Geography of Rural Broadband Providers

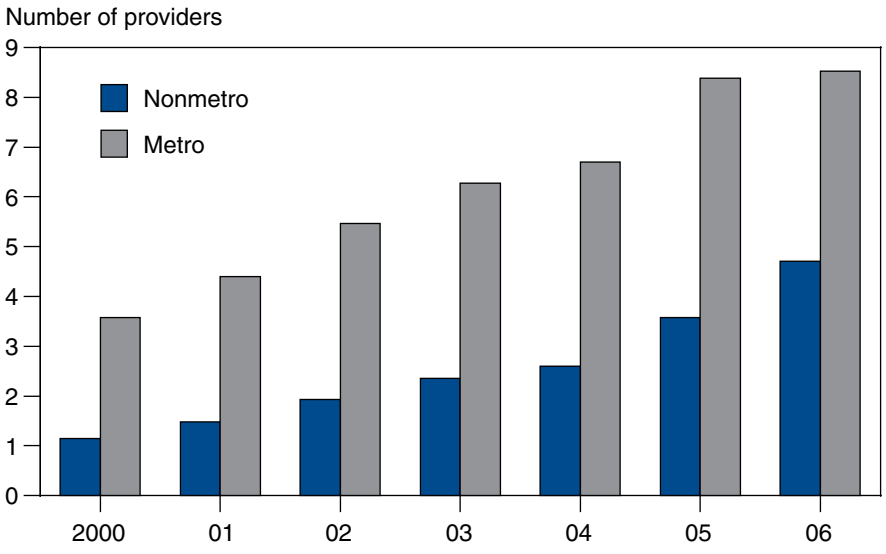
Broadband provision follows a geographical pattern tied to population size and the urban-rural hierarchy. Limited provision is most strongly associated with low population size in a given area, but also exhibits regional patterns that reflect differences in urban concentration and challenges associated with mountainous terrain. The Federal Communications Commission (FCC) data on the number of broadband providers by ZIP Code area (see Appendix B) are the only source of geographically detailed information with national coverage. More robust findings would come from data measuring the actual number of broadband customers and variation in the price of service, rather than just the number of companies providing access. The FCC data, however, serve as the best available proxy of broadband accessibility.

Metro ZIP Code areas average 88 square miles apiece and include just over 16,700 people on average.[2] Nonmetro ZIP Code areas are generally much larger (131 square miles) with far fewer people (3,000) on average. Such population diversity drives geographic variation in the cost of broadband provision. While U.S. metro areas averaged close to nine providers per ZIP Code area in 2006, nonmetro ZIP Code areas averaged half that number (fig. 5).

Despite significant expansion, the metro-nonmetro gap in number of broadband providers remains and has even widened by some measures since 2000, when broadband provision was much more limited in scope. It is not surprising that, as broadband access has expanded to encompass a large majority of Americans, the remaining areas of limited coverage increasingly reflect the higher costs associated with providing service to smaller populations.

[2]Metro and nonmetro categories used here are based on the ERS Rural-Urban Commuting Areas and are defined using criteria similar to OMB's county-based metro and nonmetro areas. Nonmetro ZIP Code areas are defined as those outside urban centers of 50,000 or more and their surrounding commuting zones

Figure 5
Average number of broadband providers per ZIP Code by metro versus nonmetro area, 2000-2006



Source: USDA, Economic Research Service, using data from the FCC.

The Economics of Broadband Delivery

The main economic principles underlying the diffusion and adoption of communication services across rural-urban space are twofold: companies invest where they earn the highest returns and households adopt if they can afford these services and either need or desire them (Davies, 1979; Rogers, 1995). The adoption and use of communication and information services, therefore, are not uniform across the country or among income groups.

Here we are interested in differences between rural and urban areas or, in Federal policy terminology, between high-cost and low-cost areas. Residents in rural areas have always faced higher costs for telecommunication services than those in urban areas and, at least for the foreseeable future, will continue to do so. Economies of scale for the current technology set are at the core of why they face higher costs (Stenberg, 2004).

