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"Small" Broadband Providers and Federal Assistance Programs: Solving the Digital Divide?

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Abstract. Recent data from the Federal Communications Commission allows for examination of the location decisions of "small" broadband providers, i.e. those with less than 250 subscribers. While anecdotal evidence suggests that small providers may be serving disadvantaged or underserved areas, the data indicates that more than two-thirds service urban areas and seemingly choose areas with high demand potential. This paper models the location decision of these small providers and analyzes whether they are influenced by federal assistance programs such as USDA broadband grants and loans. The results suggest that while small providers do tend to locate in urban areas with higher levels of education and income, they also favor rural areas with high levels of Hispanics and African-Americans. No statistical impact is found for the federal-level policies included in the analysis, implying that the focus of these programs may be on the wrong areas.

1. Introduction

Broadband Internet access has become increasingly popular for households and businesses since its introduction in the late 1990's.[1] These high-speed connections allow users to send and receive enormous quantities of data, audio or video files; and can also enhance voice communication (Horrigan and Rainie, 2002; Prieger, 2003). Broadband access has the potential to benefit a wide cross-section of society, including businesses, governments, consumers, and communities. For the private sector, broadband access provides the opportunity to take advantage of new input and output markets, and allows firms to increase their productivity by improving information exchange, value chain transportation, and process efficiency (Thomas, 2005). Broadband access also adds value to public sector services such as education, health, and local government services by increasing the availability of data and speeding feedback to and from constituents (Bauer et al., 2002). Moreover, broadband access has the potential to enhance the quality of life of consumers through economic, social and cultural development (Warren, 2007).

Broadband access is particularly important for rural and remote areas.[2] These geographically isolated regions have the most to gain from the distance-negating nature of the Internet, including the opportunity to participate in the digital economy and become part of the information revolution (Lindroos and Pinkhosov, 2003; Warren, 2007). However, as with every technological revolution, some people and areas have been slower to adopt than others. The "digital divide," or the gap in Internet access between urban and rural areas, has received a large amount of attention from researchers, politicians, and policy makers (Strover, 2001; Whitacre and Mills, 2007). Research on the determinants of broadband infrastructure finds that rural location does in fact have a significantly negative impact on its availability (Malecki, 2003; Prieger, 2003; Strover, 2003). This is in part due to the profitability decisions of infrastructure providers, based on factors such as number of potential adopters, prospective demand, and cost to provide. Therefore,

[1] Broadband access, also called high-speed access or advanced service, is defined by the Federal Communications Commission as 200 Kilobits per second (Kbps) (or 200,000 bits per second) of data throughput in at least one direction.

[2] This paper defines rural and urban based on ZIP code classifications of the Rural – Urban Commuting Area (RUCA) system. For an overview of this classification see WWAMI (2002).

urban areas, with higher levels of education, income, population, and lower cost to provide were the first to receive broadband infrastructure (Ward, 2007).

Anecdotal evidence suggests that small-scale providers may be servicing the broadband needs of some rural communities (Richtel and Belson, 2005; Hurley, 2003; Richtel, 2003; Whitacre, 2007). For example, a local citizen with an entrepreneurial mind might set up a wireless tower to connect his hometown, or the local telephone or cable company might upgrade their systems due to a sense of pride in their community. However, until recently these "small" providers would not have been accounted for by the most commonly referenced data collection effort for broadband providers – that performed by the Federal Communication Commission (FCC).

The FCC has collected data on subscribers to broadband service since 1999 (via a document commonly known as Form 477) in an effort to evaluate the deployment of advanced telecommunications capability. Initially, a list of the ZIP codes serviced was collected twice a year from high-speed providers with at least 250 lines in a particular state. This led to concern that although some rural and remote areas were being depicted as unserved in the data, they did in fact have infrastructure available to them – their providers were simply not large enough (250 subscribers) to meet the necessary filing requirements. To this end, the June 2005 Form 477 required ALL providers of high-speed connections to report. Thus, while the number of filers reporting under this new requirement was more than double the previous amount conducted just six months earlier, the total number of broadband lines provided followed the historical trend (Figure 1).

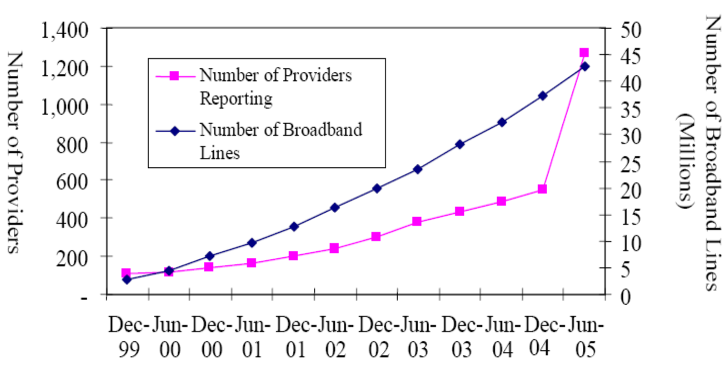

Figure 1. Number of broadband providers reporting and broadband lines in the U.S., December 1999 – June 2005 (source: FCC Form 477 date June 2005).

The availability of this data allows for some insight into those broadband infrastructure providers who service a smaller number of subscribers.[3] Meshing this data with secondary demographic information permits identification of factors impacting the location decisions of these "small" broadband providers. This paper augments the existing knowledge base on broadband infrastructure by 1) comparing areas served by small providers to those served by large providers, 2) describing the location of small broadband providers, including Geographic Information System (GIS) mapping techniques and demographic comparisons of communities with and without small providers; and 3) modeling the determinants of where these providers choose to locate – particularly for rural areas that previously had no access. One unique contribution of this paper is to explore the roles that federal assistance programs (namely United States Department of Agriculture (USDA) broadband grants and loans) play in attracting small broadband providers to previously unconnected areas. These results are of interest to individuals involved in community development, given the recent finding that broadband access leads to growth in employment and number of businesses (Lehr, Osoria, Gillett, and Sirbu, 2006). Understanding the location decisions of small broadband providers and the role of federal policies in where they locate has implications for policy makers seeking to reduce the infrastructure gap between rural and urban areas, as well as for rural areas attempting to bring broadband providers to their community.

The paper is organized as follows. Section 2 discusses the data used and provides descriptive statistics. Section 3 sets up the econometric models and section 4 reports the results from these models. Finally, section 5 draws several conclusions and discusses their policy implications.

