Broadband Internet Use and Rural Businesses

One of the salient features of the Internet is its capacity to provide information quickly and cheaply compared to other dissemination methods (Henderson et al., 2000). Wider and more convenient access may reduce the costs of communicating, transacting, and sourcing information. With improved information and knowledge, individuals' perception of products and services provided would be more accurate, thereby improving the adoption of worthwhile technologies and discarding those that have little value (Hooker et al., 2001; Just and Just, 2001). As a result, Internet use may lead to greater efficiency in the agricultural and other rural business sectors (Borenstein and Saloner, 2001; Gloy and Akridge, 2000; Greenstein and Prince, 2006).

Crandall (2008) pointed out during the ERS workshop that the effect of information and communications technology (ICT) on productivity growth is clear. Overall U.S. labor productivity growth from 1995 to 2000 was 2.5 percent per year, with an estimated 30 percent of it ascribed to ICT-producing and 56 percent due to ICT-consuming sectors of the economy (Fuss and Waverman, 2005). Measuring broadband Internet's contribution to this, however, is challenging due to data limitations and the problems of separating out overlapping causal effects (Crandall). As a consequence, empirical studies directly linking broadband to regional productivity growth are largely nonexistent.

Crandall and some of his colleagues, however, studied the effect of broadband on output and job growth. In their attempt to establish a relationship between State gross domestic product (GDP) or job growth and broadband deployment, they conducted a cross-section regression analysis on variables capturing local economic characteristics (unionization, business tax, education, wage rates), quality-of-life characteristics (climate, mean temperature), and broadband lines per capita. They found that total nonfarm employment growth was significantly related to broadband lines per capita. The results for GDP were not statistically significant. The strongest effects of broadband Internet on employment growth were in finance and insurance, real estate, and education services. The results largely supported an earlier study by Gillett et al. (2006).

Rural Businesses and Broadband

Pociask (2005) found evidence that rural small businesses did not use broadband as much as their urban counterparts. He attributed the lower usage to fewer employees, on average, in rural businesses and higher prices for rural broadband service. Socioeconomic characteristics—such as rural-urban differences in age, education, and affluence—may also play a role (Pociask, 2005; Stenberg, 2000). But what does this gap in broadband adoption mean for rural businesses?

Lamie et al. (2008) in their ERS workshop paper examined rural small business adoption of e-commerce practices. The rural businesses in their study were primarily manufacturing and retailing firms that fell into one of a number of e-commerce classifications: traditional local businesses that increased their market ranges and sales through e-commerce, virtual businesses (all marketing and sales conducted through e-commerce), businesses

that used e-commerce primarily to reduce marketing inputs and costs, and businesses that used e-commerce primarily for business-to-business (B2B) or business-to-consumer (B2C) transactions.

Most businesses in their study used e-commerce because it provided an opportunity for increased profits and enhanced sustainability. E-commerce may benefit a firm in product development, inventory management, manufacturing, marketing and sales, and customer service. The 28 rural businesses in the case study had varied experiences in the application of e-commerce. Most felt that e-commerce activities benefited their operations. Economic returns from their e-commerce activities were enhanced if the business served a niche market, took advantage of public and private IT service providers in the maintenance of their e-commerce operation, and integrated e-commerce into multiple aspects of the business operation.

Rural Retailers and Broadband

Retailers are a particularly important type of rural business. They are present in nearly every community, are often major local employers, and often serve as a social hub. In their workshop presentation, Stoel and Ernst (2008) examined the attitudes and beliefs of rural retail business owners (specifically apparel, hardware, and grocery) that may act as impediments to accepting the Internet in their businesses. Included were owners' attitudes toward use of the Internet in their business, the perceived ease of use, and the Internet's usefulness in operational efficiency, strategic positioning, and other applications.

In their survey of 181 retail business owners, Stoel and Ernst found that retail store owners that used the Internet were less enamored of the Internet than nonusers, perhaps due to a fuller realization of some of its shortcomings or to a begrudging compliance with suppliers' demand that they use it. Broadband Internet access, however, did appear to facilitate using the Internet for operational effectiveness and business strategic positioning. Rural broadband users seemed to capitalize on the Internet's capacity to increase operational effectiveness and exploit market niches. Broadband users perceive the Internet to be easier to use than non-broadband users (which may say something about slow-speed toleration in business Internet operations).

Ernst and Stoel (2008), in a more thorough survey of rural grocers, found that these retailers felt that they had to be more price competitive because consumers received more information and explored more options via the Internet. As a result, businesses were expanding their markets and commercial business was moving faster. Rural grocers did not believe that e-commerce reduced their profits or threatened their existence. Rather, customers were more familiar with their business because of the Internet.

