“Small” Broadband Providers: Where and Why?

Phumsith Mahasuweerachai

Graduate Research Assistant

phumsit@okstate.edu

Brian E. Whitacre

Assistant Professor & Extension Economist

brian.whitacre@okstate.edu

Department of Agricultural Economics

Oklahoma State University

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29 – August 1, 2007.

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 also have the potential to enhance voice communication (Horrigan and Rainie 2002; Prieger 2003). Broadband access has the potential to benefit businesses, governments, consumers, and communities by contributing to productivity and efficiency increases. For the private sector, broadband access provides the opportunity to take advantage of new input and output markets, allowing firms to increase their productivity by improving information exchange, value chain transportation, and process efficiency (Thomas 2005). Broadband access could also improve the efficiency of public sector services such as education, health, and local government services by increasing the availability of data and speeding feedback to and from their constituents (Bauer et al. 2002). Moreover, broadband access could enhance the quality of life of consumers through economic, social and cultural development.

For rural and remote areas, broadband access is particularly important. 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). However, as with every technological revolution, some people and areas have lagged behind. The "digital divide", or the gap in Internet access between urban and rural areas, has received

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

a large amount of attention from researchers, politicians, and policy makers (Strover 2001; Mill and Whitacre 2003).[2] Research on the determinants of broadband access 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 population density and potential demand. Therefore, urban areas, with higher education, income, and population density were the first to receive broadband infrastructure.

Anecdotal evidence suggests that small-scale providers may be servicing the broadband needs of some rural communities. 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

[2] This paper uses the 2000 U.S. Census designations of non-metropolitan and metropolitan countries to compare rural-urban area differences in residential Internet access. Metropolitan counties generally have population greater than 100,000 or a town or city of at least 50,000 and are referred to as urban areas. Non-metropolitan counties are those counties not classified as metropolitan and are referred to as rural areas.

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).

The availability of this data allows for some insight into those broadband infrastructure providers who service a smaller number of subscribers. Meshing this data with secondary demographic information allows for identification of factors impacting the location decisions of these "small" broadband providers. This paper augments the existing knowledge base on broadband infrastructure by 1) describing the location of these small broadband providers, including Geographic Information System (GIS) mapping techniques and demographic comparisons of communities with and without small providers; and (2) 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 policies (USDA broadband grants and loans) play in attracting small broadband providers to these previously unconnected rural areas. These results will be 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 et al. 2006). A solid understanding of these factors is of interest to policy makers seeking to reduce the infrastructure gap between rural and urban areas, as well as to rural areas attempting to bring broadband providers to their community.

The paper is organized as follows. Section 2 describes 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.

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.[3] In particular, 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 data. Thus, comparing of the number of providers between December 2004 and June 2005 provides limited information for these ZIP codes. However, the majority of the ZIP codes (66 percent) 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

[3] Other drawbacks of the FCC data include the fact that a single subscriber in a ZIP code implies that the entire ZIP code has broadband access. This drawback has been noted by several sources (GAO 2006, Flamm 2006, Lehr et al. 2006).

2005, 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).[4]

This data on infrastructure availability can be combined with demographic data from the U.S. Census Bureau. This Census data - also reported by ZIP codes - can be used to describe household characteristics that might affect the availability of broadband providers.[5] Table 2 displays descriptive statistics for rural and urban areas that either have no broadband provider or have at least one broadband provider. On average, rural and urban areas that have at least one broadband provider have significantly higher levels of intuitive variables – including the number of households and businesses, and levels of education and income – than those areas that have no broadband provider. Table 2 also indicates that rural areas with at least one broadband provider are slightly less racially diverse when compared to those areas that have no broadband providers, however; for urban areas, those with at least one broadband provider are much more racially diverse than those without any broadband providers. Rural and urban areas that have at least one broadband provider also have a higher percentage of younger residents (under 65 years old) than those areas that have no broadband providers.