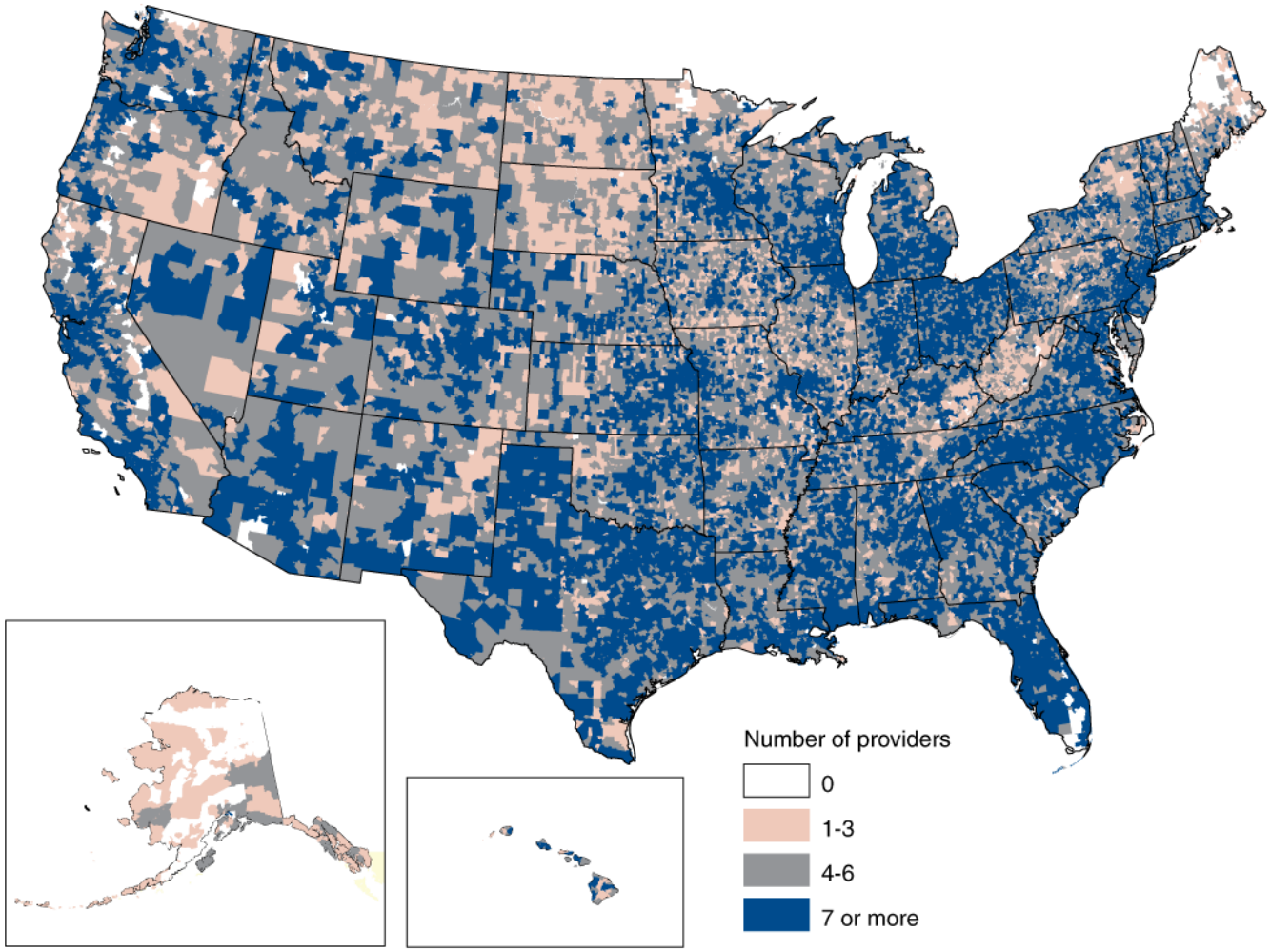
Rural areas are characterized by low population density. With fewer people in any geographic space, the per capita costs of providing telecommunication services rise. Fewer customers share in the cost of the central office switches, loop maintenance, and other common components of the local telecommunication system.

Rural areas also have few large businesses or government operations. In the United States, private business and government use of telecommunication services has indirectly subsidized household use. In practice, this has meant that urban telecommunications service providers often charge higher rates to their business customers and lower rates to household customers than they would in a perfectly competitive market for telecommunication services (Egan, 1996). Rural telecommunications companies often do not have this luxury.