2. Data and descriptive statistics

The data used in this study come from a number of publicly available secondary sources. The numbers of broadband providers (at the ZIP code level) are obtained from the Federal Communications Commission via form 477. The main drawback of this data is that proprietary concerns prevent full disclosure.[4] In par-

[3] A reviewer notes that ZIP codes do not necessarily reflect economic areas and questions their appropriateness for evaluating market entry decisions. However, the FCC data represents the lowest level of detail on broadband subscribers available at the national level and has been used in several studies of this nature (Prieger, 2003; Grubesic and Murray, 2004)

[4] Another drawback of the FCC data is the fact that a single subscriber in a ZIP code implies that the entire ZIP code has broadband

ticular, ZIP codes that have between one and three providers are reported by a "*" symbol in an effort to reduce insight into the number of broadband providers in those areas, which might be considered proprietary information. Thus, comparing the number of providers between December 2004 and June 2005 provides limited information for these ZIP codes. However, most ZIP codes are not under this proprietary concern, allowing for identification of those ZIP codes that experienced a provider increase over this period.

Data from the June 2005 FCC Form 477 indicates that over one-third of all ZIP codes reported an increased number of providers since December 2004. This same report notes that, "small providers of high-speed connections, many of whom serve rural areas with relatively small populations, were therefore unrepresented in the earlier data" (FCC, 2006, p.2). However, the majority of the ZIP codes that saw an increase in the number of providers over this period were in fact *urban* (Table 1).[5]

Table 1. Overview of ZIP codes with provider increase, December 2004-June 2005

Area	Total ZIP Codes	# with Increased Providers 12/04 – 6/05	% Total with Increase
Rural	15,036	4,285	34%
Urban	16,571	8,299	66%
Total	31,607	12,584	

Source: FCC Form 477 dated December 2004 and June 2005; WWAMI RUCA classifications by ZIP code

This data on infrastructure availability can be combined with demographic data from the U.S. Census Bureau. The Census data, also reported by ZIP code, can be used to describe household characteristics that might affect the availability of broadband providers.[6] One question that immediately arises for this dataset is whether there are any obvious differences in ZIP codes with "large" providers versus those with "small" providers. Table 2 compares ZIP codes that had at least one large provider (in 2004) with those that had at least one small provider (derived from the 2005 data).[7] A simple means test indicates that both large and small providers tend to focus on ZIP codes with demand potential. However, discrepancies between served and unserved ZIP codes are larger for small providers than they are for large providers. In particular, while the number of households, population density, and number of businesses are relatively similar for ZIP codes both with and without a *large* broadband provider, their levels are significantly higher for ZIP codes with at least one small provider than for those with no *small* providers. Similar patterns hold for education and income / work characteristics, with differences between ZIP codes served / not served by small providers tending to be noticeably larger than those for large providers. For example, the income gap between ZIP codes with and without small broadband providers is over $4,500, compared to only $2,700 for large providers. Perhaps unexpectedly, small providers serve ZIP codes with higher levels of African-American and Hispanic households than the ZIP codes served by larger providers, indicating that small providers may be catering to this market. Age characteristics are similar for ZIP codes with both large and small providers, although areas with no small providers are much more likely to be composed of senior citizens. Commute times for residents are not statistically different for areas with and without large providers; however, significant differences do exist for small providers. Areas with small providers have higher rates of commuters with less than 30 minute drives and lower rates of those with more than 60 minute commutes, suggesting that small providers may target households with a close work-home connection. Additionally, only 34 percent of ZIP codes with small providers are rural, while 45 percent of those with a large provider are rural. These patterns suggest that small providers are "cherry-picking" ZIP codes with the best demand potential by focusing on those with higher numbers of people and businesses;

access. This drawback has been noted by several sources (GAO, 2006, Flamm, 2006, Lehr et al., 2006).

[5] Recall that ZIP codes that experienced an increase between December 2004 and June 2005, but still had between 1 and 3 providers in each report, would display a "*" in both reports and would therefore not show up as having increased numbers of providers. This may be a partial cause of the large percentage of providers denoted as urban, since these areas are less likely to be under this proprietary concern.

[6] Some ZIP codes in the Census data are "artificial" ZIP codes (unclassified areas, or areas consisting of bodies of water) that do not have a corresponding "real" ZIP code with a population of at least 1 person, and were dropped from the study. Further, there is a noted discrepancy between the ZIP code list used by the FCC (the proprietary geographic mapping system from Dynamap) and the ZIP code list from the 2000 Census (Flamm, 2006). Any ZIP code included in the Census list but not in the FCC list is assumed to have zero broadband providers in this paper.

[7] While some ZIP codes that saw an increase may have actually attracted a "large" provider between December 2004 and June 2005, the dramatic increase in providers displayed in Figure 1 suggests that the vast majority were "small" providers. Data constraints limit our ability to differentiate between large and small providers.

Table 2. ZIP codes with and without large broadband providers (December 2004) and ZIP codes with and without small broadband providers (June 2005)

	2004		2005	
Variable	No large provider	At least one large provider	No small provider	At least one small provider
Number of Households	2,063	2,315*	1,422	3,588*
Population Density	913	1,181*	788	1,693*
Number of Businesses	198	231*	125	381*
Education				
No HS	0.226	0.216*	0.231	0.198*
HS Diploma	0.357	0.343*	0.361	0.321*
Some College	0.265	0.269*	0.261	0.280*
College Degree	0.101	0.111*	0.097	0.130*
Graduate Degree	0.048	0.057*	0.048	0.068*
Income / Work				
Median income	37,272	40,067*	37,026	43,803*
Percentage below poverty	0.135	0.124*	0.134	0.112*
Percentage working at home	0.050	0.048	0.052	0.041*
Percentage unemployed	0.067	0.063*	0.065	0.061*
Race / Ethnicity				
Percentage African-American	0.063	0.073*	0.061	0.087*
Percentage Hispanic	0.065	0.061	0.055	0.072*
Percentage Other Race	0.049	0.046	0.045	0.047
Age				
Percentage 16 and under	0.239	0.237*	0.238	0.237
Percentage 17 - 29	0.154	0.154	0.149	0.161*
Percentage 30 - 64	0.461	0.465*	0.464	0.465
Percentage 65 and over	0.143	0.142	0.147	0.135*
Commute time				
Less than 30 minute	0.608	0.608	0.599	0.623*
Between 31 and 45 minute	0.181	0.183	0.183	0.183
Between 46 and 60 minute	0.074	0.075	0.076	0.073
More than 60 minute	0.083	0.083	0.086	0.078*
Rural	0.637	0.453*	0.565	0.341*
Number of ZIP Codes	3,873	27,734	19,023	12,584

Source: Census 2000; U.S. Census Bureau and FCC Form 477 data dated December 2004 and June 2005
Note: * indicates the means are statistically different at the p = 0.05 level.

