Rural Broadband Internet Access Supply and Demand

Peter Stenberg and Mitchell Morehart

USDA- Economic Research Service
1800 M Street NW
Washington, DC 20036

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Peter Stenberg and Mitchell Morehart
Economic Research Service[2]

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, video on demand, telecommuting, collaborative scientific projects, videoconferencing, and virtual environments in the nation's 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. High speed platforms, known as broadband Internet, are viewed by many as necessary to fully utilize current applications and to realize the future potential from the Internet.

Rural communities have not been left out of the ever changing information economy, though there has been an issue of equal access across the rural-urban milieu. Rural households are almost as likely as urban households to use the Internet. Broadband Internet access in rural areas, however, has been less prevalent than in more densely populated areas of the country. Circumstantial evidence suggests that the difference may lie in the higher cost or limited availability of broadband Internet access in rural areas.

As a consequence, national policy makers have been trying to address the shortfall in broadband access in rural areas through the 5-year farm bills (Food, Conservation, and Energy

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[2] The views expressed are those of the authors and do not necessarily reflect the views of the Economic Research Service or the U.S. Department of Agriculture

Act of 2008 and The Farm Security Act of 2002). In addition the Economic Recovery Act of 2009 has a number of provisions providing funds for rural broadband.

Several questions arise from the policy intervention. How much broadband access has increased in rural areas as a consequence of the programs already in place? What is the demand for rural broadband access? Does availability beget 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.

The paucity of national geographically-specific data, however, presents a challenge in trying to analyze questions of broadband take-up. Data from the 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 Agricultural Resources Management Survey (ARMS) and industry data to develop proxies for local broadband service price indices. We perform descriptive statistics and multinomial logistic regressions. Additional data in our models came from the Bureau of Census, and the Federal Communications Commission.

Internet use and rural businesses

Farm and rural businesses have shown increasing demand for broadband Internet access (Stenberg and Morehart). 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). 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; Barton).

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 (Morehart and Stenberg). Pociask suggests that rural businesses do not use broadband as much, in part, due to higher rural prices for broadband.

Rural retailers often use the Internet due to the requirements of their suppliers (Ernst and Stoel). 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; Stricker et al). The Internet has also increased the competition businesses face. A prime example is the banking industry; many banks are no longer local in nature and customers have been increasingly conducting their banking business on-line (DeYoung and Duffy; Keeton).

Broadband has become necessary for some on-line activities

As the Internet economy has evolved, more and more applications now require higher data transmission rates for their use, making broadband Internet access more a necessity than a luxury. Most on-line activities have become more sophisticated using more data intensive methods, especially graphics; e-mail, for example, is becoming more data intensive as people are more inclined to attach photos and videos to them (Stenberg).

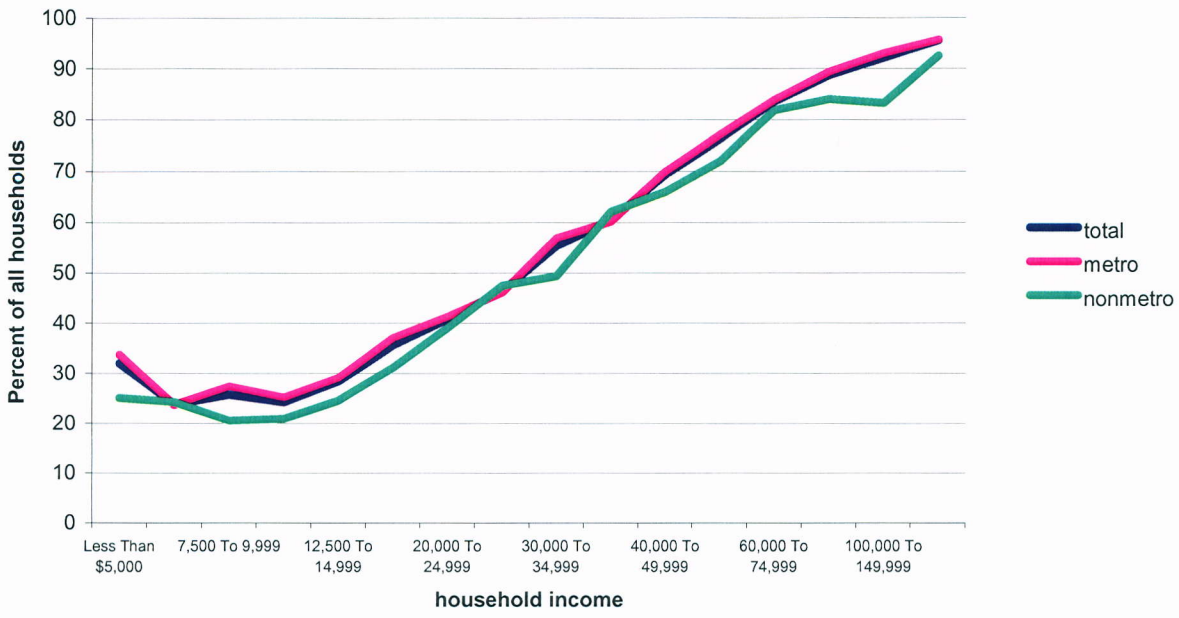
Thus the type of access, or speed of the Internet connection, impacts Internet use. Broadband users use the Internet more intensively than dial-up users. Analysis of Bureau of Census and PEW data suggest the high adoption rate of broadband technologies by urban Internet users indicates people value what broadband Internet access has to offer.