Interestingly, only urban areas with broadband providers have higher levels of population density than their unconnected counterparts. This pattern is reversed for rural areas, as those ZIP codes without any provider actually have more densely populated areas than those with providers. This is unexpected, as the factors affecting the decision

[4] The FCC's use of ZIP codes as the geographic unit of analysis requires that we measure rurality via Rural-Urban Commuting Area (RUCA) codes as defined by the USDA/ERS.
[5] 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 in the analysis, so we dropped these ZIP codes from our analysis. 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.

to invest in infrastructure should be the same for providers regardless of location – namely, how many potential customers can be reached in a given area. However, it does give some credence to the idea that small broadband providers take other non-economic factors into consideration when making the investment decision. This issue is further explored in our econometric model.

Having observed the location characteristics of any broadband providers, we turn now to the characteristics of small broadband providers. GIS mapping techniques allows 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 when only rural ZIP codes are observed (figure 3). Interestingly, highly rural regions such as the mountain or west south central have very few small broadband providers.

Demographic data from the U.S. Census Bureau provides additional information regarding where small broadband providers locate. Table 3 displays descriptive statistics of rural and urban ZIP codes that either saw an increase or did not see an increase in the number of broadband providers between December 2004 and June 2005.[6] Several patterns emerge when table 3 is viewed in conjunction with table 2. In particular, 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 – similar to rural and urban ZIP

[6] 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.

codes with at least one provider (table 2). Also, rural and urban ZIP codes with small broadband providers have slightly younger populations (under 65 years old) than those ZIP codes that have no small broadband providers. The percentage of the population between 17 and 29 is particularly higher. However, in the case of race and ethnicity, both rural and urban ZIP codes that have been served by small broadband providers are much more racially diverse than those that have no small broadband providers. This differs from the case for any type of broadband providers (table 2), where rural areas with any provider were actually less diverse than those without any provider.

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 rural 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.

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 effect that each variable has on the probability of attracting a small broadband provider.

Methodology

Econometric Model

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

$$(1) \qquad y_i^* = \mathbf{X}_i\boldsymbol{\beta} + \mathbf{Z}_i\boldsymbol{\delta} + \mathbf{H}_i\boldsymbol{\gamma} + \mathbf{N}_i\boldsymbol{\tau} + \mathbf{R}_i\boldsymbol{\eta} + D_j\alpha_j + \varepsilon_i$$

$$y_i = 1 \text{ if } y_i^* \geq 0$$
$$y_i = 0 \text{ if } y_i^* < 0$$

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, $\mathbf{X}_i$ is a vector of household income levels, $\mathbf{Z}_i$ is a vector of residents' education levels, $\mathbf{H}_i$ is a vector of other demographic characteristics, $\mathbf{N}_i$ is a vector relating to market size, $\mathbf{R}_i$ is a dummy variable indicating when a ZIP code is rural in nature; $\boldsymbol{\beta}, \boldsymbol{\delta}, \boldsymbol{\gamma}, \boldsymbol{\tau},$ and $\boldsymbol{\eta}$ 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 α_j. These regions are depicted in figure 4.[7]

[7] The nine regions are New England (NE), Middle Atlantic (MA), East North Central (ENC), West North Central (WNC), South Atlantic (SA), East South Central (ESC), West South Central (WSC), Pacific (PF), and Mountain (MT). The default category for our model is the Mountain region. Note that variables for broadband loans and grants are not included in this model, but will be in a later version.

Because y_i^* takes on one of two explicit values (one if a 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).

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 the whether or not a small broadband provider serves the area. In particular, some racial and ethnic groups (such as Hispanics and Blacks) have been slower to adopt broadband than others; however, adoption among these groups has recently seen dramatic increases (Horrigan 2006). Small providers may have targeted 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 familiar with broadband technologies by interacting with them at school, and therefore may be more comfortable adopting them at home and / or work. Thus, ZIP codes with a large percentage of young residents may attract broadband providers, including smaller ones. 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 ZIP codes in this area in figure 4. 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

$$(2)\quad y_i^* = \mathbf{X}_i(\beta_U + \beta_R) + \mathbf{Z}_i(\delta_U + \delta_R) + \mathbf{H}_i(\gamma_U + \gamma_R) + \mathbf{N}_i(\tau_U + \tau_R) + D_j(\alpha_U + \alpha_R) + \varepsilon_i$$

where y_i^*, $\mathbf{X}_i$, $\mathbf{Z}_i$, $\mathbf{H}_i$, $\mathbf{N}_i$, 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 (1), but the data is restricted to only those ZIP codes that were depicted as having no providers in 2004. Most of ZIP codes are rural (65 percent). 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 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.

