amount of $0, respondents were asked to provide their maximum WTP. Respondents answering "Yes" to the WTP amount in the initial question did not answer any further questions since the goal of the survey would not be to extract the entire consumer surplus, but rather support broadband infrastructure investments.

When approaching the Internet use question, farmers were asked whether they, a family member, or someone who works for them use the Internet for farming operations. Of the survey respondents, 70.2% reported using the Internet for farming operations while in 2007 the state average was only 50.6%. It is plausible that this increase occurred because broadband is becoming more available and the benefits to

Table 2. Internet Use for Producers

Variable	Variable Description	N	Mean	Standard Deviation
Purpose for Agricultural Internet Use				
Weather	1 if uses the Internet for weather reports	920	0.823	0.382
E-mail	1 if uses the Internet for e-mail	920	0.812	0.391
Market reports	1 if uses the Internet to check market reports and prices	920	0.758	0.428
Ag news	1 if uses the Internet for agricultural news	920	0.708	0.455
Input information	1 if uses the Internet for input or machinery information	920	0.655	0.475
Purchase inputs	1 if uses the Internet to purchase farm inputs or parts	920	0.625	0.484
Extension publications	1 if uses the Internet to access Extension publications	920	0.534	0.499
Direct farmers	1 if uses the Internet for direct marketing to farmers	920	0.220	0.414
Direct	1 if uses the Internet for direct marketing to consumers	920	0.126	0.332
Consumers cattle associations	1 if uses the Internet for cattle association websites	920	0.022	0.146
Online sales	1 if uses the Internet for online sales or sale information	920	0.015	0.122
Finances	1 if uses the Internet for finances, tax info, banking	920	0.011	0.104
Avenues for Direct Marketing				
Direct e-mail	1 if respondent direct markets using e-mail	245	0.522	0.500
Direct Ebay Craigslist	1 if respondent direct markets using Ebay or Craigslist	245	0.498	0.501
Direct farm website	1 if respondent direct markets using farm's website	245	0.286	0.453
Direct Facebook	1 if respondent direct markets using Facebook	245	0.212	0.410
Direct other websites	1 if respondent direct markets using other websites	245	0.094	0.292
Reasons for Not Having Broadband in Home or Farm Office				
Not needed	1 if respondent signifies "not needed"	420	0.381	0.486
Cost too high	1 if respondent signifies "cost is too high"	420	0.226	0.419
No access	1 if respondent signifies "no access available"	420	0.333	0.472
Have no use	1 if respondent signifies "have broadband, but don't use it for farming"	420	0.040	0.197
Age too old	1 if respondent signifies "age: no desire to have at their age"	420	0.038	0.192
Knowledge	1 if respondent signifies "not sure how to use computer and/or Internet"	420	0.033	0.180
WTP One-time Payment to Support Broadband Infrastructure Investment:				
WTP 100	1 if respondent signifies "Yes" to the $100 WTP level	100	0.340	0.476
WTP 200	1 if respondent signifies "Yes" to the $200 WTP level	85	0.212	0.411
WTP 300	1 if respondent signifies "Yes" to the $300 WTP level	115	0.191	0.395
Maximum WTP for those Answering "No" to Initial Payment Level				
Max WTP	Maximum WTP (continuous variable)	220	17.045	34.774

Internet use are becoming more apparent to farmers who had not already adopted its use. More than 75% of the households in 112 of the 120 Kentucky counties had broadband availability in 2007 with seven of the lower availability counties being the least densely populated counties (Stenberg et al., 2009).

In the survey, 89.9% of the respondents who reported using the Internet for farming operations utilized broadband. However, when calculating the percentage of broadband use based on the total survey population we find that 63% of the total farmers used broadband Internet. When considering the reasons for the non-use of broadband 33.3% of those respondents not using broadband stated they had "no access available," which represents 10.7% of the total respondents.

Results from this survey regarding the motivations for Internet use were consistent with findings from similar surveys to broader audiences. The three predominant motivators for those using the Internet for farming operations were weather reports (82.3%), e-mail (81.2%), and checking market reports or commodity prices (75.8%). In addition, 65.5% of respondents reported using the Internet for purchasing inputs or machinery parts. Producers may be seeking lower priced and and/or more specialized inputs, which can improve their profitability and long-term viability. Conversely, this may force local farm stores to provide inputs at a lower cost to retain customers or potentially risk losing their local market share.

