Farm Businesses, the Digital Economy, and High-Speed Access to the Internet

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INTERNET use has grown rapidly over the last 15 years and so has its integration into the rural economy. Connecting to the Internet via high-speed technology such as DSL lines, cable, satellite, and wireless networks increases bandwidth and makes the Internet much more useful to businesses, households, and governments. Overall increased Internet access speed has ignited an explosion of electronic commerce. Rural and farm communities have not been left out. Using descriptive statistics and binomial logistic regression we find: Farms buying over the Internet were more likely to have converted, supporting the argument that users find positive utility in acquiring broadband Internet access. The larger farm operations, as measured by the economic class, were more likely to convert to broadband access (after taking into account that the largest farms were the most likely to have had broadband access by 2005). DSL service was the most common broadband Internet access option among farms, unlike what has been occurring in highly urbanized areas of the country where cable and fiber optics have had the largest gains over the last few years. While broadband Internet access availability is necessary for take-up of broadband Internet access, there are other factors that are also limiting broadband Internet use such as price of access, age of user, household income, and educational attainment.
Key Words: Farm Business, Digital Economy, Internet Access, etc.

Connecting to the Internet via high-speed technology such as DSL lines, cable, satellite, and wireless networks, makes the Internet much more useful to businesses, households, and governments. The increased incidence of high-speed Internet access has quickened the growth of electronic commerce, video on demand, telecommuting, collaborative scientific projects, videoconferencing, and virtual environments resulting in deepening integration of online activities within the economy. A great deal of business, household, and government activities have moved onto Internet platforms with some Internet activities not even requiring direct human involvement on either or both ends of the process.

Rural communities have not been left out of the evolving digital economy. Equal access across rural-urban space, however, is an issue. While rural households are almost as likely as urban households to use the Internet, broadband Internet access in rural areas has been less prevalent. Circumstantial evidence suggests that the difference may lie in the higher cost or limited availability of broadband Internet access in rural areas (Stenberg, et al., 2009). Does evidence to suggest pent-up demand for rural broadband Internet service exist? That is the question addressed here.

The paucity of sub-national geographically-specific data, however, presents a challenge in trying to analyze questions of pent-up demand for broadband. Data from the National Agricultural Statistics Service (NASS) June Agricultural Surveys, however, can be used to address this. The other difficulty has been obtaining data on local prices for use in demand analysis. We use our Agricultural Resources Management Survey (ARMS) as well as industry data to develop proxies for local broadband service price indices. We perform descriptive statistics and binomial logistic regressions. Additional data in our models came from the U.S. Bureau of the Census, and the Federal Communications Commission.

The discussion roughly falls into five parts or themes. The first presents a general discussion on e-commerce, especially with respect to agriculture. The second presents descriptive evidence of demand for broadband Internet service. The third covers where broadband service currently exists.

The fourth part attempts to measure analytically the shortfall, if any, in supply of broadband Internet. The final discussion covers policy, specifically U.S. federal government provisions to encourage the availability of information technology in rural areas and in farm and rural businesses.

Agricultural E-Commerce over Time

The concept of e-commerce has been used to cover a number of economic activities and over time its meaning has changed. As Dillman has pointed out e-commerce has existed for over a century in rural America and other rural areas. He has argued that the e-commerce in rural America first came with the telephone because the telephone replaced the day-trip for rural residents, primarily farmers, to town. Although, it could also be argued that the telegraph (with the critical assist of the railroad) actually first ushered in U.S. agricultural e-commerce decades earlier because the telegraph made it possible for farms and household goods to be easily available at great distances and led to the first retail giants, such as Sears, Roebuck, and company; and J.C. Penny.

Dillman argues that there have been three waves of technological change altering the e-commerce milieu (Dillman, 2000). The initial wave came with the first rural telephone systems around 1900. The most notable impact from the first telephone systems was the decline in the need to make day trips from farmstead to towns. Farmers could address some of their farm and household needs with respect to farm inputs, household goods, veterinary and medical services, information and other services without leaving the farmstead.

During this period, though, telephones were considered a luxury and were not available to a high percent of farms, though later, roughly from the period spanning from World War I to World War II, improved technology allowed shared communication lines. The diffusion in American rural areas during this period was faster than it was in large urban centers. Telephone systems became much more integrated into regional economies and the systems contributed to the building of rural communities. The era was dominated by local- and regional-based economic activity.

The second wave came in the middle of the 20th century. Long-distance communication improved greatly and declined in price. The era was marked with increasing vertical economic integration into the national economy of regions and corporations and other business enterprises, including increasing farm consolidation. Markets became more national in focus.