Rural telecommunications service providers must spend more per customer for maintenance and repair crews than urban providers. Rural maintenance and repair crews, especially those providing services in very remote regions, cover a larger territory than urban crews, resulting in more overtime, more travel expenditures, and all the other resultant expenditures that crews face when they are not near their home base (National Telephone Cooperative Association, 2000). Rural providers also need more resources per customer than urban telecommunications service providers, including duplicate facilities and backup equipment, to ensure network reliability (Egan, 1996).

Clusters of lower service provision in 2006 highlight clearly discernable regional patterns (fig. 6). The northern Great Plains, eastern Oregon, and northeastern New Mexico are sparsely populated. The Missouri-Iowa border area has experienced persistent population loss and an aging population. An extensive area of low service is evident in West Virginia and eastern Kentucky, but extends from Tennessee through upstate New York. This mountainous terrain, divided by innumerable ridges and narrow valleys, impedes broadband service provision to its widely dispersed, rural and small-town population. Though topography creates similar challenges in the West, people living there tend to concentrate more in towns and small cities, making broadband service less expensive to provide to each household.

Figure 6
Number of broadband providers, 2006

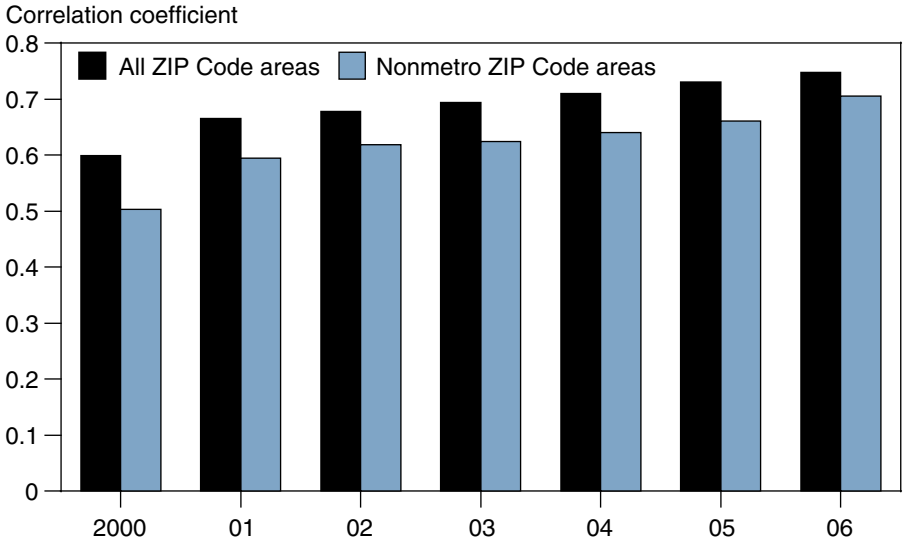


Source: USDA, Economic Research Service, using data from the FCC.

Access to services of any kind—hospitals, grocery stores, public transportation, Internet—is strongly related to overall population size, the degree to which population is concentrated in urban centers, and the population of neighboring areas. In the case of broadband service, as measured by the FCC data, population size is the predominant explanatory feature. For all ZIP Code areas nationally, the very strong (0.6, or 60 percent) correlation between population size and service provision in 2000 increased to 0.75 by 2006 (fig. 7). Thus, low-service areas that remain, though far fewer, are more likely to be in sparsely settled territory throughout nonmetro America.

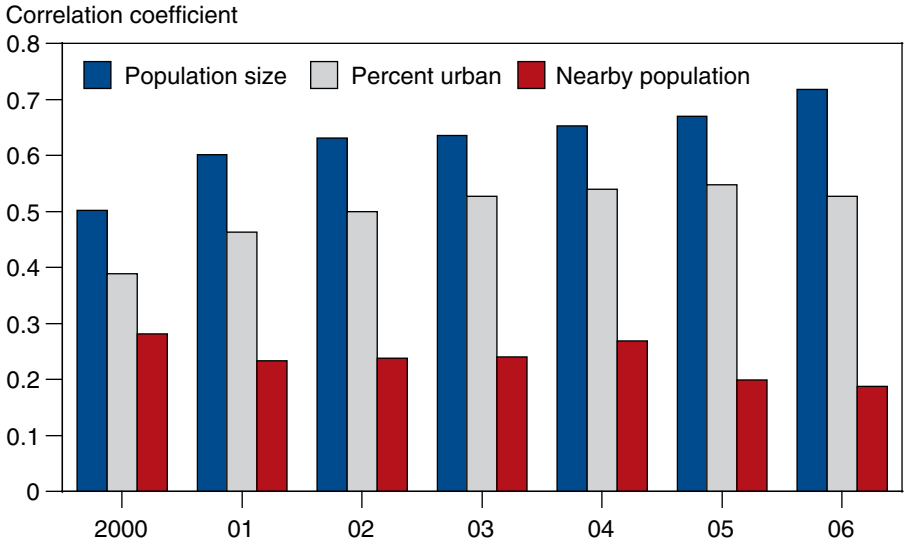
Within nonmetro areas, population size is the strongest predictor of where broadband access is likely to be available. Other dimensions of nonmetro population distribution, however, strongly correlate as well, especially the degree of population concentration as measured by percent urban (fig. 8). Correlation between broadband provision and the relative size of neighboring ZIP Code areas weakened from 2000 to 2006, as broadband provision increased.