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. However, 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 "regular" broadband providers (Horrigan 2006; Strover 2003). Small broadband providers may try to avoid these markets in order to avoid competing with the larger provider.

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.[8]

Surprisingly, a high proportion of Black residents raises the presence of a small broadband provider. This result is interesting, as several results have shown Black households to lag behind other races in term of Internet connectivity (Mills and Whitacare 2003; Horrigan 2006). This seems to imply that small providers feel the Black population 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

[8] 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).

(Horrigan 2006). 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 may imply that people between the ages of 16 and 64 make better potential customers due to their income and preferred 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 – implying 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 “median-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 increase in small broadband providers. This implies that even after controlling for differences in household characteristics 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 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 probability of increase in small broadband providers when compared to the Mountain region. These highly significant regional variables indicate that small provider presence is quite spatial in nature, reinforcing the finding of the negative rural coefficient.

Further, 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 (model 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.

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 Black 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 Black and Hispanic population variables are positive shifts from their urban coefficients. This would imply that rural areas with high proportions of Black and Hispanic residents may be more attractive to small broadband providers. These results give validity to the idea that Black 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 provider for rural areas that have high number of household. 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 whether small providers exist in 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 an additional variable to model (1) when using this restricted subset – namely, the presence of a USDA broadband grant or loan program. Results from this model will 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 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 their local community. Additionally, the patterns observed in model 2 on 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 to 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 that, according to GIS mapping (figure 5), the Mountain region has the fewest broadband providers relative to other regions. This may imply that the Mountain region is considered as the market with the best potential for small broadband providers when compared to other regions.

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, statistically, we do not find 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.[9] 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.

Summary and Conclusion

This article looks at descriptive characteristics and develops 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, the areas with high median incomes, number of households, and number of businesses tend to have 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

[9] Only 6 of the 59 ZIP codes that obtained Community Connect grants (and only 55 of 1,276 ZIP codes with Broadband loans) had broadband providers in 2004 according to the FCC Form 477 data.

are attracted to areas with a high proportion of Black 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 sparely 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.

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 not only on rural areas with a high proportion of Black residents but also areas with a high proportion of Hispanic residents. Moreover, small broadband providers still consider market size, 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 government 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 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 appear to differ 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.

References

Bauer, J. M., G. Ping, K. Junghyun, M. A. Thomas, and W. S. Steven. 2002. "Broadband: Benefits and Policy Challenges." Working paper, The James H. and Mary B. Quello Center for Telecommunication Management and Law, Michigan State University.

Federal Communications Commission. 2007. *Local Telephone Competition and Broadband Deployment Data*. Available at www.fcc.gov/wcb/iatd/comp.html, accessed 7 January 2007.

Federal Communications Commission-Industry Analysis and Technology Division. 2006. *High-Speed Services for Internet Access: Status as of June 30, 2005*. Washington DC, April.

Flamm, K. 2006. "Diagnosing the Disconnected: Where and Why is Broadband Access Unavailable in the U.S.?" Paper presented at the Telecommunications Policy Research Conference, Fairfax VA, 30 September.

Government Accountability Office (GAO). 2006. "FCC Needs to Improve Its Ability to Monitor and Determine the Extent of Competition in Dedicated Access Service." Report GAO-07-80, November.

Greene, W.H. 2003. *Econometric Analysis*, 5th. ed. New Jersey: Prentice Hall.

Grubesic, T. 2003. "Inequities in the Broadband Revolution." *The Annals of Regional Science*. 37:2, 263-289.