The third wave began in the late 20th century with new information technology, such as the fax and Internet. This has meant instant access to many parts of the world and is the current era, the Information Age. The Information Age, however, uses information technology from all three eras. Farmers still call their local cooperative or other business affiliate. Agricultural businesses still make long distance calls to complete or start business deals. The new era offers new, and alters some existing, business channels of communication.

Agricultural E-Commerce Today, the Third Wave

On-line activities may be grouped into three broad categories: information gathering, purchase channels, and sales channels. Information gathering is the most common application for farm operators and consumers (Hopkins and Morehart; Stenberg [1999]; Varian). For farm operators with Internet access, 98 percent use it to gather information. Price tracking was the next most common application, 82 percent of farm operator use internet for price track (Hopkins and Morehart). American farmers use the Internet to acquire information from farm cooperatives and the U.S. Department of Agriculture as well as read such trade publications as the Farm Journal. Consumers have used the Internet for information on items such as prices of goods, nutrition, and food products. E-mail remains one of the most popular activities on the Internet for farmers and non farmers alike.

When the dot-com boom began, people dreamed of vast new markets opening up (Beurskens, 2003). The facts have proved more mundane. Communication and information technology improved the efficiency of input chains and sales channels, but new channels were the exception and not the rule (Barton; Stricker et al., 2003 Zilberman et al., 2002). Farmers have increasingly purchased inputs

through the Internet, but they typically purchased from suppliers with whom they had prior business relationships (Mueller, 2001). Trust has been a key factor in the determination of suppliers.

Business-to-business (B2B) transactions over the Internet have increased substantially in the agriculture sector (Kinsey and Buhr, 2003; Stricker et al., 2003; Zilberman et al., 2002). Although, commerce between companies already took place through electronic data interchange (EDI) systems, the Internet has opened up the system more and has reduced transaction costs (Barton, 2003; Brynjolfsson and Smith, 2000).

Agriculture sales direct to the household have also increased. These activities include supermarket home delivery, direct sales from manufacturer to consumer, and horticulture and other specialty farm produce direct to consumer sales. These e-commerce activities increased efficiencies in existing relationships, increased market presence because of the reduction of cost in reaching larger market areas, and brought about new services (Kinsey and Buhr, 2003).

In the U.S. economy one major trend with the new technology has been towards disintermediation, or eliminating or reducing the economic involvement of the broker and other business middlemen. More bank transactions, for example, are taking place through ATMs or on-line instead of on-site. According to a PEW survey in 2005, a quarter of all American adults, or 44 percent of all adult Internet users, use the Internet for on-line banking. On any given day 7 percent of all American adults perform some on-line banking activity.

Overall the Internet through its e-business application has become a multi-faceted business channel. For the year ended June 30, 2006, there were $98 billion (USD) in e-commerce retail sales, approximately 2.5 percent of all retail sales in the U.S. according to data from the Bureau of the Census. This does not include the $78 billion (USD) in on-line travel sales in the United States during the same period that E-Marketplace estimated to have taken place. According to Bureau of Census statistics, on-line wholesale trade in 2003 was estimated to have been $386 billion, or approximately 13 percent of all U.S. wholesale trade. The on-line wholesale trade farm products were estimated to be $3.7 billion, or approximately 3 percent of all wholesale farm product sales.

Internet Use and Rural Businesses

Farm and rural businesses have shown increasing demand for broadband Internet access (Stenberg and Morehart, 2007). Rural businesses, such as retail businesses, have been adopting more e-commerce and Internet practices, offering some improvements in business economic vitality (Stoel and Ernst, 2008). Broadband Internet enables businesses to increase efficiencies in existing commercial relationships, increase market presence by reducing the cost of reaching larger market areas, and introduce new services (Akridge, 2003; Barton, 2003).

Business adoption of the Internet has been rapid; in 1997, 13 percent of farmers were using the Internet; ten years later, this had increased to 55 percent. As Internet adoption increases, the need for high speed Internet also increases as on-line purchasing and marketing becomes more the norm. Rural businesses do not use broadband as much as urban businesses, but those that do argue that the use of the Internet improves their economic vitality. Many farm businesses purchase inputs and make sales on-line, potentially reducing costs of their operations and increasing margins on sales (Stenberg and Morehart, 2007). Pociask suggests that rural businesses do not use broadband as much, in part, due to higher rural prices for broadband. (Pociask, 2005)

Rural retailers often use the Internet due to the requirements of their suppliers (Ernst and Stoel, 2008). Rural retail business Internet users found broadband access allowed them to capitalize on the benefits of the Internet to increase operational effectiveness and allow the exploitation of market niches (Mueller, 2001; Stricker et al., 2003). The Internet has also increased the competition businesses face. A prime example is the banking industry; many rural American banks are no longer local in nature and customers have been increasingly conducting their banking business on-line (DeYoung and Duffy, 2002; Keeton, 2001).