Figure 7
Strength of relationship between number of broadband providers and population size, 2000-2006



Source: USDA, Economic Research Service, using data from the FCC.

Figure 8
Strength of relationship between number of broadband providers in nonmetro ZIP Code areas and three population measures, 2000-2006

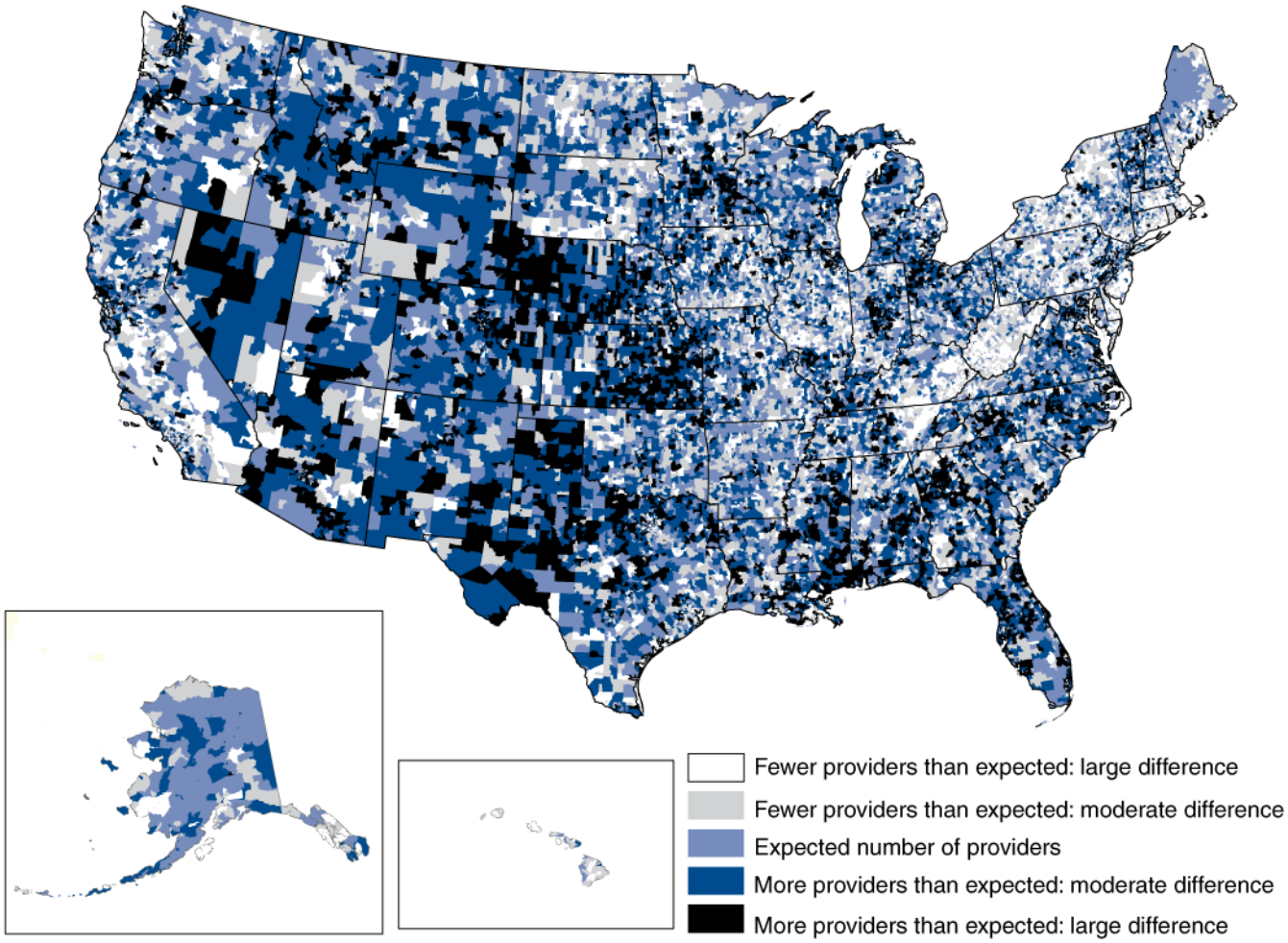


Source: USDA, Economic Research Service, using data from the FCC.

Results of a regression analysis conform to expectations regarding the geography of broadband provision driven by relative costs per capita (for a description of the ordinary least squares model, see Appendix C). In combination, the three population-based measures explained 63 percent of variation in broadband availability. Population size contributed the largest effect, but percent urban and size of nearby populations also were significantly related to broadband provision in 2006.

Additional insights may be gained by examining where the number of broadband providers is higher or lower than expected, once these very strong and universal population effects are taken into account. This is accomplished by mapping the residuals from our regression model for 2006 (see Appendix C for an explanation of the model and the variables used). Residuals are measured for each ZIP Code area as the difference between the actual number of providers in that area and the number of providers predicted by the model, based on the area's population size, urban concentration, and proximity to nearby population centers. In the West, higher-than-expected service occurs in the most sparsely populated sections (fig. 9). In Nebraska and Kansas, including the more densely settled eastern parts, broadband provision is higher than expected, compared with most neighboring States. Vermont similarly stands out among New England States.

Figure 9
Difference between the actual number of providers and the expected number based on population, 2006



Note: The map shows residual regression values. The highest and lowest categories are greater than one standard deviation above and below the mean residual value of zero. Areas of moderate difference fall between one-quarter and one standard deviation above and below the mean. Areas with the expected number of providers are within one-quarter standard deviation above or below the mean.

Source: USDA, Economic Research Service, using data from the FCC.

In Appalachia, broadband service provision is consistently lower than expected. The Ozarks in northeastern Arkansas show values similar to Appalachia, pointing to the role of topography in influencing broadband provision in the eastern half of the United States.

