A Need for Speed? Rural Internet Connectivity and the No access / Dial-up / High-speed Decision

Brian E. Whitacre
Visiting Assistant Professor
bwhitacr@vt.edu

Bradford F. Mills
Associate Professor
bfmills@vt.edu

Department of Agricultural and Applied Economics
Virginia Polytechnic Institute and State University

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23 – 26, 2006.

Introduction

The rise of residential Internet access during the late 1990s and early 2000s has been well-documented (e.g. NTIA, 2002; Horrigan, 2005), but persistent geographical disparities in access remains a source of concern for rural communities. Several studies have indicated that this "digital divide" could exacerbate existing inequalities in rural and urban household economic well-being (Drabenstott, 2001; Forestier, 2002). This concern is heightened by the recent shift to high-speed access, which has come to dominate the rural – urban digital divide (Figure 1).[1] In 2000, rural households lagged their urban counterparts in terms of general residential Internet access by 14 percentage points, and the majority of the gap (11 of the 14 percentage points) was due to lower rates of dial-up access. By 2003, rural America still lagged behind urban areas in terms of general access by around 13 percentage points, but dial-up access rates were approximately *equal* to those in urban areas. Residential rates of high-speed access were, on the other hand, 14 percentage points lower in rural areas in 2003. Hence, in a brief four year span, the rural – urban digital divide rapidly transformed into a divide in high-speed access.

The Internet adoption decision has been linked to a number of factors, including household characteristics, place-based characteristics, and the availability of infrastructure. Individual characteristics such as education and income levels, age, race, marital status, and the presence of children have all been associated with the likelihood of Internet adoption (McConnaughy and Lader 1998; Rose, 2003; Cooper and Kimmelman

[1] High-speed access, also called Broadband or advanced service, is defined as 200 Kilobits per second (Kbps) (or 200,000 bits per second) of data throughput. This is about 4 times faster than most dial-up access, which is typically provided at 56 Kbps.

1999). The importance of place in the adoption decision has also been documented in studies detailing the diffusion of information from centralized areas to outlying regions (Townsend, 2003). Additionally, given the fact that many on-line communities consist of local users (Horrigan, 2001), the value of the Internet to a household in a particular region may increase as the share of other connected households in the region increases. This notion of a "network externality" is another important aspect of place (Graham and Aurigi, 1997). The presence of infrastructure has also been linked to the Internet adoption decision, with the availability of digital communication technology (DCT) infrastructure typically viewed as a necessary condition for high-speed access (Grubesic and Murray, 2004).

Identifying the roles of people, place, and infrastructure in the current rural – urban digital divide requires a deeper understanding of the interrelated dial-up and high-speed household Internet access decisions. However, research to date has primarily focused on the determinants of the *general* access gap (e.g. Mills and Whitacre, 2003; Malecki, 2003), and ignores the more complex choice faced by the household with the emerging option for high-speed access that offers users quicker download times and other benefits. This paper augments the existing knowledge base on the digital divide by (1) estimating a nested multinomial logit model of the no-access, dial-up, high-speed residential Internet choice and (2) using the results to decompose the dial-up and high-speed divides into underlying rural – urban differences in people, place, and infrastructure.

Data and Descriptive Statistics

The paper employs several sources of empirical data. Household characteristics and local rates of access (which serve as a proxy for network externalities) are obtained from Current Population Survey Supplemental Questionnaires on Household Computer and Internet Use. These nationally representative surveys of roughly 50,000 households collect basic household member demographic and employment information on a monthly basis, while the supplement focuses specifically on residential computer and Internet use for a single month in 2000, 2001, and 2003. Residential Internet access is defined by a positive response to the question, "Does anyone in the household connect to the Internet from home?" Additionally, the survey identifies whether the household connects via a dial-up modem or a higher-speed connection.[2] The primary drawback of this data is that the lowest level of geographic information available on a household is rural or urban status within a state. Hence, "local" rates of access cannot be calculated at the zip code or even county level. Rather, they are average access rates for all rural (urban) households in the state.