Broadband has become Necessary for Some on-line Activities

The speed of Internet access has been a major impediment limiting the economic returns from on-line activity. The slower the Internet access speed, the less useful the Internet becomes. Dial-up has been the slowest way to connect to the Internet. The greatest speed data can be transferred using dial-up is 56 kilo bytes per second (kbps). In US rural areas the speed often has been much less, with connection speeds of 14kbps common. Effectively this has meant the user could at best use their connection to the Internet for simple text e-mail messages only. Anything requiring large graphics was simply not practical. High-speed Internet access has become necessary to make use of much of what is now offered on the Internet.

Broadband is the term used to denote high-speed access to the Internet. Although the term has been used to refer to other services, such as digital television, that can be carried using other than Internet technologies, the matter of most interest to consumers, providers, and policy makers is broadband Internet connectivity (Eisenberg, 2002). With the convergence of video, audio, text, graphics and other analogous enduring and ephemeral products and services into digital streams that can be transported across the Internet, broadband Internet connections have become a necessity for common Internet usages and applications. A virtuous cycle has been taking place where as Internet access speeds have increased the more robust Internet application have become, as more and better the Internet applications have become the greater the demand for faster Internet access has increased.

The Federal Communications Commission (FCC) defined 200 kilobits per second in one transmission direction as the minimum speed for Internet service to be classified as broadband Internet service. Unfortunately the definition includes a wide array of technologies ranging from the old ISDN and T-1 lines to satellite service leading one to include very slow transmission and sometimes unreliable service as well as superfast fiber optic home service, thus making economic impact analysis and discussion of broadband Internet service challenging.

Most household broadband Internet access in the country is through DSL or cable modem technologies and is faster than the FCC standard. Fifty-five percent of all households have broadband Internet access, 46 percent of these have DSL, 39 percent have cable modem, and 12 percent have wireless connections (PEW).

Internet is in Demand by Rural Residents

Seventy-six percent of all Americans go on-line at home, work, school, or elsewhere. Rural citizens are only slightly less likely to go on-line, 71 percent. These rates of proclivity to go on-line vary to some extent across regions of the country. A greater disparity exists in the share of rural and urban households with in-home Internet access; 63 percent of rural households have in-home access as compared to 73 percent of urban households.

Income differences explain much of the disparity in Internet use between rural and urban households. Lower income households have less in-home Internet access less than higher income households and rural households, on average, have lower incomes than urban households (Figure 1). Income, of course, is not the end of the story as income is highly correlated with education, age, and other factors. It is also unclear whether use of the Internet leads to higher household income or whether less household income leads to less Internet use.

Most households with in-home Internet access, 82 percent, have a broadband connection. This rate varies little across urban regions across the country. A marked difference in broadband access, however, exists between urban and rural residents. Only 70 percent of rural households with in-home Internet access have broadband access as compared to 84 percent of urban households, which suggests that broadband is less likely to be available to rural residents.