Horrigan, J.B. 2006. "Home Broadband Adoption 2006." The PEW Internet and American Life Project. Available at www.pewinternet.org, accessed 5 February 2007.

Horrigan, J.B., and L. Rainie. 2002. "The Broadband Difference: How Online Americans' Behavior Changes with High-Speed Internet Connections at Home." The PEW Internet and American Life Project. Available at www.pewinternet.org, accessed 5 February 2007.

Lehr, W. H., C. A. Osorio, S. E. Gillett, and M. A. Sirbu. 2006. "Measuring Broadband's Economic Impact." Paper presented at 33rd Research Conference on Communication, Information, and Internet Policy (TPRC), Arlington VA, 23-25 September.

Lindroos P., and M. Pinkhosov. 2003. "Broadband Driving Growth: Policy Responses." Unpublished, Organization for Economic Co-operation and Development.

Malecki, E.J. 2003. "Digital Development in Rural Areas: Potentials and Pitfalls." *Journal of Rural Studies* 19: 201-214.

Mills, B.F. and B.E. Whitacre. 2003 "Understanding the Nonmetropolitan - Metropolitan Digital Divide." *Growth and Change* 34(2): 219-243.

Prieger, J.E. 2003. "The Supply Side of the Digital Divide: Is There Equal Availability in the Broadband Internet Access Market?" *Economic Inquiry* 41(2): 346-363.

Strover, S. 2001. "Rural Internet Connectivity." *Telecommunications Policy* 25: 331-347.

Strover, S. 2003. "The prospects for broadband deployment in rural America." *Government Information Quarterly* 20: 95-106.

Thomas, A. 2005. "Broadband: A Key Development Strategy." Unpublished, Communications for the Public Interest.

Wallsten, S. 2005. "Broadband Penetration: An Empirical Analysis of State and Federal Policies." Working Paper, AEI-Brookings Joint Center for Regulatory Studies.

Whitacre, B.E. and B.F. Mills. 2005. "The Role of Infrastructure in the Rural-Urban Divide." Paper presented at AAEA annual meeting, Providence RI, 24-27 July.

United States Census Bureau. 2007. *Census 2000 Summary File 3 (SF 3)*. Available at http://factfinder.census.gov/home/staff/main.html., accessed 10 January 2007.

United States Department of Agriculture, Office of Inspector General. 2005. *Audit Report: Rural Utilities Service Broadband Grant and Loan Programs*. Audit Report 09601-4-Te. September.

Table 1. Overview of Zip Codes with Provider Increase, December 2004-June 2005

Area	Total Zip Codes	Number with Increased Providers Between December 2004 and June 2005	Percent of Total with Increase
Rural	15,036	4,285	34.05%
Urban	16,571	8,299	65.95%
Total	31,607	12,584	

Source: FCC Form 477 dated June 2005; RUCA codes - Economic Research Service

Table 2. Rural and Urban Communities with and without Broadband Providers, June 2005

	Urban		Rural	
Variable	No provider	At least one provider	No provider	At least one provider
Number of Households	841	3,731	162	1,070
Population Density	1,423	1,739	396	138
Number of Business	103	322	13	67
Education				
No HS	0.223	0.201	0.267	0.228
HS Diploma	0.350	0.315	0.376	0.374
Some College	0.242	0.278	0.240	0.266
College Degree	0.097	0.133	0.074	0.091
Graduate Degree	0.054	0.072	0.038	0.041
Income				
Median income	38,571	44,563	31,476	35,024
Percentage below poverty	0.119	0.113	0.169	0.133
Percentage working at home	0.038	0.039	0.054	0.059
Percentage unemployed	0.069	0.065	0.076	0.062
Race / Ethnicity				
Percentage Black	0.061	0.096	0.051	0.049
Percentage Hispanic	0.063	0.083	0.052	0.040
Percentage Other Race	0.041	0.050	0.057	0.041
Age				
Percentage 16 and under	0.215	0.237	0.228	0.239
Percentage 17 - 29	0.153	0.165	0.147	0.145
Percentage 30 - 64	0.447	0.465	0.460	0.464
Percentage 65 and over	0.151	0.132	0.160	0.151
Number of ZIP Codes	1,445	15,126	2,034	13,002