Table 1 displays descriptive statistics for households with different modes of Internet access. Several patterns persist across all years in the study. If high-speed access, dial-up access, and no access is viewed as a continuum of intensity of access, then households with higher levels of Internet access have, on average, higher levels of education and income. Furthermore, households with some type of Internet access are less likely to have Black or Hispanic household heads, and are more likely to be headed by a single

[2] The 2000 CPS questionnaire only differentiates between dial-up and higher speed connections. The 2001 and 2003 questionnaires include categories for DSL, cable, satellite, and wireless (all of which are considered high-speed for the purposes of this paper).

individual. Households with higher levels of Internet access are also more likely to be headed by a male, and typically have younger household heads. Intensity of residential access is also positively associated with the frequency of Internet access at work (netatwork).

Measures of DCT infrastructure are constructed from two separate data sources.[3] Information on county-level cable Internet capacity is documented in the *Television and Cable Factbooks* for 2000, 2001, and 2003. These factbooks list every cable TV system in the U.S. (approximately 9,700 in 2003), the counties they serve, and whether or not they provide high-speed Internet. The Tariff #4 dataset available from the National Exchange Carriers Association (NECA) provides similar information on the city served and the DSL capability of every central office switch in the U.S (approximately 38,000 in 2003). This data is also available for 2000, 2001, and 2003. A DCT infrastructure index is then created for every county (or city) by weighting the capability of various technologies in that county (or city) by the population level.[4] In order to mesh this index with household data from the CPS, it is further aggregated within each state as the percentage of the population living in rural and in urban areas that have DCT infrastructure (either DSL or cable) available to them, or DCT infrastructure capacity. A national summary of the share of the rural and urban populations with DSL and cable Internet capacity in their counties for the period 2000 to 2003 is presented in Table 2. The results highlight the dramatic increases in the percentage of both rural and urban

[3] Because cable Internet and Digital Subscriber Link (DSL) have accounted for over 99 percent of the high-speed market every year from 1998 to 2003 (FCC, 2003), only data on these two types of high-speed connections are used. Satellite and wireless connections account for the other 1 percent (FCC, 2003).
[4] Data on city / county population levels is taken from the 2000 census, provided by the Bureau of Labor Statistics.

populations with cable and DSL high-speed infrastructure capacity. But on aggregate, rural areas still lag behind urban areas in both cable and DSL infrastructure.

Methodology

The household decision process for Internet access has three exclusive outcomes, indexed by $j \in$ J = {0,1,2): no Internet access (j = 0), dial-up access (j = 1), and high-speed access (j = 2). Assume that the utility (which cannot be observed) that household i derives from alternative j (denoted U_{ij}) can be written as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where V_{ij} can be modeled and ε_{ij} is an error term.[5] The probability that household i selects outcome j from outcome set J is then

$$\mathrm{Pr}_{ij} = P(j \mid J) = \mathrm{Pr}(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}) \qquad \forall k \in J, j \neq k \tag{2}$$

The non-stochastic portion of the utility (V_{ij}) is dependent on both characteristics of the household (X_i) and characteristics of the alternative (Z_{ij}).[6] Hence we can re-write V_{ij} as:

$$V_{ij} = \beta_j ' X_i + \gamma ' Z_{ij} \tag{3}$$

where $\beta_j '$ and $\gamma '$ are the parameter vectors associated with X_i and Z_{ij}, respectively. If a logistic distribution is chosen, the probability that household i will choose alternative j can be written as:[7]

[5] The framework is based on random utility theory and has been explicitly discussed by Ben-Akiva and Lerman (1985) and Train (1986).
[6] X_i is a vector of household characteristics (education and income levels), while Z_j is a vector of characteristics that vary by alternative, such as measures of telecommunications infrastructure and network externalities.
[7] By using the logistic distribution we are implicitly assuming that the unknown terms are distributed according to a special form of the generalized extreme value (GEV) distribution (McFadden, 1981).