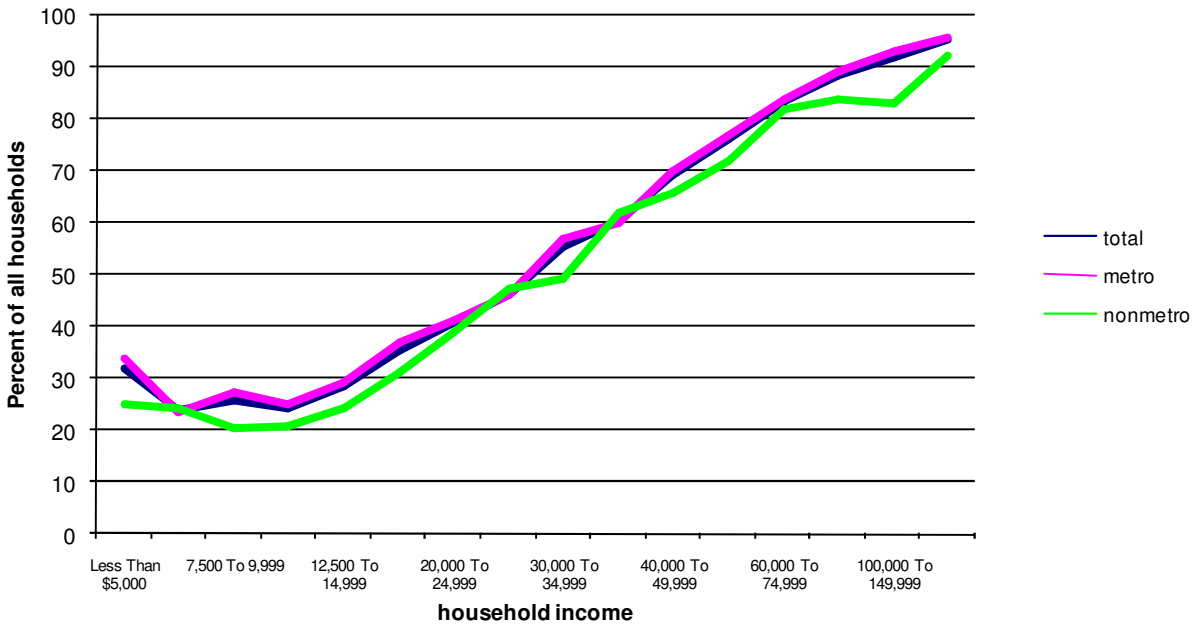

Figure 1: Home Internet Access by Income, 2007

Source: Authors.

The broadband rural-urban dichotomy becomes even more apparent when household income is taken into account (Figure 2). The relationship suggests that income is not much of a factor in opting for broadband over dial-up for an in-house Internet connection. The gap between rural and urban household use of broadband connections thus would suggest that broadband availability is more of a challenge for rural than urban households regardless of income.

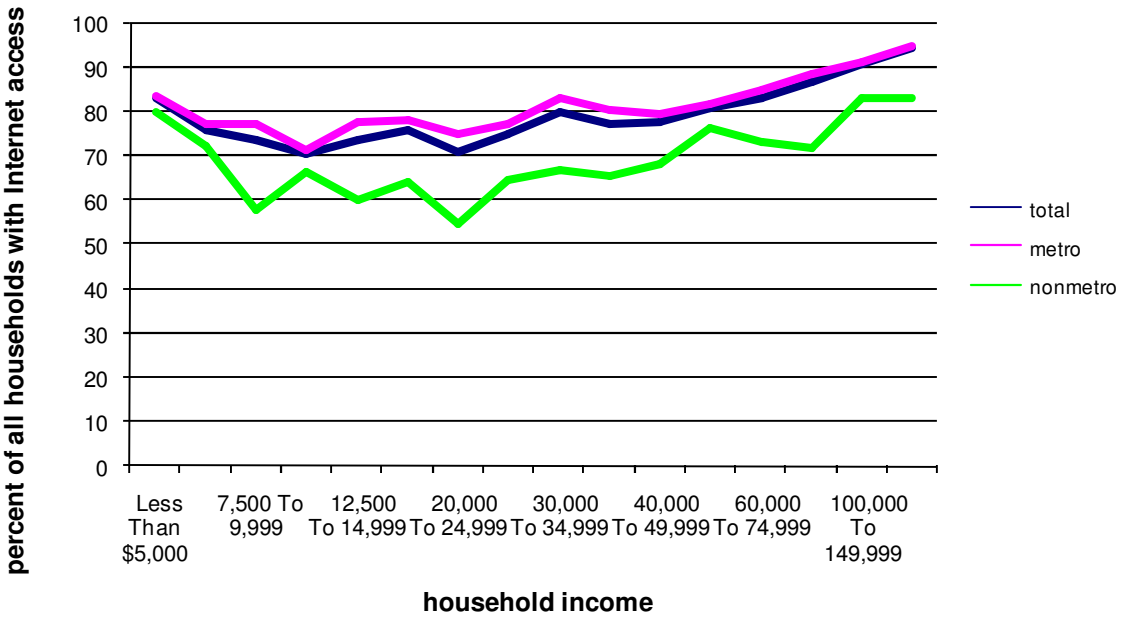

Figure 2: Households with Broadband Access by Income, 2007

Source: Authors.

Where in Rural Areas is Broadband Less Readily Available?

Measuring broadband access availability has been problematic for researchers. The only national data available comes from the Federal Communications Commission (FCC) Form 477 survey. Form 477 provides data collected from high-speed Internet service providers and indicates whether they have customers in any given zip-code. As can be seen in Figure 3, broadband was often unavailable in rural areas in 2000, but has increasingly become available throughout the country.

The data, however, are misleading. While clearly showing increased availability across the country, the data are biased upwards. All that is required to indicate a provider is offering service within a zip-code is for the provider to have one customer. If there is one federal office, state office, or some private business (such as a railroad repair facility) with service in the zip-code area, data will likely indicate the presence of a high-speed Internet provider. Despite this measurement issue we can use the data in a number of ways to tackle what we trying to address.