Table 3. Demographic Characteristics of Rural and Urban ZIP Codes with and without an Increase in Providers, December 2004-June 2005

Variable	Urban		Rural	
	No Increase	Increase	No Increase	Increase
Number of Households	2,395	4,544*	645	1,703*
Population Density	1,567	2,492*	189	145*
Number of Businesses	223	499*	50	150*
Education				
No HS	0.218	0.188*	0.240	0.218*
HS Diploma	0.338	0.298*	0.376	0.367*
Some College	0.266	0.284*	0.258	0.273*
College Degree	0.112	0.147*	0.085	0.097*
Graduate Degree	0.060	0.081*	0.039	0.045*
Income / Work				
Median income	41,085	46,963*	33,402	37,395*
Percentage below poverty	0.120	0.107*	0.145	0.121*
Percentage working at home	0.041	0.036*	0.061	0.052*
Percentage unemployed	0.067	0.064*	0.066	0.059*
Race / Ethnicity				
Percentage African-American	0.083	0.103*	0.046	0.057*
Percentage Hispanic	0.076	0.086*	0.040	0.045*
Percentage Other Race	0.044	0.054*	0.047	0.054*
Age				
Percentage 16 and under	0.236	0.235	0.237	0.240*
Percentage 17 - 29	0.160	0.168*	0.143	0.149*
Percentage 30 - 64	0.461	0.465	0.463	0.465
Percentage 65 and over	0.137	0.130*	0.155	0.147*
Commute time				
Less than 30 minute	0.594	0.620*	0.602	0.627*
Between 31 and 45 minute	0.191	0.187	0.176	0.174
Between 46 and 60 minute	0.081	0.075	0.072	0.069*
More than 60 minute	0.088	0.080	0.085	0.075*
Number of ZIP Codes	8,272	8,299	10,751	4,285

Source: Census 2000; U.S. Census Bureau and FCC Form 477 data dated December 2004 and June 2005.
Note: * indicates the means are statistically different at the $p = 0.05$ level.

essentially choosing ZIP codes with levels of education, income, and age / location that imply increased probabilities of broadband use.

Discrepancies between rural and urban areas can also be observed from this demographic data. Table 3 displays descriptive statistics of rural and urban ZIP codes both with and without small providers according to the December 2004 and June 2005 FCC data. In general, patterns for areas with a small provider are similar regardless of rural or urban location. Rural and urban ZIP codes that have been served by small broadband providers have significantly higher education and income levels, and more households and businesses than those areas that have no small broadband providers. Also, rural and urban ZIP codes with small broadband providers have slightly younger populations (under 30 years old) than those ZIP codes that have no small broadband providers. The percentage of the population between 17 and 29 is particularly higher in both rural and urban areas. In terms of commuting time, rural areas display significant differences in three of the four categories, while urban areas only show a difference in one. This may indicate that small providers pay more attention to commuting times in rural (as opposed to urban) areas. For race and ethnicity, both rural and urban ZIP codes served by small broadband providers are much more racially diverse than those that have no small broadband providers. Overall, the similar trends indicate that the impact of specific characteristics on the location decision of a small provider may not differ greatly between rural and urban areas. This hypothesis is further tested in our econometric models.

Having looked at the characteristics of ZIP codes of small providers, we focus now on the geographic location of these broadband providers. GIS mapping techniques allow for visualization of where these small providers are located. Plotting the location of all small providers suggests that they are in existence throughout the U.S; however, they are not evenly dispersed. Most of the small providers are located in the northeast, north central, and southeast regions while the central region seems to lag behind (Figure 2). These patterns hold for both rural and urban ZIP codes. Interestingly, highly rural regions such as the mountain or west south central have very few small broadband providers. The importance of these patterns is tested through a series of regional dummy variables in our models.