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_{k \in J} \exp(V_{ik})} \qquad \text{for all } j \in \text{J} \tag{4}$$

The probabilities shown in equation (4) are those for the multinomial logit model. The distinctive characteristic of the multinomial logit model is that it assumes the independence of irrelevant alternatives (IIA). Simply stated, IIA implies that if only two choices existed (say, no access or dial-up access), then the addition of a third choice (high-speed access) would not change the ratios of probabilities of the first two choices. Put another way, the pool of high-speed users would be drawn equally from those with no access and dial-up access. The nested logit model, however, allows the IIA restriction to be relaxed and permits dial-up and high-speed access to be modeled as closer substitutes with each other than with the no access decision.

The two-level nested decision depicted in Figure 2 entails a slightly more complicated specification of the probability of household *i* selecting access type *j*. The joint probability of a household selecting branch *k* and twig *j* is:

$$\text{Pr [branch } k\text{, twig } j] = P_{kj} = \left(P_{j|k}\right)\left(P_k\right). \tag{5}$$

The conditional probability is defined as

$$P_{j|k} = \frac{\exp\left(\frac{1}{\tau_k} V_j\right)}{\sum_{l \in J^k} \exp(V_l)}, \tag{6}$$

where τ_k represents the degree of similarity between the alternatives in branch *k*. The marginal probability of selecting branch *k* is equal to

$$P_k = \frac{\exp(\tau_k IV_k)}{\sum_{k \in K} \exp(\tau_k IV_k)}. \tag{7}$$

For the kth branch, $IV_k = \ln \sum_{j \in J^k} \exp(\frac{1}{\tau_k} V_j),$ (8)

where IV indicates the inclusive value that, together with its parameter τ_k, represents the feedback between the upper and lower levels of the tree. Inserting (6) and (7) into (5), the probability of selecting branch *k* and twig *j* is:

$$P_{kj} = \left(\frac{\exp\left(\frac{1}{\tau_k} V_j \right)}{\sum_{l \in J^k} \exp(V_l)} \right) \left(\frac{\exp(\tau_k IV_k)}{\sum_{k \in K} \exp(\tau_k IV_k)} \right) \tag{9}$$

For the degenerate branch containing no access, there is only one element $j \in J^k$. In this case, $IV_k = \ln(\exp(V_j)) = V_j$. As noted above, τ_k represents the degree of similarity between the alternatives in one nest. Hence, for the degenerate branch associated with no access ($k = 0$), τ_k = 1 because there is only one alternative in the nest. Note that the special case of τ_k =1 for all *k* collapses to the multinomial logit specification. Hence, allowing τ_k to vary between branches relaxes the IIA restriction associated with the multinomial model. An IV parameter statistically different from one can be taken as strong support for the nested logit model relative to the multinomial model (Hausman and McFadden, 1984).

Results

Nested logit model parameter estimates from 2003 are presented in Table 3. Results for 2000 and 2001 are also included in appendix tables A.1 and A.2. Due to the similarity of the results across all three years, the following discussion will focus only on 2003 (Table 3). Interpretation of nested logit results requires that one potential outcome is selected as the "default" (McFadden, 1973). With dial-up access arbitrarily selected as this default category, *all coefficients for a characteristic group should be interpreted as relative to a "default household" – that is, one with the default characteristic value and dial-up access.* The "default household" can be construed from the base characteristics: the household head did not finish high-school; the household income is less than $5,000; the head is white and non-Hispanic; is female, single, has no children, and is not retired. Columns two and three of the table present coefficient estimates for urban households dealing with the probability of having no access and high-speed access relative to no access, respectively. Hence, the resulting parameters can be interpreted as the change in likelihood of either no access or high-speed access *relative to dial-up* when a characteristic changes. The fourth and fifth columns present parameter estimates on interaction terms for rural dummy variables with each characteristic. These coefficients can be interpreted as rural shifts in the probabilities of no access and high-speed access relative to dial-up access, respectively.