Source: Census 2000; U.S. Census Bureau and FCC Form 477 dated June 2005

Table 3. Demographic Table of ZIP Codes that Saw an Increase in Provider, 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 Business	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				
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 Black	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
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

Table 4. Model Results

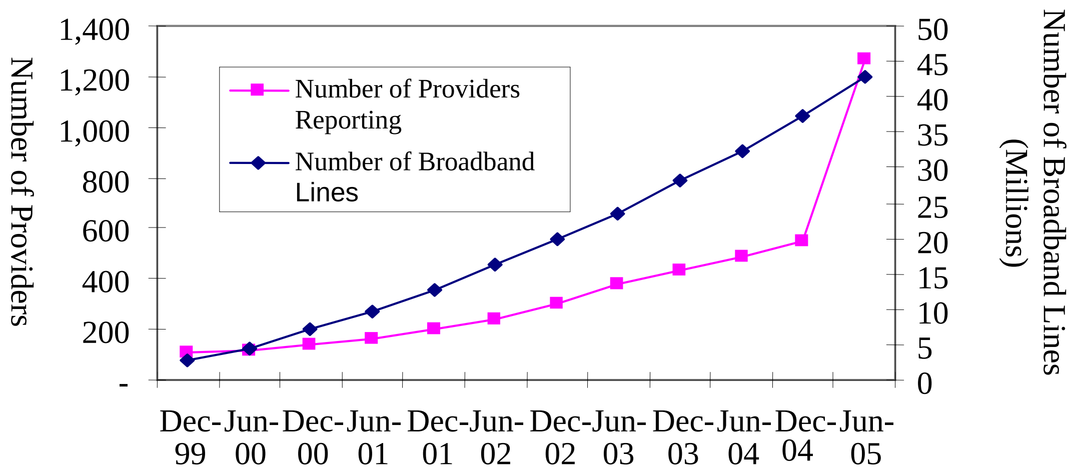
Independent Variable	Model 1	Model 2		Model 3
		Urban	Rural	
	Coefficient	Coefficient	Coefficient	Coefficient
High school diploma	0.594**	0.002	1.222**	2.005***
	(0.280)	(0.396)	(0.569)	(0.763)
Some college	1.017***	1.115***	0.004	1.472**
	(0.239)	(0.325)	(0.496)	(0.729)
College	0.129	-0.149	0.553	0.924
	(0.360)	(0.462)	(0.772)	(0.987)
Graduate degree	-0.979**	-1.228**	0.314	-4.717***
	(0.445)	(0.551)	(1.011)	(1.893)
Income (log)	0.419***	0.284**	0.362*	-0.671***
	(0.089)	(0.118)	(0.188)	(0.227)
Number of business (log)	0.392***	0.496***	-0.310***	-0.174***
	(0.021)	(0.027)	(0.045)	(0.053)
Number of household (log)	0.179***	0.067**	0.367***	0.848***
	(0.022)	(0.027)	(0.048)	(0.067)
Black	0.500***	0.165	1.009***	-0.134
	(0.103)	(0.128)	(0.224)	(0.305)
Hispanic	0.052	-0.509***	1.762***	-1.160*
	(0.138)	(0.174)	(0.291)	(0.606)
Other race	0.259	0.451*	-0.071	-0.282
	(0.165)	(0.242)	(0.339)	(0.335)
Age 16 to 29	0.962***	0.297	0.646	-1.154
	(0.348)	(0.449)	(0.760)	(1.149)
Age 30 to 64	1.407***	0.997**	0.716	2.436***
	(0.351)	(0.481)	(0.724)	(0.891)
Age over 65	0.456	0.110	0.725	1.258*
	(0.320)	(0.416)	(0.667)	(0.756)
Poverty	0.497	0.695	-0.400	-1.133*
	(0.313)	(0.445)	(0.667)	(0.622)
Work at home	1.118***	1.196**	0.208	3.384***
	(0.336)	(0.534)	(0.699)	(0.683)
Commute 30 to 45 minutes	0.488***	0.450*	0.059	1.343***
	(0.166)	(0.238)	(0.337)	(0.349)
Commute 45 to 59 minutes	0.410	0.609	-0.292	1.387***
	(0.275)	(0.382)	(0.557)	(0.533)
Commute over 60 minutes	-0.360	-0.441	0.310	0.281
	(0.242)	(0.327)	(0.494)	(0.632)