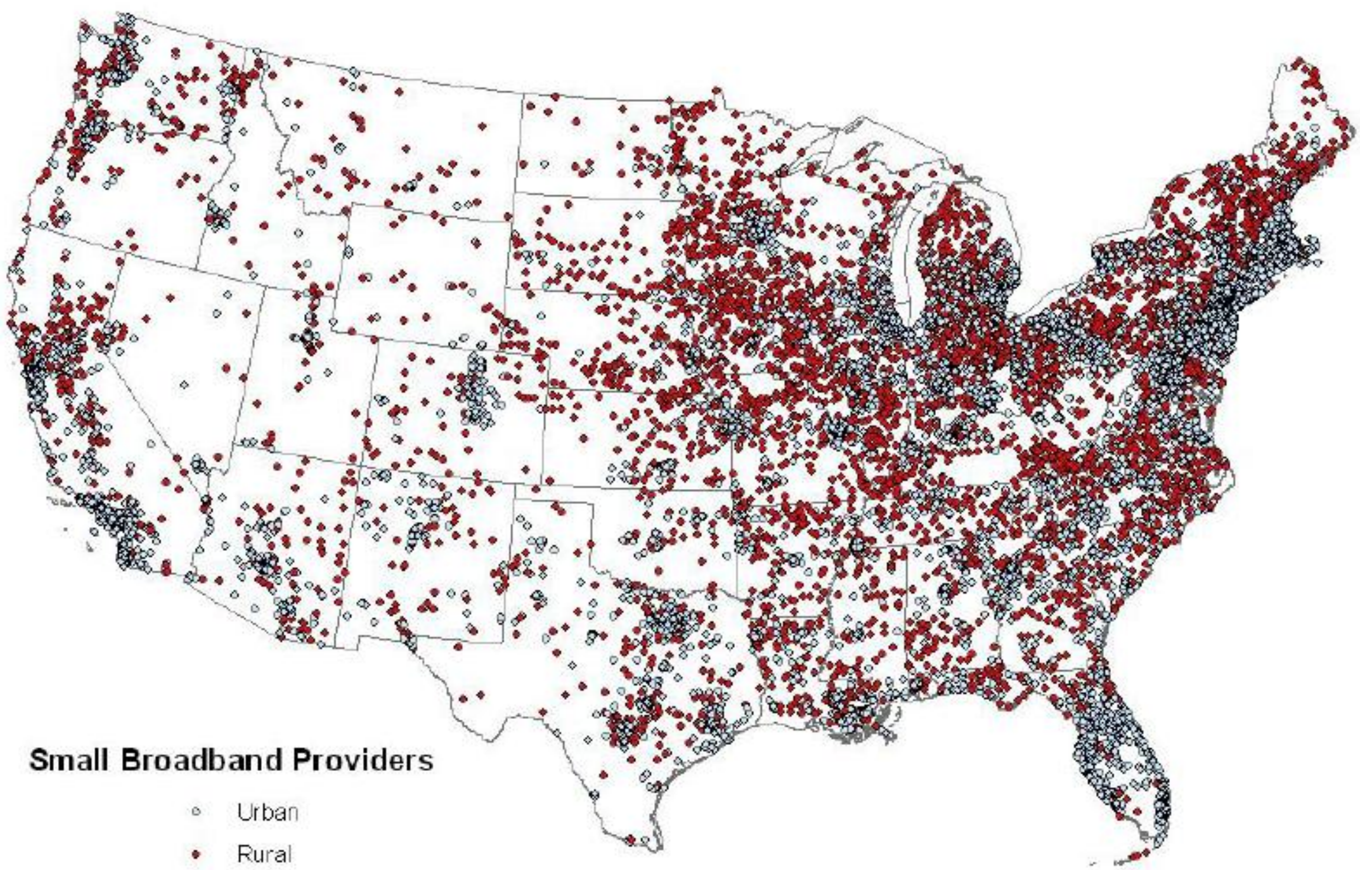

Figure 2. Availability of small broadband providers (source: FCC Form 477 date June 2005).

A separate contribution of this paper is to analyze the impacts of federal-level policies, namely the Community Connect Grants and Farmbill Broadband Loans, to increase broadband access in rural and remote areas. Community Connect Grants were provided by the United States Department of Agriculture (USDA) to boost broadband access in rural and remote areas by giving grants to broadband providers serving in such areas. Farmbill Broadband Loans were also awarded by USDA to provide loans and loan guarantees to fund the cost of construction, improvement, or acquisition of facilities and equipment for the provision of broadband service in eligible rural communities. The names of all communities receiving either grants or loans between 2002 and 2005 were provided by USDA, and mapped into relevant ZIP codes. Around 150 grants and loans were awarded that impacted approximately 1,300 communities over this period (Figure 3).

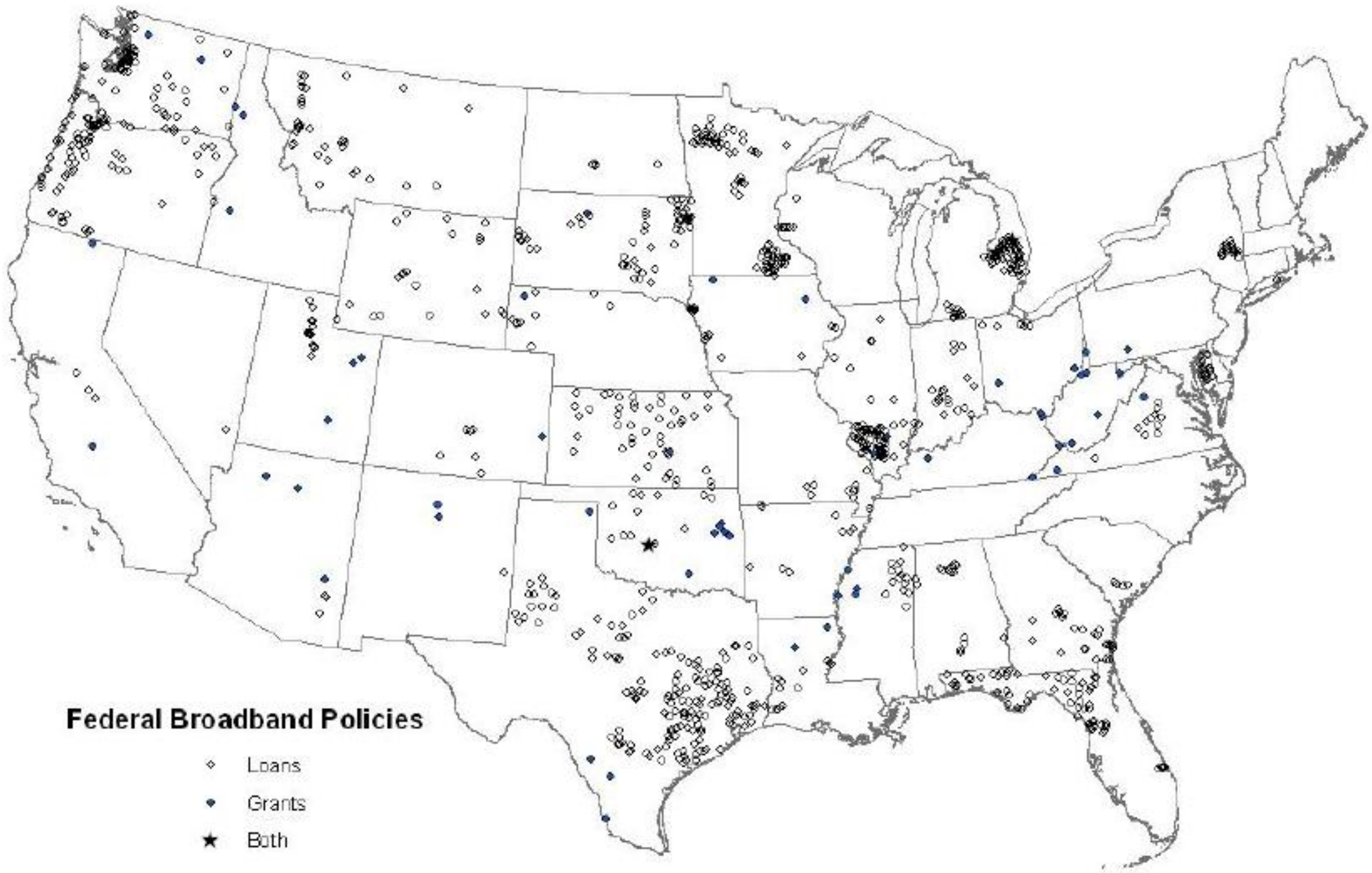

Figure 3. USDA Broadband Grants and Loans, 2002 – 05 (source USDA Rural Utilities Telecommunications Program)

The descriptive statistics displayed in Tables 2 and 3 provide some insight into the demographic and economic characteristics that factor into the small broadband provider location decision. The impact of federal policies on this decision can also be explored using data from USDA grants and loans. The following section discusses the econometric models employed to estimate the sign and size of the effect that each variable has on the probability of attracting a small broadband provider.