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.

Figure1: Home internet access by income, 2007



Source: authors

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.

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

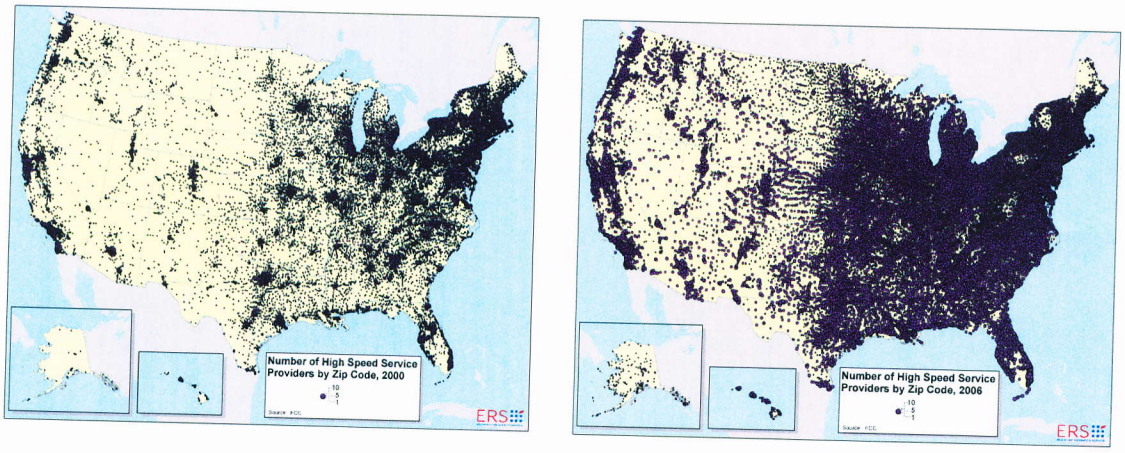
Where in rural areas is broadband less readily available?

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.