In 2000, terrestrial broadband service provision clearly clustered in highly urbanized areas with some spread to rural areas. By December 2006, broadband was more common in highly-urbanized areas. Rural areas had gotten more service with only the more isolated areas showing no broadband service available at all.

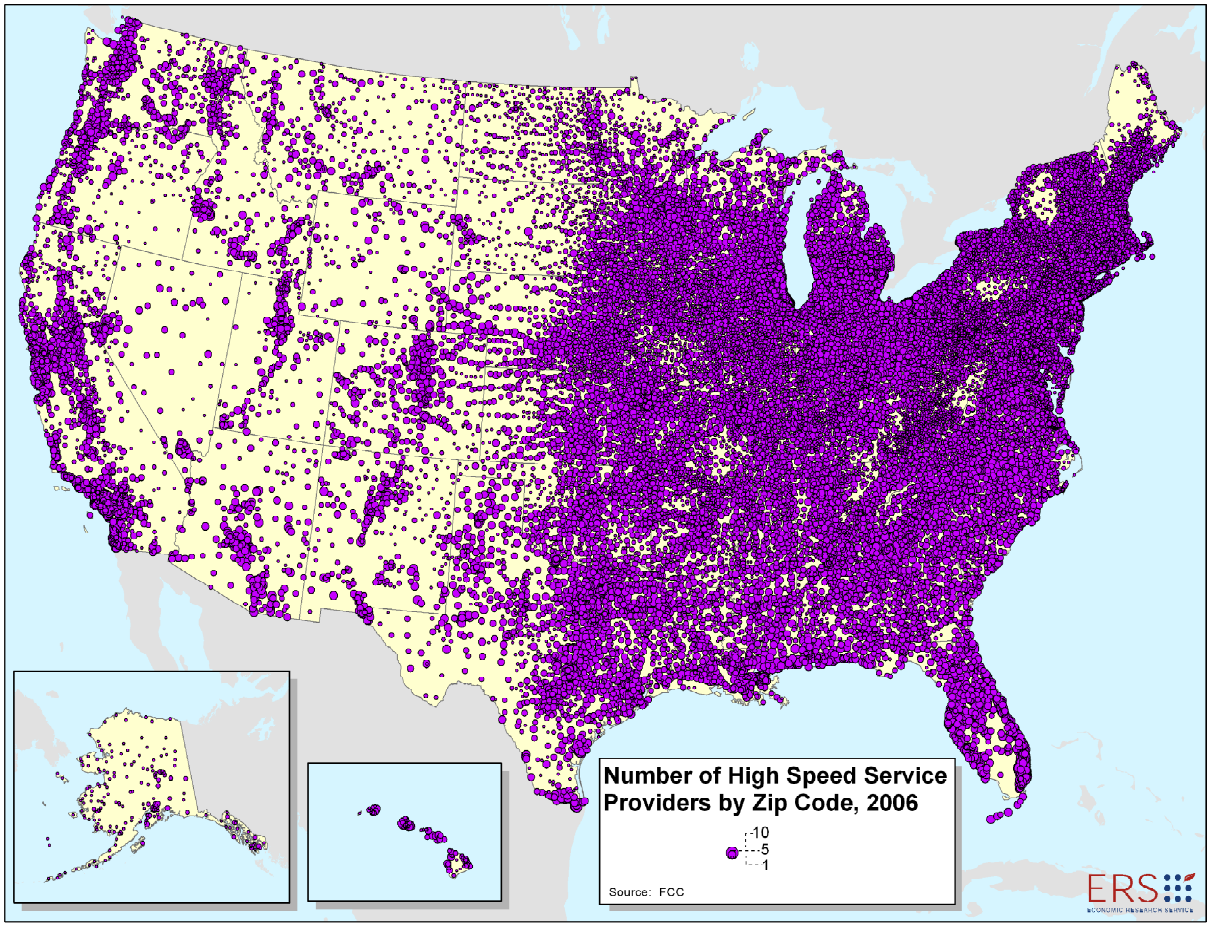

Figure 3: Broadband Internet Availability Increased between 2000 and 2006

Source: Authors Using Data from the Federal Communications Commission.

Analyzing the Availability of Rural Broadband Internet Access: Enhancing the FCC Data

Two facts come from this discussion that leads to our taking steps to enhance analyses derived from the FCC data: population and adjoining area effects on a location's broadband availability. From the FCC data we developed broadband availability density maps that constitute our most basic measure for a number of our research applications. This basic broadband data base is composed of sub-zip-code zonal building blocks. The data bases are further refined.