Model results for 2003 are now discussed with respect to the household characteristic, place-base characteristic, and infrastructure variable groupings.

Household characteristics

Higher levels of education and income *decrease* the probability of no access relative to dial-up access. At the same time, higher levels of education and income *increase* the probability of high-speed access relative to dial-up, but only at relatively high levels of education (coll and collplus) and the highest level of income (faminc13). These results are not surprising given the relationships observed in Table 1. None of the rural interaction terms for education or income are significant, indicating that the influence of these characteristics on access is similar in rural and urban areas. Internet access at work (netatwork) is a significant influence on both no access and high-speed access, with its presence decreasing the probability of no access and increasing the probability of high-speed access relative to dial-up access. Furthermore, the interaction of the rural dummy variable and netatwork is one of the few (weakly) significant interaction terms, with the positive sign indicating that the presence of Internet access at work is associated with a higher increase in the propensity for households in rural areas to have high-speed access than for households in urban areas.

The presence of a Black or Hispanic household head increases the probability of no access and decreases the probability of high-speed access relative to dial-up, implying that even after controlling for a multitude of other characteristics race and ethnicity still play a role in residential Internet access decisions. The presence of a married household head and between one and three children in the household decreases the probability of no access relative to dial-up access, but interestingly has no significant effect on high-speed access. This result is somewhat surprising due to the high-speed nature of many on-line activities for children under 18, such as gaming and music downloading (Horrigan, 2005). Similarly, a retired household head is related to a lower propensity to have no access relative to dial-up, but has no significant impact on the relative probability of high-speed access.

Place-based characteristics

Coefficients on local access rates (rate) are strongly significant, implying network externalities may play an important role in household access decisions. Thus, higher rates of a distinct type of access in an area (whether it is no access, dial-up, or high-speed) increase the probability of an individual household obtaining that particular type of access. Further, the rural interaction terms indicate that the effects of local access rates are amplified in rural areas.

Digital Communications Technology Infrastructure

The parameter estimates for DCT infrastructure (both DSL and cable) are not significantly related to any of the relative probabilities of technology use. This is particularly noteworthy for high-speed access, due to the hypothesized importance of DCT infrastructure to the high-speed access decision.

It is also worth noting that the IV parameter estimate is significantly different from unity in all three years, implying the nested logit model is more appropriate than the multinomial specification.

Model Decomposition

A generalized extension of Nielson's (1998) decomposition technique is implemented to isolate the impact of rural-urban parameter estimate differences, and directly test the contributions of various characteristics to the rural – urban high-speed digital divides. To generate the decomposition, equation (9) dealing with the nested logit probability of choosing alternative *j* is rewritten as:

$$P_{kj} = \left(\frac{\exp\left(\frac{1}{\tau_k} V_j \right)}{\sum_{l \in J^k} \exp(V_l)} \right) \left(\frac{\exp(\tau_k IV_k)}{\sum_{k \in K} \exp(\tau_k IV_k)} \right) = F_j[X, \beta, \tau] \tag{10}$$

since utility (V_j) is expressed in terms of *X* and β. The associated log-likelihood function then becomes:

$$\ln(L) = \sum_{i=1}^{N^U} \sum_{j=0,1,2} S_{ij} \ln F_j[X_i^U, \beta, \tau] + \sum_{i=1}^{N^R} \sum_{j=0,1,2} S_{ij} \ln F_j[X_i^R, (\beta + \delta), \tau] \tag{11}$$

where S_{ij} = 1 when household *i* chooses alternative *j*, and is 0 otherwise. The superscript *G*=(*U*,*R*) represents the metropolitan status of household *i*, N^G is the total number of households having status *G*, X_i^G is a vector of characteristics for household *i* with status *G*., and δ is a shift to the parameter β that occurs only for rural households. In order to assess the roles that the various characteristics play, the following three probabilities are simulated:

$$\hat{P}_{uj} = \frac{\sum_{i=1}^{N^U} F_j[X_i^U, \hat{\beta}, \hat{\tau}]}{N^U} \tag{12}$$

$$\hat{P}_{rj} = \frac{\sum_{i=1}^{N^R} F_j[X_i^R, (\hat{\beta} + \hat{\delta}), \hat{\tau}]}{N^R} \quad (13)$$

$$\hat{P}_{rj}^0 = \frac{\sum_{i=1}^{N^R} F_j[X_i^R, \hat{\beta}, \hat{\tau}]}{N^R} \quad (14)$$