Table 4. Continued

Independent Variable	Model 1	Model 2		Model 3
		Urban	Rural	
	Coefficient	Coefficient	Coefficient	Coefficient
Rural	-0.079*** (0.030)	-	-	0.411*** (0.119)
New England	0.383*** (0.091)	0.339** (0.137)	0.159 (0.189)	-0.687** (0.293)
Middle Atlantic	0.277*** (0.083)	0.250** (0.126)	0.038 (0.174)	-2.143*** (0.286)
East North Central	0.282*** (0.080)	0.213* (0.125)	0.137 (0.167)	-1.295*** (0.301)
West North Central	0.138* (0.081)	-0.003 (0.131)	0.295* (0.169)	0.895*** (0.255)
South Atlantic	0.226*** (0.080)	0.203 (0.125)	-0.014 (0.168)	-1.338*** (0.328)
East South Central	-0.325*** (0.089)	-0.445*** (0.139)	0.166 (0.184)	-0.134 (0.266)
West South Central	-0.164** (0.078)	-0.137 (0.124)	-0.155 (0.164)	-1.196*** (0.259)
Pacific	-0.098 (0.085)	-0.244* (0.130)	0.327* (0.177)	-0.635* (0.336)
Grant	-	-	-	0.835 (1.104)
Broadband loan	-	-	-	-0.261 (0.384)
Constant	-9.319*** (1.038)	-6.906*** (1.394)	-6.349*** (2.164)	-0.226 (2.335)
Number of observation	31,607	31,607		3,792
Pseudo R^2	0.1663	0.1700		0.2708

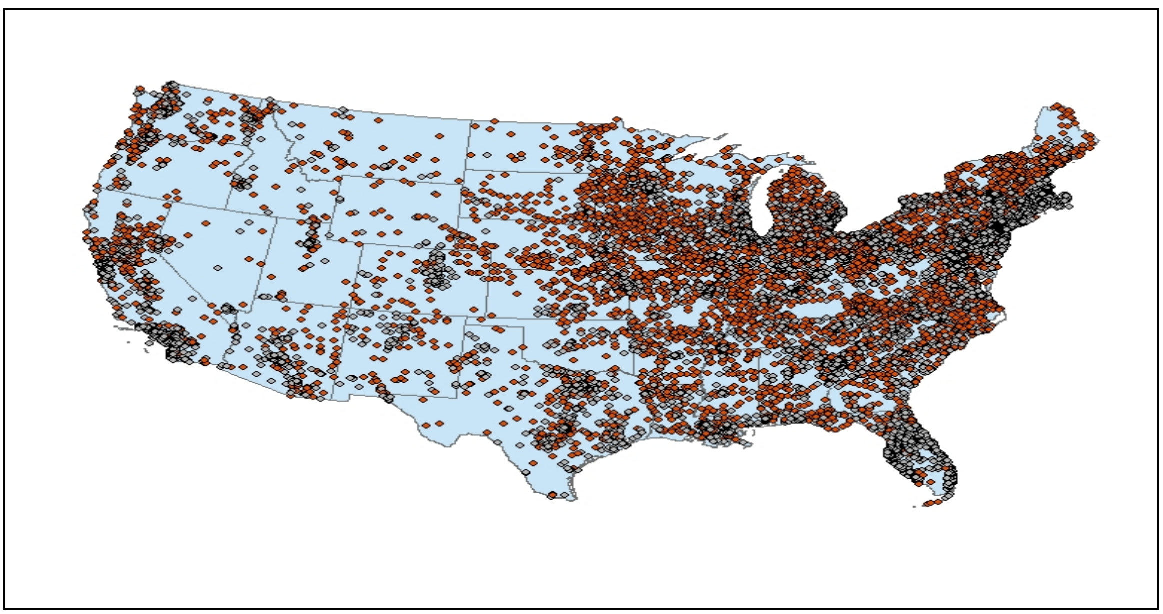
Note: Dependent variable for each model is an increase/not increase in small broadband providers. Standard errors are in parentheses. Three (***), two (**), and one (*) asterisks indicate significance at 1%, 5%, and 10% level, respectively.