Notably, 53.4% of those using the Internet for farming operations also access Cooperative Extension Service publications. This represents 37.5% of the total population accessing Cooperative Extension Service publications online. Although these percentages are encouraging since producers are seeking research-based Extension publications online, it still displays a potential for improvement in encouraging more producers to access Extension publications online in the future. The responses of cattle association, online sales, and finances were the three primary write-in responses in the "other" category. When considering the avenues for direct marketing, 52.2% reported using e-mail, 49.8% reported using either Craigslist or EBay, and 21.2% reported using Facebook.

Econometric Model

The WTP survey data were evaluated utilizing maximum likelihood estimation for an interval regression. Because the follow-up question did not take the form of a referendum, a discrete choice model was not used in the analysis. Respondents were provided several lower values to choose from in the follow-up question to indicate their WTP. Between the values they indicated and the value at the next level, an interval was formed. As a result, an interval regression is adopted with the dependent variable equal to the interval of values the respondents indicated. This approach recognizes the fact that the dependent variables are represented in intervals and the highest interval is unbounded from above.

Data utilized for this analysis include those respondents who do not use the Internet, use dial-up Internet and do not have access to broadband, or use broadband but do not have access in their home or farm's office. As indicated, intervals are then formed using the respondent's maximum WTP as the lower bound with the upper bound being $0.01 less than the next level in the follow-up question. Respondents answering "Yes" to the initial WTP amount were assumed to have an upper bound interval of $49.99 greater than the WTP amount they agreed to. Producers signifying that they do not use broadband because it is "not needed" or they deemed themselves "too old" as a write-in response in the other category are assumed to have a zero WTP for the lower bound if they did not complete the WTP questions.

In analyzing the data, an ordinary least square (OLS) regression would not reflect the exact WTP values for each interval or handle the issues of left and right censoring in the tails, but would provide a baseline estimate for the parameters as an ad hoc check for normality, which is assumed in an interval regression (Yang et al., 2011). Therefore, an OLS model was constructed with the dependent variable calculated at the midpoint value of the interval for each response. The resulting estimated coefficients between the OLS model and Interval model would likely differ significantly if normality was incorrect (Yang et al., 2011). The following is the econometric specification for the interval regression (Yang et al., 2011):

$$(1) \quad y_i^* = x_i'\beta + u_i,$$

$$(2) \quad \Pr\left[a_j \le y^* \le a_{j+1}\right] = \Pr\left[y^* \le a_{j+1}\right] = F^*\left(a_{j+1}\right) - F^*\left(a_j\right),$$

where y_i^* is the respondents' true WTP known only to them, which is located within $(j + 1)$ and the mutually exclusive intervals of $(-\infty, a_1)$, (a_1, a_2), . . ., (a_j, ∞). For example, y_i^* in this survey is located within one of the following intervals:

$$(3) \quad 0 \le y^* \le 24.99, 25 \le y^* \le 49.99, \ldots, \text{ and } 300 \le y^*,$$

where x_i' are a set of independent variables and β are the coefficients being estimated. Several interval regression models were estimated with the coefficients being robust across the models. The maximum likelihood estimation is therefore designed based on the probability of the observation being within an interval, assuming normality of disturbances. The WTP of a one-time payment in additional property taxes to support broadband infrastructure can then be calculated using the following empirical specification (Yang et al., 2011):

$$(4) \quad WTP = y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_9 X_9 + \varepsilon,$$

where

X_1 = Age of respondent (*age*)
X_2 = Number of acres farmed that are owned and rented (*acres*)
X_3 = Type of farmer (*fulltime*)
X_4 = Gross farm sales < \$9,999 (*Sales_$9,999_Less*)
X_5 = Gross farm sales > \$50,000 (*Sales_$50,000_Greater*)
X_6 = Internet use for farming operations (*Use_Internet*)
X_7 = Broadband availability (*No_Access*)
X_8 = An interactive variable created to identify those respondents that use the Internet but do not have access to broadband (*UseNet_NoAccess*)
X_9 = A dummy variable for those specific respondents where a zero value is assumed for their WTP (*Calculation_Variable*).

The *Age* and *Acres* variables represent continuous variables while the remaining variables are discrete variables. The gross farm sales categories were consolidated into three primary categories for the analysis with the sales group of less than \$9,999 remaining unchanged. For analysis purposes the category of sales between \$10,000 to \$24,999 and \$25,000 to \$49,000 were combined into one category, while the sales from \$50,000 to \$99,999 and greater than \$100,000 were combined into another category. In the 2007 Census of Agriculture, 66.5% of Kentucky farms had gross farm sales less than \$9,999, 22.2% had gross farm sales from \$10,000 to \$49,999, and 11.2% had gross farm sales greater than \$50,000.