3. Method

We model the presence of a small broadband provider (less than 250 subscribers) in each ZIP code as a function of demographic, economic, and geographic characteristics. The model is specified as

$$y_i^* = X_i\beta + Z_i\delta + H_i\gamma + N_i\tau + L_i\pi + R_i\eta + D_j\alpha_j + \varepsilon_i \quad (1)$$
$$y_i = 1 \text{ if } y_i^* \geq 0$$
$$y_i = 0 \text{ if } y_i^* < 0$$

where y_i* is a latent measure of the relative benefits to costs perceived by small broadband providers of serving ZIP code i, y_i is the actual observation of an increase in broadband providers between December 2004 and June 2005, X_i is a vector of household income levels, Z_i is a vector of residents' education levels, H_i is a vector of other demographic characteristics, N_i is a vector relating to market size, L_i is a dummy variable indicating the presence of a "large" provider in December 2004, R_i is a dummy variable indicating when a ZIP code is rural in nature; $\beta, \delta, \gamma, \tau, \pi$ and η are the respective associated parameter vectors, and ε_i is the statistical model's error term. In addition, we include a series of dummy variables, D_j , where j equals one of nine regions of the U.S., along with their corresponding parameters a_j. These regions are depicted in Figure 4. Note that variables for broadband loans and grants are not included in this model, but are in a later version.

Figure 4. Nine regions of the U.S. as denoted in the Bureau of Labor Statistics Current Population Survey.

Because y_i^* takes on one of two explicit values (one if small broadband provider serves the ZIP code, zero otherwise) a binary choice model such as the linear probability, probit or logit may be employed. In this paper, a logit model is selected because it has benefits over the other binary choice models – namely, restricting outcomes to the [0, 1] interval (which the linear probability model does not), and providing a closed form solution (unlike the probit model) (Greene, 2003). Although the presence of spatial dependency in the data would lead to heteroskedasticity or autocorrelation and thus render logit estimates inconsistent and/or inefficient, spatial estimators are not used for several reasons. First, our models are estimated with heteroskedastic-consistent standard errors. Second, the patterns displayed in Figure 2 give little evidence to suspect that the presence of a small provider in one ZIP code would impact a similar presence in neighboring ZIPs. In fact, the variation seems to be more regional in nature, which we account for through a series of regional dummy variables D_j as noted above. Finally, testing for autocorrelation among ZIP codes would require inverting a 31,607 x 31,607 weighting matrix that is computationally infeasible for the software package used for this analysis.[8]

Economic theory and previous research provide a basis for the expected signs of the relationships between the presence of broadband providers and the independent variables. "Small" broadband providers likely take these same variables into account, although their attempt to cater to under- or un-served communities may alter the relationships. Thus, while the association between demographic / economic characteristics and "regular" broadband providers has been well documented, the connection between these characteristics and "small" providers is left as an empirical question. For example, several studies have noted that individuals with higher income and education levels tend to have higher demand for broadband access (Horrigan, 2006; Strover, 2003). However, the largest recent increases in broadband access rates have come from those with high-school diplomas and low-to-medium income levels (Horrigan, 2006). Thus, smaller broadband providers may tend to market their services towards communities with these types of demographics. Similarly, while research suggests that market size - namely the number of business and households in a ZIP code - is positively associated with broadband providers (Prieger, 2003); small providers may choose to locate in relatively smaller markets that have a higher probability of not being served by the large telecommunications companies. Other demographic characteristics such as race / ethnicity and age are also expected to have an impact on whether or not a small broadband provider serves the area. In particular, some racial and ethnic groups (such as Hispanics and African-Americans) have been slower to adopt broadband than others; however, adoption among these groups has recently seen dramatic increases (Horrigan, 2006). Small providers may target these underserved communities with large minority groups. Communities having a large number of individuals working from home are expected to increase the probability of a small provider, since most probably require broadband access to perform their work. Younger household heads are more likely to be famili-

[8] The complexity issue associated with spatial estimators is raised in Klier and McMillen (2005).

ar with broadband technologies by interacting with them at school, and therefore may be more comfortable adopting them at home and / or work (Rose, 2003). Thus, ZIP codes with a large percentage of young residents may attract broadband providers, including smaller ones. We also include a dummy variable for the presence of a large broadband provider in an attempt to account for potential competition. Previous existence of a broadband provider may deter entry for small providers; however, ZIP codes can be relatively big areas and the presence of a large provider does not necessarily mean that the entire ZIP code is served. In terms of place-based characteristics, we noted previously that rural areas have been found to significantly decrease the probability of broadband areas. Therefore, the expected sign of the rural dummy variable is negative. Further, the Mountain region is used as the base category for the regional dummy variables given the relatively few small providers depicted in this area in Figure 2. Since larger numbers of small providers seem to be in existence in all other regions, the expected sign of the remaining regional dummies are all positive.

In addition to the model specified in (1), a separate model tests for rural and urban differences in the effects of demographic and economic characteristics. By including a rural interaction term for each characteristic, the impact is allowed to vary between rural and urban areas. The model is specified as

$$y_i^* = X_i(\beta_U + \beta_R) + Z_i(\delta_U + \delta_R) + H_i(\gamma_U + \gamma_R) + N_i(\tau_U + \tau_R) + L_i(\pi_U + \pi_R) + D_j(\alpha_U + \alpha_R) + \varepsilon_i \quad (2)$$

where y_i^*, X_i, Z_i, H_i, N_i, L_i, and D_j are as previously defined, but the associated parameter vectors are allowed to vary by rural and urban status. Thus, any statistically significant rural parameter denotes a meaningful difference in the way the associated variable impacts rural and urban areas.

We also focus on ZIP codes that previously had no broadband providers at all. This model is similar to model displayed in (1), but the data is restricted to only those ZIP codes that were depicted as having no providers in 2004. The signs of independent variables are expected to be the same as the model displayed in (1). However, the rural dummy variable could be either negative or positive. The prevalence of unserved rural ZIP codes (65 percent of ZIP codes in this restricted dataset are rural) suggests that many opportunities exist for them to be served by "small" providers, possibly resulting in a positive coefficient. Perhaps the most interesting component of this more focused model is the inclusion of federal-level policies to increase broadband access in rural and remote areas. These include the Community Connect Grants and Farmbill Broadband Loans, both sponsored by the United States Department of Agriculture. The presence of policy awards in a ZIP code is expected to be positively associated with an increase in small broadband providers.

4. Results

The pooled parameter estimates for the presence of a "small" broadband provider between December 2004 and June 2005 are presented in Table 4 (model 1). Most of the results are intuitive, with parameter estimates having the expected sign and statistical significance. For example, most of the education coefficients are positive. This implies that, relative to the proportion of the population with no high school education, an increase in the proportion of people who have higher levels of education increases the probability of the presence of small broadband providers. Surprisingly, the graduate degree coefficient has a negative sign and is significantly different from zero. This may be due to the fact that highly educated people tend to have high demand for broadband adoption, so areas with high proportion of these individuals have already attracted a large broadband provider (Horrigan, 2006; Strover, 2003). Small broadband providers may try to avoid these markets in order to avoid competing with the larger provider. However, the parameter associated with the presence of a large provider in 2004 is statistically insignificant, perhaps due to a high correlation with other demand proxies such as income and education.