Figure 1. Number of Broadband Providers Reporting and Broadband Lines in the U.S., December 1999 – June 2005



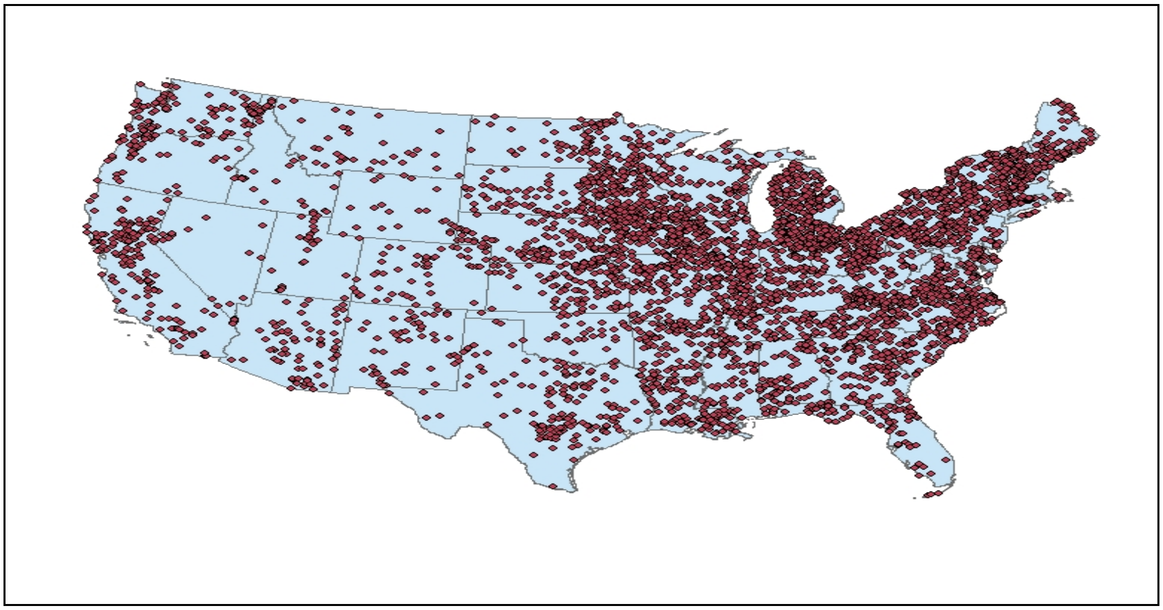
Source: FCC Form 477 dated June 2005

Figure 2. Availability of Small Broadband Providers



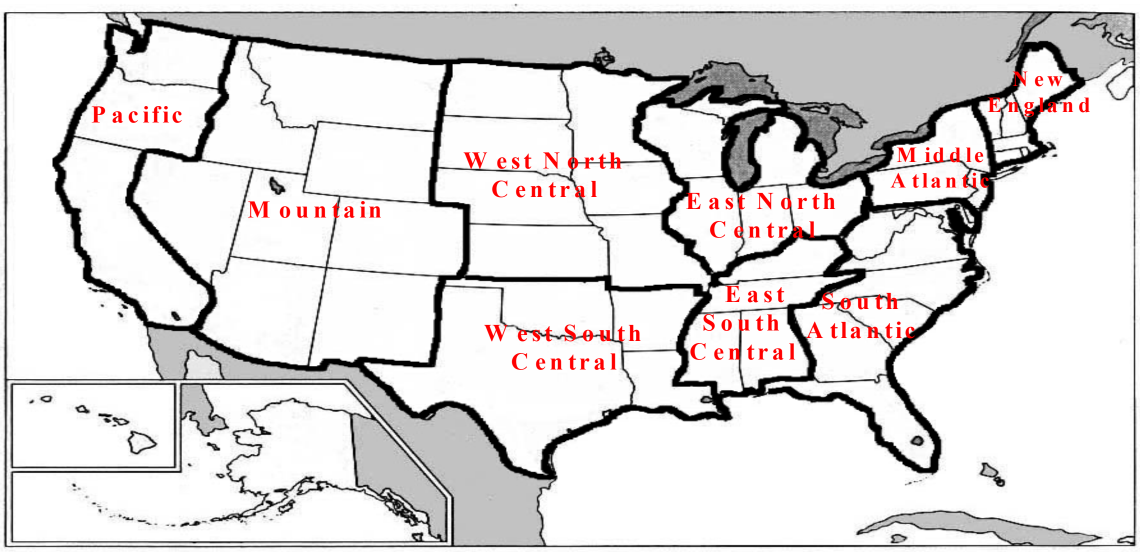
Source: FCC Form 477 dated June 2005