Essentially these basic building blocks show the likelihood of having broadband available at any zonal point within the lower 48 states at different points of time. We have done this by using the population centroids of the zip-code areas as the center of the service region. The service region is defined as the distance from centroid as measured by the typical limitation of DSL Internet service of 15 thousand feet; due to technical reasons DSL service can not go beyond a certain distance from its' signals' point of origin without additional equipment along the telephone line. Likelihood is increased the more the number of providers there are within a zip-code. Overlapping provision areas increase the likelihood of service to any location within the overlap. High provision in adjoining zonal areas increases the likelihood of broadband availability in a zonal area.

Our density map was tested against June Agricultural Survey data of farm broadband use. The June Agricultural Survey (JAS) data is a geographic-based survey of farms in the lower 48 states. Internet

use data has been collected since 1997. The JAS Internet data gives geographic – and time-specific use and non-use of broadband Internet.

The density map matched very well with the JAS data in all areas except what is essentially the Great Plains region. The challenge here is the large geographic size of some of the zip-code areas suggesting the population centroid does not match as well the broadband Internet service area. Additional data was used, primarily location of schools to further define the likelihood of broadband Internet service in an area; schools are useful because of their widespread use of broadband Internet. With the additional data the surface map was adjusted to include additional provision area. The resulting broadband density is essentially a likelihood measure – the probability of broadband Internet access for any given point in geographic space (Figure 4). As can be seen from Figure 4, likelihood of broadband Internet access is centered in urban areas and radiates out from these urban centers. The FCC data and the various selected indices that we developed from them form the basis for the analysis that follows.

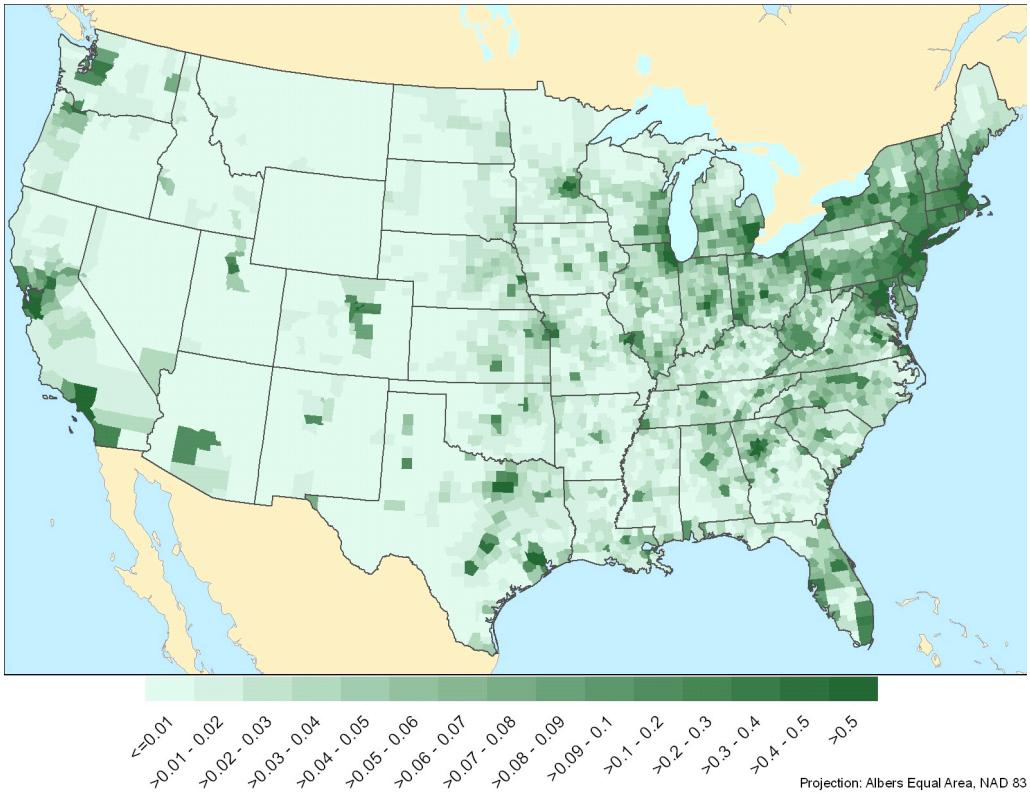

Figure 4: County Representation of Average Broadband Provision per Square Kilometer, 2000

Source: Authors Using Data from FCC.

Does Broadband Availability Lead to Use?

If broadband becomes available recently for a household then the take up of broadband may be higher in those communities than where broadband has been less readily available. A higher adoption rate would be another indicator that unserved households have a pent-up demand for broadband Internet services.