The coefficient of income is positive and significant, which means that areas with higher median incomes are more likely to have a small broadband provider. Additionally, the coefficients of market size, namely the number of households and number of businesses in a ZIP code, are positive and significantly different from zero. Thus, similar to large broadband providers, small broadband providers are more likely to locate in areas with more potential customers.[9]

Surprisingly, but consistent with our descriptive statistics, a high proportion of African-American residents raises the probability of a small broadband provider. This result is interesting, as several results have shown African-American households to lag behind other races in term of Internet connectivity (Mills and Whitacre, 2003; Horrigan, 2006). This seems to imply that small providers feel the African-American popu-

[9] A separate model using population density instead of number of households did not show a statistically significant impact for this variable, similar to findings in Flamm (2006).

Table 4. Model results

Independent Variable	Model 1	Model 2		Model 3
		Urban	Rural	
	Coefficient	Coefficient	Coefficient	Coefficient
High school diploma	0.601** (0.283)	0.005 (0.371)	1.228** (0.584)	2.005*** (0.697)
Some college	1.019*** (0.239)	1.117*** (0.314)	0.004 (0.507)	1.472** (0.705)
College	0.136 (0.352)	-0.146 (0.437)	0.561 (0.779)	0.924 (1.076)
Graduate degree	-0.980** (0.432)	-1.229** (0.522)	0.313 (1.004)	-4.717** (1.861)
Income (log)	0.418*** (0.087)	0.284** (0.113)	0.360* (0.187)	-0.671*** (0.239)
Number of businesses (log)	0.392*** (0.021)	0.067*** (0.026)	-0.310*** (0.044)	-0.174*** (0.059)
Number of households (log)	0.179*** (0.021)	0.496** (0.025)	0.367*** (0.048)	0.848*** (0.074)
African-American	0.498*** (0.104)	0.164 (0.128)	1.005*** (0.220)	-0.134 (0.339)
Hispanic	0.053 (0.144)	-0.508*** (0.177)	1.761*** (0.295)	-1.160** (0.555)
Other race	0.260 (0.173)	0.452* (0.249)	-0.071 (0.352)	-0.282 (0.387)
Age 16 to 29	0.962*** (0.344)	0.297 (0.441)	0.647 (0.751)	-1.154 (1.038)
Age 30 to 64	1.409*** (0.343)	0.998** (0.462)	0.715 (0.716)	2.436*** (0.828)
Age over 65	0.455 (0.313)	0.110 (0.398)	0.721 (0.665)	1.258 (0.817)
Poverty	0.499 (0.311)	0.698 (0.423)	-0.404 (0.648)	-1.133* (0.700)
Work at home	1.117*** (0.344)	1.195** (0.482)	0.207 (0.695)	3.384*** (0.667)
Commute 30 to 45 minutes	0.488*** (0.163)	0.450 (0.229)*	0.057 (0.335)	1.343*** (0.398)
Commute 45 to 59 minutes	0.412 (0.263)	0.610 (0.352)	-0.290 (0.536)	1.387** (0.552)
Commute over 60 minutes	-0.362 (0.235)	-0.441 (0.309)	0.308 (0.481)	0.281 (0.576)
Rural	-0.079*** (0.029)	-	-	0.411*** (0.113)
New England	0.377*** (0.090)	0.336** (0.137)	0.155 (0.189)	-0.687* (0.405)
Middle Atlantic	0.274*** (0.082)	0.249** (0.126)	0.037 (0.175)	-2.143*** (0.311)
East North Central	0.279*** (0.080)	0.212* (0.126)	0.134 (0.168)	-1.295*** (0.252)
West North Central	0.136* (0.081)	-0.003 (0.131)	0.293* (0.169)	0.895*** (0.212)

Table 4. Model results (continued)

Independent Variable	Model 1	Model 2		Model 3
		Urban	Rural	
	Coefficient	Coefficient	Coefficient	Coefficient
South Atlantic	0.223***	0.201	-0.015	-1.338***
	(0.081)	(0.125)	(0.170)	(0.251)
East South Central	-0.327***	-0.446***	0.165	-0.134
	(0.090)	(0.138)	(0.186)	(0.263)
West South Central	-0.166**	-0.137	-0.156	-1.196***
	(0.077)	(0.124)	(0.163)	(0.237)
Pacific	-0.102	-0.246*	0.325*	-0.635**
	(0.084)	(0.130)	(0.175)	(0.291)
2004 Provider	0.042	0.021	0.035	-
	(0.040)	(0.055)	(0.081)	
Grant	-	-	-	0.835
				(0.980)
Broadband loan	-	-	-	-0.261
				(0.352)
Constant	-9.343***	-6.920***	-6.359***	-0.226
	(1.026)	(1.345)	(2.159)	(2.615)
Number of observation	31,607	31,607		3,792
Pseudo R^2	0.1663	0.1701		0.2708

Note: Dependent variable for each model is an increase/no increase in broadband provider over the period December 2004 – June 2005. Robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

lation is a relatively untapped market. On the other hand, there is no evidence to suggest that high proportions of Hispanics and other racial categories affect the existence of a small broadband provider. This result is somewhat counter-intuitive due to recent results suggesting Hispanics are dramatically increasing their broadband connectivity (Horrigan, 2006). It may indicate that small providers have recognized the potential of African-American adopters but not Hispanic adopters. Additionally, areas with a large "working age" population (16 – 64) are more likely to experience an increase in small broadband providers when compared to areas that have a large proportion of population below 16. This implies that people between the ages of 16 and 64 make better potential customers due to their preferred Internet activities when compared to those under 16 (or over 65, which show no statistical impact). Our results also suggest that the relationship between where a person lives and works is important. In particular, areas that have higher a proportion of their population working at home tend to have a higher probability of a small broadband provider – indicating that broadband access is important to these individuals, and that small providers may look for such areas. We also find a positive impact for many "medium-distance" commutes (between 30 to 45 minutes) when compared to the default category of under 30 minutes.