Figure 3. Availability of Small Broadband Providers in Rural Area



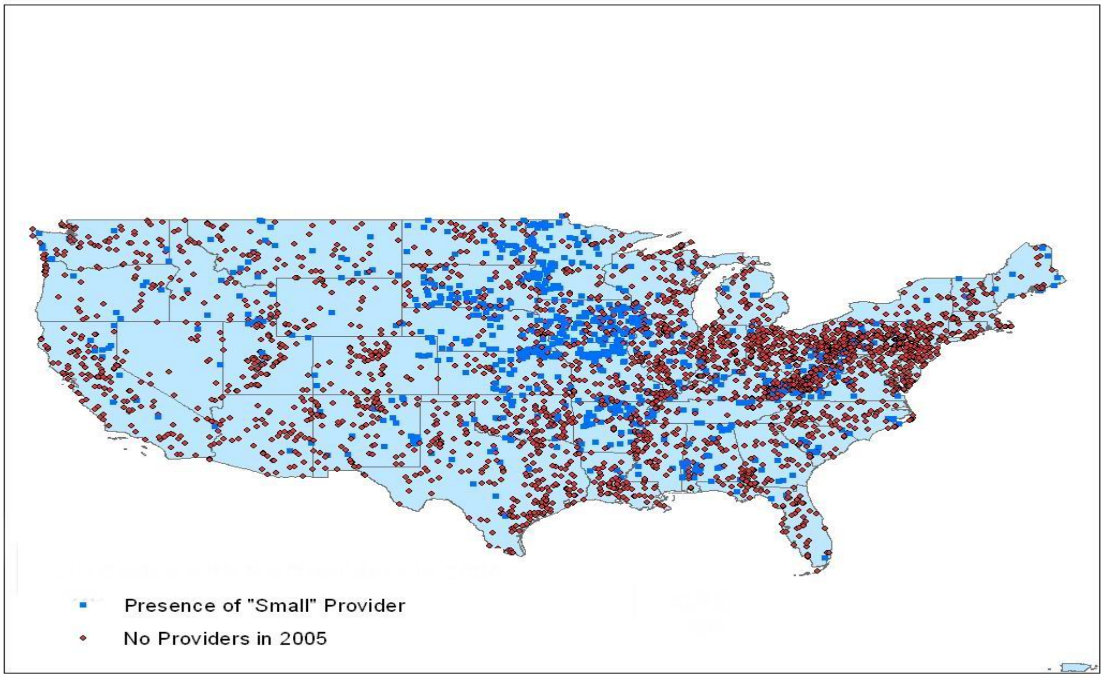
Source: FCC Form 477 dated June 2005

Figure 4. Nine Regions of the U.S.



Source: Whitacre and Mills 2005.

Figure 5. ZIP Codes with no Provider in 2004



Source: FCC Form 477 dated June 2005