Results

Results to the OLS and interval regressions can be viewed in Table 3. Using the OLS model as an ad hoc check of normality for the interval model yielded coefficient estimates for both models that closely resembled one another. These results suggest that the normality assumption for the interval regression was maintained by the data. The scale parameter of the interval regression is interpreted similar to an F-value in an OLS regression simply by dividing the scale parameter by its standard error. Doing so results in a scale parameter that is significant. The coefficients in the interval regression are intuitive and can be interpreted similar to an OLS model with the coefficients representing a dollar amount. Continuous variables are interpreted as, for each one unit increase in the variable the farmer is willing to pay the coefficient amount that many times more or less depending on the sign of the coefficient. The coefficients for discrete variables are interpreted as a dollar amount for the event pertaining to the variable occurring.

The interpretations of the interval regression results are intuitive with regards to the signs of the coefficients for *age* and *acres*. As one would expect, for each year older a producer is willing to pay \$0.80 less to support broadband infrastructure investments. Conversely, for each additional acre a producer farms they are willing to pay \$0.03 more for broadband. These variables are significant at the 1% level. The results

Table 3. OLS and Interval Regression Results

Variable	OLS Coefficients		Interval Coefficients	
Constant	78.411***	(20.616)	78.051***	(20.031)
Age	−0.807***	(0.295)	−0.801***	(0.287)
Acres	0.029***	(0.012)	0.029***	(0.012)
Fulltime	−15.167*	(8.165)	−15.195*	(7.920)
Less_9999	10.006	(8.923)	9.597	(8.653)
Greater_50,000	14.392	(10.207)	14.189	(9.913)
Use_Internet	5.399	(14.826)	5.311	(14.355)
No_Access	27.523***	(9.706)	27.053***	(9.409)
UseNet_NoAccess	76.739***	(18.510)	76.375***	(17.963)
Calculation_Variable	−32.192***	(8.708)	−19.429**	(8.428)
Scale	63.770	(2.392)		
N	378		378	
F−value	28.41			
Log likelihood	−852.58			
Adjusted R^2	0.395			
Lower interval R^2	0.377			
Upper interval R^2	0.393			

Notes: Standard errors are reported in parentheses.
*, **, and *** denote 10%, 5%, and 1% significance.

also suggest that as a farm's gross sales increase their WTP also increases, but they failed to display significance. Interestingly, the *fulltime* variable, which was significant at the 10% level, revealed a negative coefficient. This would be interpreted as full-time producers being willing to pay $15.20 less than a part-time producer. One theory for this occurrence could be that part-time producers have accessed broadband Internet through off-farm employment locations. Therefore, they would understand the advantages and capabilities of broadband use while also having a greater knowledge base on computer and Internet use. In addition, when calculating the average age of the part-time farmers utilized in this subset, it becomes evident they represent farmers who were on average three years younger than the full-time farmers in the subset.

Results for the variables pertaining to Internet use and broadband access were also intuitive with the *Use_Internet, No_Access,* and *UseNet_NoAccess* variables all revealing positive WTP values. The *UseNet_NoAccess* variable was derived as an interactive variable between the *Use_Internet* and *No_Access* variables. The interactive variable is interpreted as those producers who use the Internet for farming operations, but do not have access to broadband at their home or farm location. The *No_Access* and *UseNet_NoAccess* variables were significant at the 1% level, but the *Use_Internet* variable failed to detect significance. Also, as would be expected the *Calculation_Variable* revealed a negative WTP and was significant at the 5% level. This variable represents those respondents where a zero WTP was assumed due to their response of "not needed" or "age" as reasons for not using broadband.

Utilizing the coefficients revealed through the interval regression, various levels of WTP can be calculated based on differing demographics. Results for the varying WTP scenarios can be viewed in Table 4. The table displays the WTP based on the corresponding demographics for each category.