Turning now to the impact of place-based variables, rural status has a significant and negative effect on the increase in small broadband providers. This implies that even after controlling for differences in household and economic characteristics between rural and urban areas, location in rural areas decreases the probability of the existence of a small broadband provider. This result shows that, even in terms of small broadband providers, the "digital divide" between urban and rural areas still exists. Additionally, relative to Mountain region, areas in the New England, Middle Atlantic, East North Central, West North Central, and South Atlantic regions have a higher probability of the presence of a small broadband provider. The East South Central and West South Central regions tend to have lower probabilities of small broadband providers when compared to the Mountain region. These highly significant regional variables indicate that small provider presence varies quite a bit by location, reinforcing the finding of the negative rural coefficient. Finally, as noted previously, the presence of a large provider in 2004 has no statistical impact on the location decision. This is likely due to the minimal amount of variation for this characteristic (87 percent of all ZIP codes listed by the Census had a large provider in 2004) and correlation with other demand-oriented variables such as education, income, and number of households.

To test the different effects of demographic and economic characteristics that may exist between urban and rural areas, a rural interaction term is included for each explanatory variable (as specified in equation 2). These rural parameter coefficients represent a shift on the urban coefficient caused by rural location. Model 2 in Table 4 presents the results of this specification.

The signs and values of most urban coefficients in model 2 coincide with those for the entire population in model 1. There are several significant rural shifts, including the proportion of people with a high school diploma, the proportion of African-American and Hispanic population, median income levels, number of business, number of households, and the West North Central and Pacific regions dummy variables. These shifts indicate that multiple characteristics in rural areas do not have the same impact they would in urban areas. For instance, a rural area with a high percentage of individuals who completed their schooling at the high school level is more likely to attract a small broadband provider than is an urban area with a similar percentage. Similarly, the parameters on African-American and Hispanic population variables are positive shifts from their urban coefficients. This would imply that rural areas with high proportions of African-American and Hispanic residents are more attractive to small broadband providers. These results give validity to the idea that African-American and Hispanic populations are being targeted by small broadband providers – but only in rural areas. As noted previously, adoption among these groups (including those with a high-school level of education) has recently seen dramatic increases (Horrigan, 2006), and small providers seem to be springing up where these populations are located.

Regarding market size, the rural shift for the number of households is positive, indicating an even stronger propensity for having small broadband providers in rural areas that have a high number of households. Surprisingly, the rural parameter on the number of businesses is negative and shifts from a positive urban coefficient – implying that, in rural areas at least, small broadband providers are more driven by potential adopters in households as opposed to businesses. The last significant rural shifts are the dummies for the West North Central and Pacific regions. Their coefficients are positive and shift from negative urban coefficients. Therefore, given other variables, rural areas in the West North Central and Pacific regions tend to be more attractive to small broadband providers.

We are also interested to see what factors attract small providers to ZIP codes previously depicted as having no providers. To do this, we estimate model (1) by using only ZIP codes that were shown as having no broadband providers in the December 2004 FCC data. Figure 5 depicts this information geographically, breaking out all ZIP codes that were shown as having no providers in 2004 into two groups – those that continued to have no providers in the June 2005 report, and those that were actually served by a small provider. We also include two additional variables to model (1) when using this restricted subset – namely, the presence of a USDA broadband grant or loan program. Results from this model show whether or not small broadband providers enter these areas with the same criteria as those locating elsewhere, and whether the USDA programs are impacting their location decision. The final column of Table 4 (model 3) shows these results. The coefficient of the rural dummy variable is statistically significant at the 1% level, and turns from negative in the pooled data (model 1) to positive when the data is restricted (model 3). Thus, rural areas with no access are attractive targets for small providers, even after taking other economic and demographic variables into account. This may be due to some unmeasured attribute of rural areas, such as pride in the local community, or simply the fact that rural areas make up the majority of unserved ZIP codes. Additionally, the patterns observed in model 2 for the impact of market size in rural areas holds true for this subset of data, with a positive coefficient on the number of households but a negative coefficient on the number of businesses. Thus, market size is still an important factor for small broadband providers to enter the market; however, they may only focus on the household market.

Surprisingly, most coefficients of regional dummy variables are negative and statistically significant. This means that ZIP codes in New England, Middle Atlantic, East North Central, South Atlantic, West South Central, and Pacific, which had no providers in 2004, are less attractive to small broadband providers than the Mountain region. This result is opposite the results from models (1) and (2). The reason may be simply that the Mountain region has the fewest broadband providers relative to other regions (Figure 2). This implies that the Mountain region could be the market with the best potential for small broadband providers when compared to other regions.