$\hat{P}_{uj}$ and $\hat{P}_{rj}$ are the average probabilities of having Internet access equal to type *j* for urban and rural households, and will yield the access averages displayed in Figure 1 for rural and urban areas of the U.S. $\hat{P}_{rj}^0$ has no empirical counterpart, and is a simulated probability in the decomposition technique. $\hat{P}_{rj}^0$ is the average probability of having Internet access equal to type *j* for rural households with the parameter vector associated with urban households. This simulated probability allows us to split the total difference between rural and urban Internet access for type *j* into two distinct components:

$$\hat{P}_{uj} - \hat{P}_{rj} = (\hat{P}_{uj} - \hat{P}_{rj}^0) + (\hat{P}_{rj}^0 - \hat{P}_{rj}) . \quad (15)$$

Equations (12) and (13) indicate that the first term on the right-hand side of equation (15) uses urban parameters for both rural and urban households, and hence isolates differences in *attributes* (or characteristics) between households in rural and urban areas. Similarly, equations (13) and (14) indicate that the second term $(\hat{P}_{rj}^0 - \hat{P}_{rj})$ isolates differences in underlying *parameters* between the rural and urban groups.

By changing the vectors X_i^U and X_i^R to include different factors associated with the digital divide, the importance associated with each factor can be assessed in the term $(\hat{P}_{uj} - \hat{P}_{rj}^0)$. The initial decomposition will use X_i^U = X_i^R = 1, so that no household characteristics are included – thus, with no differences in characteristics, $\hat{P}_{uj}$ will equal $\hat{P}^0_{rj}$. Equation (15) then simplifies to $(\hat{P}^0_{rj} - \hat{P}_{rj})$ and the parameter $\hat{\delta}$ will account for all rural – urban differences in the various types of access. Next, models will include a factor (for instance, education levels of all households), so that X_i^U does not equal X_i^R. Hence, when $\hat{P}^0_{rj}$ is calculated, the education characteristics of rural households are used, along with the parameter vector associated with urban households. Thus, the term $(\hat{P}_{uj} - \hat{P}^0_{rj})$ will indicate how much of the divide for type *j* is due to differences in education levels between the two areas. The "leftover" portion of the divide still associated with the parameter vector $\hat{\delta}$ should become smaller if the rural – urban differences in explanatory variables are an important factor in the divide. Table 4 displays this sequential decomposition of the nested logit model in tabular form.

One issue with this decomposition technique is the sensitivity of the results to the ordering in which the dependent variables enter the analysis (due to the non-linearity of the nested logit functional form). To account for this, several re-orderings of specifications (2) through (6) in Table 4 will be performed, and the resulting decompositions will be compared.

Decomposition results for the years 2003, 2001, and 2000 are shown in Table 5. The first two lines indicate the urban ($\hat{P}_{uj}$) and rural ($\hat{P}_{rj}$) average rates of type *j* access for the given year, with the third line showing the “digital divide” for the relevant type of access. One group of explanatory variables is introduced at a time, starting with education levels.