Scenarios 1, 2, and 3 represent a producer who is the same as the state average from the 2007 Census of Agriculture for age and acres farmed. These scenarios also follow the same gross farm sales as the majority of producers in the 2007 Census of Agriculture. Results suggest that producers who use the Internet and/or have no access to broadband are willing to pay more money in a one-time payment to support broadband infrastructure investments in their

Table 4. Predicted Willingness to Pay

Demographic	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Age	56.5	56.5	56.5	45	63
Acres	164	164	164	750	250
Type of producer	Part-time	Part-time	Part-time	Full-time	Full-time
Gross farm sales	$9,999 or less	$9,999 or less	$9,999 or less	$50,000 or greater	$10,000 to $49,999
Use Internet	Yes	No	No	Yes	No
Broadband access	No	No	Yes	No	Yes
Calculated WTP	$155.88	$64.59	$27.71	$171.42	$0.20

area. When considering a younger producer who farms 750 acres full-time, has gross farm sales greater than $50,000, and uses the Internet for farming, but does not have access to broadband, the producer's WTP increases to $171.42. However, in a contrasting WTP scenario where a 63-year-old full-time producer farms 250 acres, earns gross farm sales between $10,000 and $49,999, does not use the Internet, and already has access to broadband, they are essentially not WTP anything to support broadband infrastructure investments in their area.

These results reflect those producers who do not have broadband access or have access, but have not adopted its use. Therefore, producers who have not already adopted its use despite access will inherently have a lower WTP since they reflect a group that may not fully value its use yet. On the other hand, those without access who have a demand for its use would have a relatively higher WTP for broadband. This study revealed that 10.7% of the total respondents did not have access to broadband Internet. It should be noted that farmers may have a higher WTP for broadband since they are operating a business and therefore can incorporate its uses into the production function to potentially improve management and marketing decisions. Broadband in a farm household therefore has the advantage of taking on the dual uses for both farming and household applications.

The WTP results are intuitive from the aspect of which demographic groups would be willing to pay more for broadband access. Results suggest that younger producers, larger farms as defined by number of acres farmed and/or gross farm sales, those already using the Internet for farming operations, and those without broadband access are willing to pay more. The results for those already using the Internet follow previous research by Peter Stenberg where he suggested farmers were less likely to directly jump from no Internet use to broadband Internet use rather than those who convert from dial-up to broadband service (Stenberg et al., 2009).

These results would be important to private telecommunications companies or local policymakers considering targeted broadband expansion into areas without current broadband access. These remaining areas without access reflect the areas where the infrastructure cost per subscriber is higher. Private telecommunications companies may be interested in the potential WTP of farmers as a means to make expansion viable into areas without current access. Companies may propose expanding access into areas based on a one-time payment from the residents to aid in the infrastructure investment. Additionally, local policymakers may be interested in the WTP results if an area of their county lacks broadband access and they are considering increasing access into these areas. Using the results of the varying demographics, private telecommunications companies or local policymakers can estimate the WTP of an area based on its underlying demographics.

Finally, the Cooperative Extension Service or organizations providing educational programs to farmers may be interested in the survey and WTP results. Farmers of varying demographics could be targeted with initiatives specific to their demographic group to educate them on the wide array of information available to them through the Internet and its applications within the farming operation. Therefore Internet use could be expected to increase. Young producers could be targeted with more extensive and in depth programs that could make them more viable and better positioned for the future of the agricultural industry.

Conclusion

The Internet's increasing use and importance in today's society has impacted the agricultural industry by providing opportunities to improve management and marketing decisions. As the Internet has progressed its websites have become more complex, which resulted in broadband becoming increasingly more important. Availability to broadband has therefore become more important for farmers to access information such as weather reports, market prices, or management information.

The intent of this study was to survey Kentucky farmers as a way to gain a better perspective on actual broadband Internet use for the farming operations, but also to understand their motivations for use or non-use. The underlying question for those not using broadband Internet was whether there is a WTP for a one-time payment in additional property taxes to support broadband infrastructure investments in their area.

The results from this study suggest that perhaps a universal investment in broadband in rural agricultural regions might not necessarily prove fruitful. Instead, public and private investment in broadband infrastructure should focus on the demographics of the producers. The age of the producers and size of the farm will dictate the level of interest in utilizing the Internet for farming purposes. With WTPs that ranged from $0.20 to $171 it would be difficult to convince a private Internet provider to invest in the extensive fixed costs to provide broadband Internet infrastructure. Thus, it would seem likely that public investment would be necessary to offset the expenses. This would be consistent with historical public investment in infrastructure in rural areas dating back to the 1930s. This study will leave the potential return on public investment in broadband infrastructure in rural areas as future research.

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