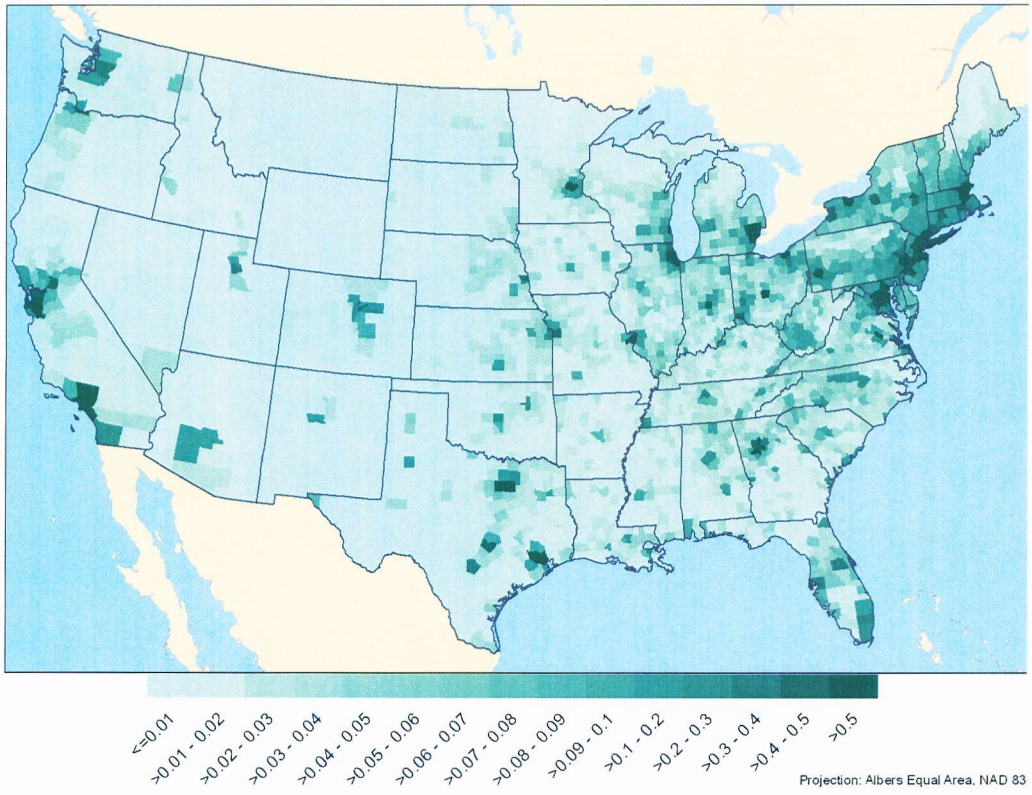
Essentially these basic building blocks show the likelihood of having broadband available at any zonal point within the lower 48 states at different points of time. We have done this by using the population centroids of the zip-code areas as the center of the service region. The service region is defined 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.



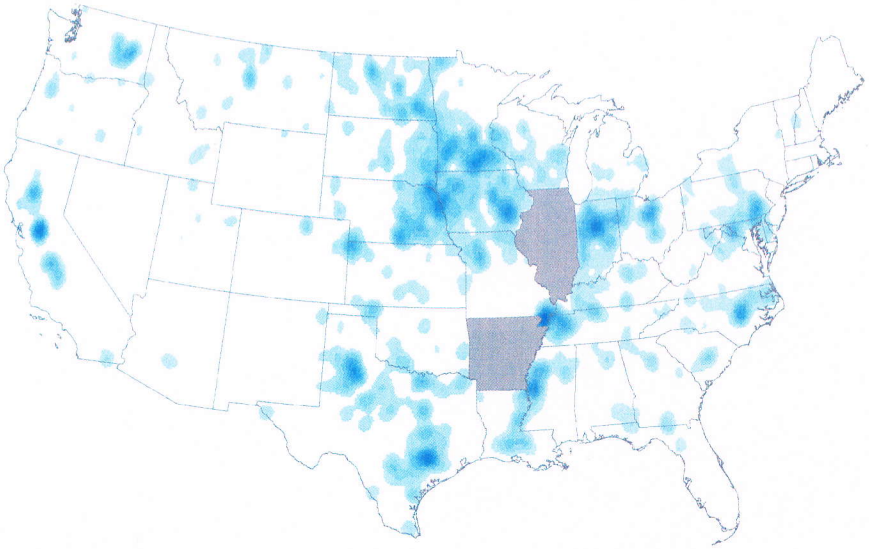
Source: authors using data from FCC

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.

Table 1: Adoption of terrestrial broadband Internet Access by farms, 2005-2007.

	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	79
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.

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 2: Binomial Logit for dial-up to terretrial broadband conversion, 2005-7.

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

Signif. codes: ('***' 0.001) ('**' 0.01) ('*' 0.05)

Conclusion

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. Rural communities have not been left out of the ever changing Information economy, though there has been an issue of equal access across the rural-urban milieu. Rural households are almost as likely as urban households to use the Internet. Broadband Internet access in rural areas, however, has been less prevalent than in much more densely populated areas of the country. Circumstantial evidence suggests that the difference may lie in the higher cost or less availability of broadband Internet access in rural areas.

Several questions arise in addressing policy intervention. How much broadband access has increased in rural areas as a consequence of the programs already in place? What is the demand for rural broadband access? Does availability beget 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.

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 USDA for loans and grants to increase broadband provision in rural areas.

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