Higher-than-expected service in Vermont, however, suggests that economic and social factors may influence the level of broadband service in nonmetro ZIP Code areas. Higher levels of income and education may increase demand for broadband. Vermont's economy depends more heavily on tourism and recreation, and its population has high levels of college and technical training, especially in engineering, finance, and health. Both these features help explain differences in service levels compared with more southern Appalachian areas.

The geography of broadband service provision in 2006—in particular, the contrast between higher- and lower-than-expected service areas—suggests several factors contributing to service gaps beyond basic population barriers. First, the variation in broadband coverage is less pronounced in the West, especially in the Intermountain West, compared with the Midwest and Appalachia. This may be due to a more concentrated population pattern (though this analysis accounts for some of this effect by including percent urban); a recreation-based economy, attracting tourists who increasingly demand broadband availability; or a rapidly growing population made up of younger, more educated individuals, including tech-savvy entrepreneurs whose businesses depend on being connected to urban-based clients.

Second, Appalachia's prominence as an underserved area suggests that topography significantly increases the cost of providing broadband service in this region. Education levels are below the national average, but no more than in many Coastal Plain States areas that are better served. The higher dependence on mining and other resource-based industries may play a role, but lower levels of broadband service exist even in areas of Appalachia where retirement and tourism have become important. And if a higher dependence on mining lowers Internet demand, the same is not true for agriculture. When population is taken into account, places with higher employment in agriculture exhibit higher levels of broadband support.

Finally, higher-than-expected service in States such as Nebraska, Kansas, and Vermont indicate that State-level policies and programs may be behind the widespread availability of broadband. Here, we face limitations of data that simply show the number of providers in a ZIP Code area and may not always reflect differences in costs or level of service. Still, conditions at the State level seemingly can transcend economic and social differences that tend to handicap some rural areas.