The paucity of national geographically-specific data, however, presents a challenge in trying to analyze whether availability leads to broadband adoption. Data from the June Agricultural Surveys provide a unique opportunity to examine geographic-specific rural changes in access methods because many of the sample segments overlap. Figure 5 shows the conversion to broadband Internet

access by farms across the country. Unfortunately, a change in area identifiers did not allow our matching data between 2005 and 2007 for Illinois and Arkansas and hence these states are omitted from the map and our analysis.

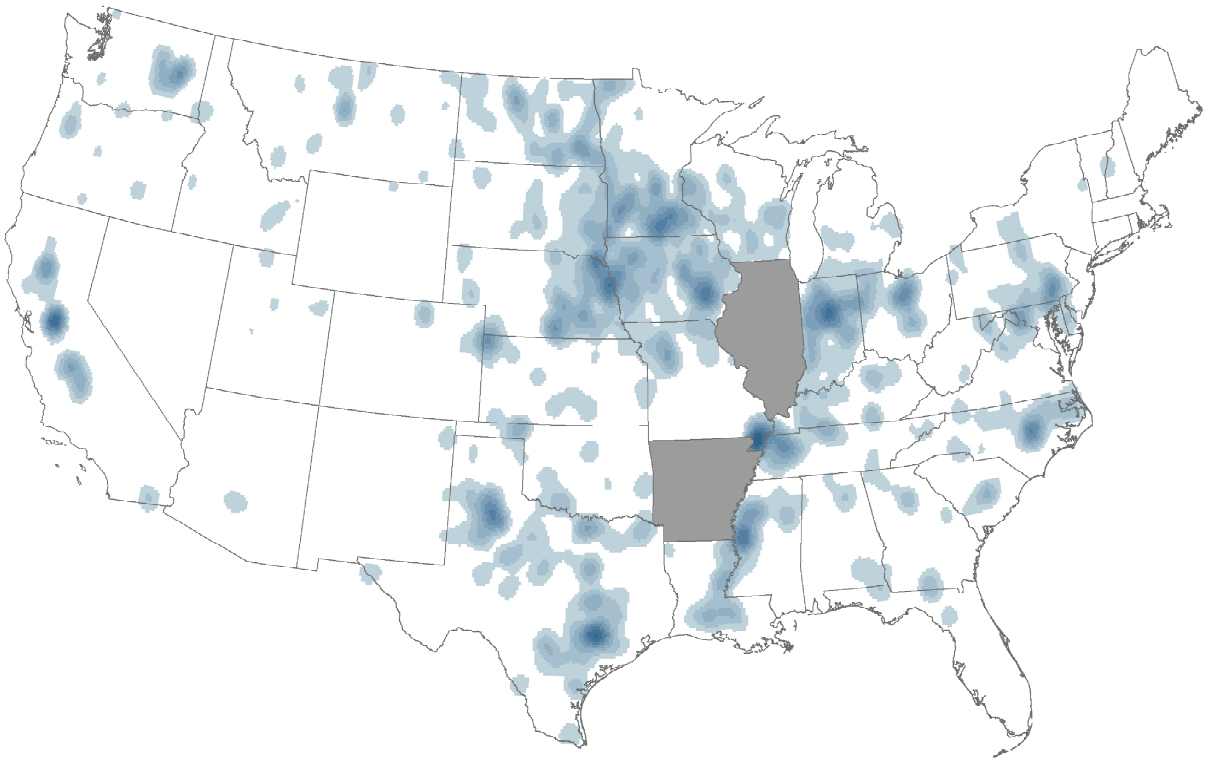

Figure 5: Change in Farm Terrestrial Broadband Use, 2005-2007

Source: Authors Using JAS Data.

The data presented in Figure 5 shows sharp differences in conversion rates across the country. When also considering changes over time exhibited in the FCC broadband availability data, results from our analysis of farm data give some credence to the hypothesis that people use broadband if given the option. Conversions were nearly non-existent in areas where broadband was generally not available outside of satellite provision (Table 1). Farms were unlikely to make the direct jump from no Internet use to Internet use with broadband access; farms that already had Internet access were more likely to convert to broadband Internet access. Some of the farms that did not convert already had broadband Internet access by 2005, roughly 24 percent of all farms using the Internet in 2005.

Farms buying inputs over the Internet were more likely to have converted supporting the argument that users find positive utility in acquiring broadband Internet access. The larger farm operations, as measured by the economic class, were more likely to convert to broadband access (after taking into account that the largest farms were the most likely to have already had broadband access by 2005). DSL service was the most common broadband Internet access option among farms, unlike what has been occurring in highly urbanized areas of the country where cable and fiber optics have had the largest gains over the last few years. The preponderance of DSL service for farms indicates both the mostly rural location of most farms as well as Internet users finding satellite a less desirable option.