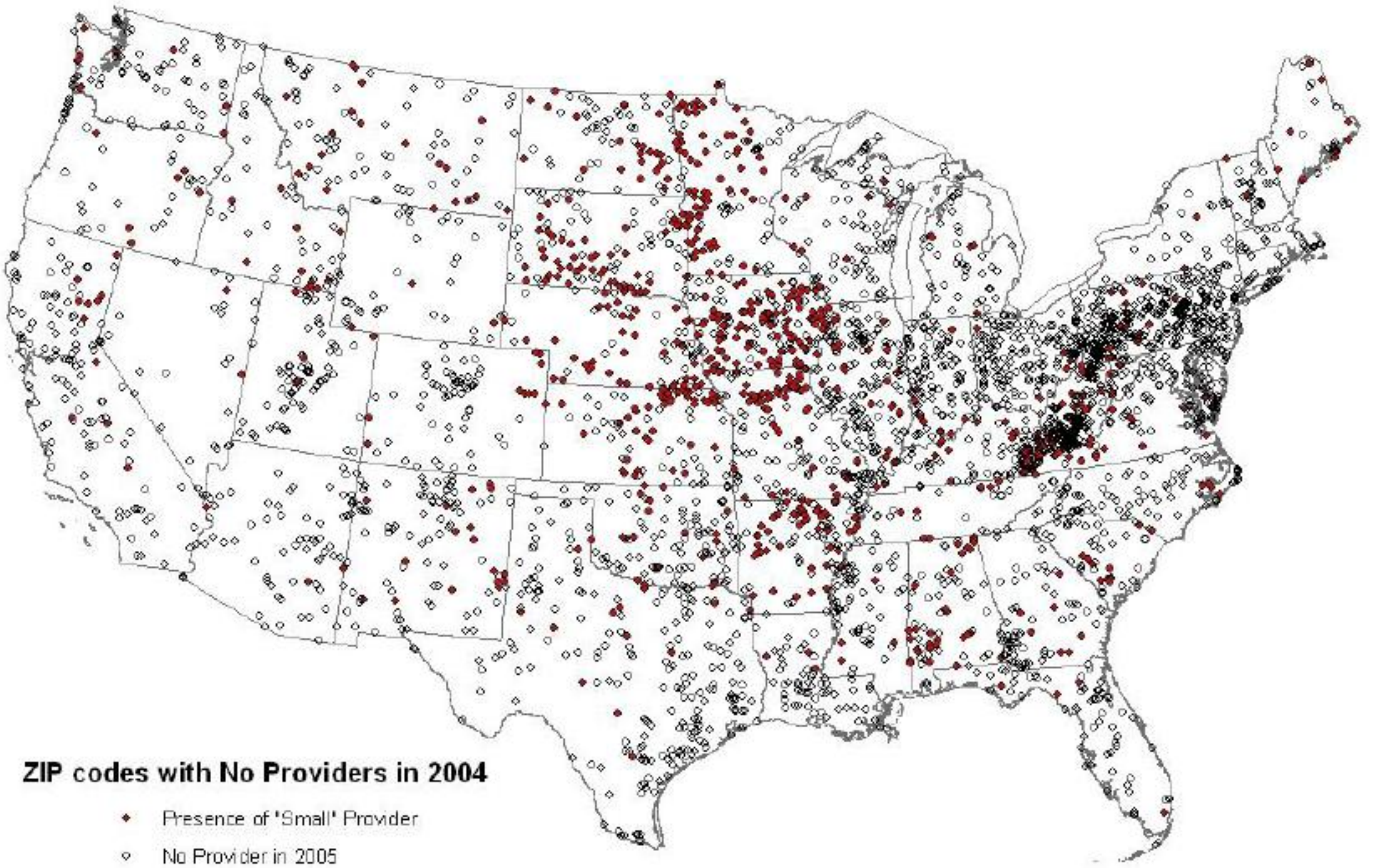

Figure 5. ZIP Codes with no provider in 2004 (source: FCC Form 477 date June 2005).

The final, and potentially most intriguing, group of variables that we include is the presence of the most common broadband grants and loans awarded by the federal government. The USDA awarded around 60 grants and 90 loans to nearly 1,300 communities over the period 2002-2005. However, the coefficients of variables for Community Connect Grants and Farmbill Broadband Loans are not statistically significant. Therefore, we find no statistical evidence that these policies have played a role in attracting small broadband providers to previously unserved areas. We also find that just 64 ZIP codes from the 3,729 ZIP codes that had no broadband providers in 2004 received either a Community Connect Grant or a Farmbill Broadband Loan.[10] Hence, while the main purpose of these policies is to bring broadband access to rural areas, they have not been successful in attracting small providers into areas that previously had no access. This lack of effectiveness of federal programs is also suggested by Feser (2007), who indicates that such top-down policies fail to adequately address the locally-specific situations of most underserved communities.

5. Summary and Conclusion

In this article, we look at descriptive characteristics and develop models that detail the location decision of small broadband providers. The first interesting finding is that small broadband providers are predominantly located in urban areas, with only 1/3 of all small providers choosing rural locations. Thus, if small providers are seeking unserved markets, they are not all located in rural areas – instead they may be finding small patches of unconnected areas in relatively urban locations (suburbs or bedroom communities, for example). The empirical results show that, to some extent, the determining factors are very similar for both large and small providers. In particular, areas

[10] Only 6 of the 59 ZIP codes that obtained Community Connect grants (and only 58 of 1,276 ZIP codes with Broadband loans) had no broadband providers in 2004 according to the FCC Form 477 data.

with high median incomes, number of households, and number of businesses tend to have a high probability of being served by a small provider – similar to results documented in the existing literature for *all* broadband providers. However, not all variables fall into this pattern. For instance, while high proportions of some education levels (high school and some college) increase the likelihood of a small provider, others (such as graduate degrees) actually decrease it. Additionally, small broadband providers are attracted to areas with a high proportion of African-American residents. These unexpected signs may indicate that small providers are entering previously untapped markets. We also find that small providers are more likely to cluster in various geographic regions, including the relatively more populated East Coast – but also in relatively sparsely populated regions such as the West North Central. Further, we can document the existence of a "digital divide" between rural and urban areas specifically in terms of small broadband providers. In general, the small provider market seems to be behaving exactly as a neoclassical economist might hypothesize – by initially catering to areas with high demand (including urban areas with dense populations and higher incomes) and those with untapped potential. As these areas become saturated with broadband availability, the industry would then move into markets with less demand potential, such as those in rural areas.

The results also show that the impacts of race and the number of businesses vary between rural and urban areas. In terms of race, small broadband providers tend to focus more heavily on rural areas with high proportions of African-American and Hispanic residents than they do on urban ones. Moreover, small broadband providers still consider market size in rural areas, but are more interested in the number of households (positive impact) than businesses (negative impact).

When our focus turns to ZIP codes previously depicted as having no providers, the coefficient of the rural dummy variable turns from negative (in pooled data) to positive and significant. Small providers seem to prefer locating in rural areas in this scenario, even after other economic and demographic variables are controlled. While it would be tempting to think that federal broadband grants and loans were responsible for attracting providers to these rural areas, our analysis does not suggest that they do. We also find that small providers seem to target only the household market when dealing with ZIP codes that previously had no providers. Additionally, regional variables are highly significant in this model, with the Mountain and West North Central regions more likely to attract small providers. These results imply that local governments without any type of access may want to find ways to support small providers (possibly through tax incentives or public / private partnerships) since they are reaching out to previously unserved areas.

The fact that we do not find any statistical significance for the USDA Community Connect Grants and Farmbill Broadband Loans is interesting. Only 64 of the 3,729 unserved ZIP codes were awarded these programs. This result seems to imply that these policies may focus on the wrong areas and/or wrong providers. This is consistent with an audit of the program performed in 2005 (USDA OIG, 2005). However, it is important to note that ZIP codes can be relatively large geographic units and that a provider serving one part of a ZIP code does not necessarily serve all of it (Wallsten, 2005; Flamm, 2006). Many of the USDA grants and loans are undoubtedly going to unserved portions of ZIP codes that have broadband access somewhere else in their vicinity. This once again points to the problematic nature of using a relatively broad geographic classification (ZIP codes) for the FCC form 477 data (also noted by GAO, 2006; Lehr et al, 2006; and Flamm, 2006).

Ultimately, small broadband providers are a part of the overall access picture, and seem to be reaching previously unserved demographics – although the characteristics attracting them differ to some degree between rural and urban areas. If the ultimate goal is to provide universal broadband access, future research should focus on the diffusion of such access in the market (including small providers) and the role of public policies in this diffusion. While national-level studies are limited by the data issues discussed above, smaller scale studies at the state or even community level (such as Grubesic, 2003) may provide a more realistic look at the dispersion of broadband access.

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