Farm Businesses and Broadband

Agriculture is another rural business sector that benefits from the Internet. For farm operators with Internet access in 2000, 98 percent used it to gather information. Price tracking (82 percent) was the next most common application (Hopkins and Morehart, 2001).

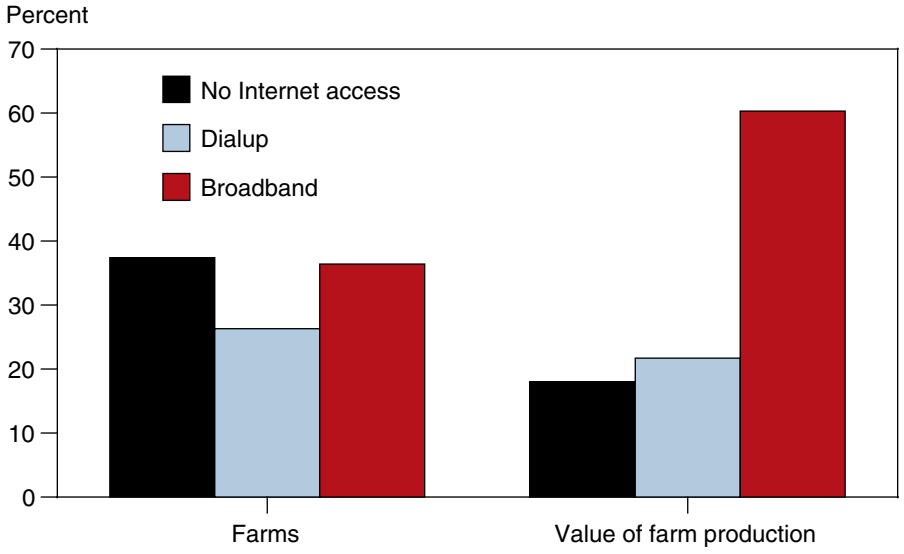
With growth in e-commerce, horticulture and other specialty farm products are increasingly sold direct to households. E-commerce has increased efficiencies in existing relationships along the food marketing chain, reduced the cost of expanding market area, and brought about new services such as supermarket home delivery and direct-to-consumer sales (Kinsey and Buhr, 2003).

Not all types of agricultural production lend themselves readily toward direct sales from producer to consumer. Still, the wholesale and retail food industry has enhanced its productivity with Internet adoption (Akridge, 2003; Beurskens, 2003; Henderson et al., 2000; Stricker et al., 2003; Zilberman et al., 2002).

Respondents to the 2007 Agricultural Resources Management Survey (ARMS) were asked if they had Internet access and if it was "high-speed." A majority of farms (63 percent) reported using the Internet in their farm business (fig. 12). Among those using the Internet, the predominant access method was broadband and this group of users accounted for over 60 percent of U.S. farm production. This is consistent with other estimates of farm broadband use. USDA's National Agricultural Statistics Service (NASS) reported that, for the first time in 2007, the majority of farm Internet users were connecting with broadband Internet technologies (USDA/NASS, 2007).

Prior research has identified several demographic and socioeconomic attributes that have consistently distinguished those who use the Internet from those who do not (Forman, 2005; Stenberg, 2006; Stenberg and Morehart, 2007). These include income, education, age, and number of children. In our analysis of the determinants of broadband Internet use among farm households, we include household income, education level attained by the farm operator, age of the farm operator, off-farm work by spouse, presence of school-age children, number of hired farmworkers, rural-urban farm location, county net migration, and number of local broadband providers.

Figure 12
Distribution of farms and value of farm production by Internet use, 2007



Source: ERS analysis of 2007 ARMS (USDA, NASS and ERS).

Income has consistently been cited as a primary factor determining Internet use (Stenberg, 2006). The greater the income level, the more likely that work is highly skilled. In addition, the more highly skilled the work, the more likely that computer technologies and the Internet are part of the work environment. As household income increases, regardless of location, the likelihood of Internet use increases (Stenberg, 2000).

Educational attainment has long been recognized as a determinant in income level (Becker, 1964). The prevalence of the Internet and computer technologies in educational institutions provides additional exposure and experience as years of formal education increase. Consequently, the greater an individual's education, the greater the likelihood of Internet use at home or in the workplace (Stenberg, 2006).

Many (Oden and Strover, 2002; Grant and Meadows, 2002; Stenberg and Morehart, 2007) have cited age as a factor in determining the likelihood of Internet use. The literature suggests that older individuals are reticent about adopting the Internet, while the young readily adopt. The average age of farm operators claiming no Internet use in 2007 was 62, compared with 54 for those who accessed the Internet using broadband (table 14).