We used a binomial logit model to test the significance of new broadband availability on the adoption of broadband Internet for on-line use. The results can be seen in Table 2. Recent broadband

availability was a significant factor in the adoption of broadband Internet use. The results suggest lack of availability hinders the adoption and use of broadband Internet access.

Table 1: Adoption of Terrestrial Broadband Internet Access by Farms, 2005-07

	No Conversion (percent)	Conversion (percent)	All farms (percent)
Broadband availability			
Broadband not newly available	98	94	96
Broadband newly available	2	6	4
Farm has Internet Access			
Yes	63	63	63
No	36	36	36
Access method			
Dial-up	100	0	62
DSL	0	64	24
Cable	0	11	4
Wireless	0	15	6
Internet used to purchase farm inputs			
Yes	19	21	19
No	81	76	19
Economic class			
$1,000 – $9,999	48	38	44
$10,000 – $99,000	30	29	30
$100,000 – $249,000	10	14	12
$250,000 or more	12	18	14

Source: ERS using June Agricultural Surveys (2005 and 2007).

Note: Due to changes in survey data mechanisms Illinois and Arkansas could not be included in 2005 to 2007 broadband conversion analysis.

Table 2: Binomial Logit for Dial-up to Terretrial Broadband Conversion, 2005-07

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	–7.93E–01	8.44E–02	-9.39	<2e-16***
Age of proprietor	2.18E–01	1.46E–01	1.49	0.13504
Farm's sales	5.35E–01	1.09E–01	4.91	9.6e-07***
New broadband service	1.06E+00	2.98E–01	3.56	0.00038***
Urban population	3.23E–07	1.06E–07	3.05	0.00231**

Source: Authors

Significance codes: ('0.001) (**'0.01) (*'0.05)***

Internet and E-Commerce Policy

Government policy has historically been influential in the diffusion of technology and encouraged its use across the United States. Federal level policy has mainly followed two legislative paths: the Communications Act of 1934 and periodic farm bills. The Communications Act of 1934, as last amended in 1996, has not required support for Internet into households, though it allows for regulatory action to mandate it. The current farm bill is the Food, Conservation, and Energy Act of 2008 continued the mandates in the Farm Security and Rural Investment Act of 2002. The 2002 Act mandated a loan program for rural broadband providers and is administered by the Rural Utility Service, U.S. Department of Agriculture, with a budget determined by Congress annually.

The Farm Security and Rural Investment Act of 2002 had three provisions and principles to encourage the investment in new technology for rural areas. First it authorized US$100 million in grants, loans, and loan guarantees for the purpose of improving access to broadband telecommunication services in rural areas. Second these grants and loans were mandated to be for the construction, improvement, and purchase of equipment and facilities for rural broadband service in eligible communities. Third the definition of what constitutes broadband service would be reviewed regularly to take into account changes in technology.

In 2009 the federal government passed a stimulus program, the American Recovery and Reinvestment Act (ARRA) aimed to help to bring the US economy out of its recession. In the ARRA were provisions to bring broadband to areas of the country that had little or no broadband service coverage and allocated $7.2 billion for this purpose. Of this at least $2.5 billion would go directly to rural and farm communities.

In the United States the federal government, however, is not the sole generator of policy initiatives. The state and local governments also play a major role in the future of broadband Internet access, though their role is constrained by the federal government (Stenberg, 2007). If federal law and state and local legislative actions conflict, the federal law takes precedence. Federal limits became even more a fact of life after the enactment of the Telecommunications Act of 1996. Nevertheless, state and local governments have a great deal of latitude (Johnson, 1999; Laudeman, 1999; Parker and Hudson, 1992; Strover and Berquist, 2001).

Conclusion

Is there evidence to suggest there is pent-up demand for rural broadband Internet service? The data shows sharp differences in conversion rates across the country, and when also considering the changes over time giving some credence to the common hypothesis that people do choose to use broadband if given the option. Conversions actually were nearly non-existent in areas where broadband was generally not available outside of satellite provision. Farms were unlikely to make the direct jump from no Internet use to Internet use with broadband access; farms that already had Internet access were more likely to convert to broadband Internet access. Some of the farms that did not convert already had broadband Internet access by 2005, roughly 24 percent of all farms using the Internet in 2005.

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Government policies that encourage deployment of broadband services have broadened, and will further broaden, availability in Rural America as they address unserved and underserved communities. The 2008 Farm Bill (Food, Conservation, and Energy Act of 2008) reauthorized USDA's telemedicine and, distance learning and rural broadband access grant and loan programs. The American Recovery and Reinvestment Act of 2009 provided $2.5 billion to the USDA for loans and grants to increase broadband provision in rural areas.

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