Only about a third of spouses on farms with no Internet use reported working off-farm, compared to more than 50 percent on farms that used the Internet. On the one hand, off-farm employment may provide more income and exposure to Internet technologies, instigating home or farm adoption. On the other hand, a spouse who works off the farm may indicate financial stress and lesser wherewithal to invest in farm-specific Internet use. Households with school-age children are expected to have a higher awareness of the Internet and more demand for bandwidth-intensive applications (Grant and Meadows, 2002). In keeping with this, the percentage of farms with school-age children was nearly two times higher in 2007 when Internet use was reported than when it was not (table 14).

We hypothesize that the greater the size and complexity of the farm business, as evidenced by the number of hired farmworkers, the more likely the farm is using broadband to access the Internet. Farms with broadband Internet access had twice the number of farmworkers, on average, as farms with no Internet access. Broadband use is also expected to be higher in ZIP Code areas with more providers, as competition for customers likely lowers the price differential between broadband and dial-up. The mean number of providers, however, showed little variation across Internet use categories (table 14) reflecting the predominantly rural location of farm operations.

Maximum-likelihood methods were used to estimate a multinomial logit model that estimates the relationship between farm household socioeconomic characteristics and the type of Internet connection used. For the most part, coefficient signs and variable significance are consistent with expectations (table 15). The model fit—as indicated by the McFadden r-squared value of 0.089—is somewhat poor, even for a cross-sectional analysis. The coefficients represent the log-odds of a farm household using dial-up or broadband Internet access, relative to the base class (no Internet use by the farm). That is, what is the chance that, instead of not using the Internet at home, the household has an in-home dial-up or broadband Internet connection? These

Table 14
Weighted means and (standard errors) for selected variables, 2007

Variable	Name	Internet use			All family farms
		No Internet	Dial-up	Broadband	1997
Continuous variables:					
Operator age	OP_AGE	61.90	55.15	53.85	57.20
		(0.45)	(0.34)	(0.38)	(0.20)
No. broadband providers	NOPROVIDERS06	6.80	6.71	6.83	6.79
		(0.09)	(0.09)	(0.09)	(0.05)
Household income	TOTHHI	61,614	77,831	121,141	87,523
		(3,912.25)	(2,396.71)	(5,286.60)	(2,548.60)
No. farmworkers	NOWORKERS	0.42	0.63	0.98	0.68
		(0.04)	(0.03)	(0.03)	(0.01)
Dummy variables:					
Population change	MIGCLS	0.58	0.60	0.56	0.58
		(0.01)	(0.01)	(0.01)	(0.01)
Children	CHILD	0.24	0.40	0.42	0.35
		(0.01)	(0.02)	(0.02)	(0.01)
Spouse working off-farm	SPOFF	0.34	0.52	0.51	0.45
		(0.01)	(0.02)	(0.02)	(0.01)
College education	COLLEGE	0.12	0.22	0.36	0.23
		(0.01)	(0.01)	(0.02)	(0.01)
Urban	RURAL	0.21	0.21	0.25	0.22
		(0.01)	(0.01)	(0.02)	(0.01)
Not urban or rural		0.61	0.64	0.60	0.61
		(0.01)	(0.01)	(0.02)	(0.01)
Rural		0.18	0.14	0.15	0.17
		(0.01)	(0.01)	(0.01)	(0.01)

Source: ERS using FCC and 2007 ARMS (USDA, NASS and ERS).

are not the odds of using dial-up or broadband, only the odds relative to not being connected to the Internet at all. The sign of the coefficient gives the direction of the relationship: increase or decrease in probability due to the predictor. For example, as the age of the farm operator increases, the probability of having dial-up or broadband Internet access relative to no Internet access declines, as indicated by the negative and significant coefficients. (More discussion on the underlying methodology of this analysis is presented in Appendix D.)

Other significant model results include:

- Larger farm businesses, as indicated by more hired workers, have a higher probability of broadband Internet access.
- Farm households with income above $50,000 have a higher probability of broadband Internet access.
- The relative probability of broadband Internet use does not increase as the number of providers in an area increases.

Table 15

Multinomial logistic regression results

Variable	Dial-up	Broadband	Dial-up	Broadband	Dial-up	Broadband
	Estimate	*Estimate*	*Std.Err*	*Std.Err*	*T value*	*T value*
(Intercept)	-0.77	-0.57	0.07	0.09	-11.26**	-6.27**
OP_AGE	-50.75	-65.10	9.08	10.49	-5.59**	-6.21**
$(OP\_AGE)^2$	-27.76	-32.38	6.75	6.99	-4.13**	-4.64**
NOWORKERS	0.08	0.15	0.03	0.03	3.32**	5.18**
TOTHHI above 50k	0.27	0.44	0.07	0.06	4.01**	8.03**
NOPROVIDERS06	-11.45	-12.88	5.69	6.52	-2.01*	-1.97*
$(NOPROVIDERS06)^2$	-12.22	-5.32	4.98	6.69	-2.45**	-0.08
MIGCLS	0.11	-0.02	0.09	0.08	1.20	-0.26
CHILD	0.17	0.29	0.09	0.12	2.10*	2.52*
SPOFF	0.29	0.12	0.10	0.12	2.93**	1.03
COLLEGE	0.70	1.34	0.11	0.11	5.89**	11.96**
Not urban or rural	-0.24	-0.38	0.12	0.10	-1.96*	-3.60**
Rural	-0.09	0.10	0.06	0.06	-1.39	1.61

LR = 380954.54; AIC = 3905755.62; McFadden R^2 = 0.089; McFadden Adj R^2 = 0.089.
Note: ** - significant at 0.01, *- significant at 0.05. Equations simultaneously estimated.
Source: ERS using FCC and 2007 ARMS (USDA, NASS and ERS).

- Having school-age children in the household is associated with higher probability of broadband Internet use.
- Operators with at least a college degree are more likely to use broadband.
- Farms located in mixed urban/rural areas are less likely to use broadband than those in urban areas.

The model's results suggest that household characteristics such as age, education, presence of children, and household income are significant factors in adopting broadband Internet use. Farm business complexity, as measured by the number of farmworkers, was also related to the use of the Internet and broadband Internet access. Distance from urban centers was not a factor in Internet use. Our proxy for county economic well-being—population migration—was not significant and may be indicative of cross currents that are present; counties under economic distress may invest in broadband to help mitigate the distress, or may not have the economic wherewithal for broadband investment.

The relationship between Internet/broadband use and farm location is less clear. Farms in mixed urban-rural areas were less likely to use dial-up or broadband Internet. This may be a result of cost or availability of service. More isolated farms, as measured by the rurality of the county, had mixed, though not significant, results. These results warrant further analysis.

Farm-Rural Linkages in the Internet Economy

The Internet may change the economic relationship between farms and their local economies. Using data drawn from the 2004 ARMS, we investigate how Internet use affects the geography of farm input purchases.

Conceptually, farmers may choose to (1) purchase inputs in the nearest local town, (2) bypass the nearest local town but purchase inputs within the market reach of the nearest farm service center, or (3) bypass the farm service center altogether. Purchasing patterns are examined for three broad categories of resource inputs: farm inputs (feed, seed, and fertilizer), farm machinery and equipment, and farm credit. Comparing input purchases in each of these three mutually exclusive categories allows us to observe the changing nature of farm/local area interrelationships and the use of the Internet. We present results using logistic regression from one of these models in table 16.

Our results suggest that the market reach of the nearest town may no longer define what the farm operator perceives as local. Making farm purchases over the Internet is the strongest factor increasing the likelihood of the operator bypassing the nearest town and even the more distant farm service center (table 16).

As farm operators increase their participation in e-commerce, their relationships with local suppliers are likely to weaken. Farm operators may increasingly opt for distant suppliers to secure lower prices or better access to niche inputs. Suppliers with an established Internet presence, including local ones, would appear better positioned to retain customers within the local economy.

Table 16
Logistic regression results[1]

Choice variable: Bypass the nearest town?	Type of purchase		
	Farm inputs	Farm equipment	Farm credit
		Odds ratios	
Farm level variables:			
Log (gross farm sales)	1.1258***	1.1223***	1.1938***
Operator's years experience	1.0063	1.0192***	.9964
Years of education	1.0710**	1.0675*	1.0244
Internet farm purchase	2.0649***	2.0148***	1.5553*
County-level variables:			
No. of farm inputs merchants	.9360***		
No. of farm equipment dealers		.9303**	
Remote county	.7456*	.7417*	1.0081
Log (highway miles)	1.3623***	1.0956	1.2733**
Log (population density)	1.1720**	1.1713*	1.0674
Log (per capita income)	1.2686	1.0424	1.4158
		Model statistics	
No. of observations	2,793	2,793	2,793
Log pseudolikelihood	-1,861.19	-1,620.98	-1,817.38
Wald 2	44.33	41.48	45.88
Prob > 2	0.0000	0.0000	0.0000
Pseudo R2	.0386	.0388	.0343

[1] *Odds ratio*$_i$ = exp ($\hat{\beta}_i$). Significance level of the coefficient estimates ($\hat{\beta}_i$):* p<.1; ** p<.05; *** p<.01.
Source: ERS analysis of 2004 ARMS data (USDA's NASS and ERS) and other data.