As more variables are added to the analysis, the percentage of the type *j* gap explained by the included variables typically becomes larger. This is intuitive, because the inclusion of more explanatory variables captures the effects that rural – urban differences in these variables have on the likelihood of type *j* access. For instance, the initial decomposition focused only on the differences in education levels between rural and urban households. Accounting for these education differences explains 56 percent of the no access gap and 31 percent of the high-speed gap in 2003.[8] Once differences in income levels are also included, Table 5 indicates that 86 percent of the no access gap and 49 percent of the high-speed gap are explained. These increases imply that income differences between rural and urban households are an important part of the gap in various access rates. Similar results are seen in the rural – urban gaps from 2000 and 2001, with differences in education levels consistently accounting for 50 – 70 percent of the no access divide, 70 – 80 percent of the dial-up divide, and around 30 percent of the high-speed divide.[9] Once income differences are added to the analysis, the decomposition accounts for 80 – 90 percent of the no access divide, 90 – over 100 percent of the dial-up divide, and 40 – 50 percent of the high-speed divide.

The inclusion of differences in other household characteristics actually decreases the percentage of each type of gap explained, but this decrease is expected. In general, characteristics in this category that lead to higher rates of Internet access (such as having a White household head, being married, or having at least one child) are

[8] Since the gap in dial-up access is virtually nonexistent in 2003, inclusion of characteristics results in very large swings in both the percentages explained and the remainders.
[9] In 2000 and 2001 the rural – urban gaps in dial-up access are 11 and 6 percent, respectively. These are significantly larger than the less than 1 percent gap seen in 2003, allowing for easier interpretation of the decomposition results.

disproportionately found in *rural* households. Hence, including these characteristics will tend to increase the synthetic rates ($\hat{P}^0_{rj}$), which in turn will shrink the amount of the rural – urban gap explained.

A dramatic increase in the percentage of the rural – urban gap explained for each type of access occurs when the measures of network externalities are included. In each year, the percentage of each type of access explained increases by approximately 30 – 50 percentage points after the inclusion of network externalities. This dramatic increase provides additional evidence that the likelihood of type *j* access for an individual household is affected by regional variations in access rates. On the other hand, the inclusion of differences in DCT infrastructure increases the percentage of the high-speed gap explained by less than 12 percentage points in each of the three years included in the analysis. This increase is small compared to other changes (such as the inclusion of education or network externalities). It is also worth noting that parameter estimates underlying the decomposition are not statistically significant.

Due to the non-linear nature of the nested logit model, the order in which the variables were introduced may influence the results. Table 6 accounts for this by reversing the order in which the variables enter the analysis. Changing the order that the characteristics enter the analysis does have an effect on the magnitude of the resulting percentages of the rural – urban gap explained. This "ordering effect" is particularly notable in the reduced role of education differences and the increased role of DCT infrastructure differences (for 2000 and 2001) under the reordering. The reordering also has little effect on the increase in the percentage of the gap explained when income and network externalities were introduced into the analysis. Accounting for income and network externality differences between rural and urban areas consistently has large impacts on both dial-up and high-speed rural – urban divides regardless of the order of the decomposition. This result is highlighted in Table 7, where the impact of introducing each variable group separately is reported. Under this experiment, the impact of rural – urban differences in DCT infrastructure remains small for all years of the analysis, never explaining more than 8 percent of any type of divide. The impact of network externalities becomes larger, however, explaining over 57 percent of the high-speed divide and over 86 percent of the no-access divide in any year.

Discussion and Policy Implications

As the nation trends towards Internet connections with higher speeds, concerns continue to exist that communities with low levels of participation in the information revolution will lag behind their more connected counterparts, in terms of both economic well-being and in access to economic opportunities. Historically, the primary course of action of the federal, state, and local governments to address this concern has been to provide DCT infrastructure subsidies in low-density regions (Leighton, 2001; Kruger, 2005). However, decomposition results for the nested logit model of dial-up and high-speed access suggests that rural – urban differences in income levels and aggregate regional high-speed access rates are the driving forces behind the high-speed divide, while rural – urban differences in DCT infrastructure levels are relatively unimportant. These results (particularly the weak contribution of DCT infrastructure to the divide) imply that efforts to close the emerging rural – urban divide in high-speed access must recognize the rural – urban income and education gaps that are important underlying factors in the divide, rather than focusing solely on increasing initiatives for DCT infrastructure investments in rural areas.

From a policy standpoint, the ultimate rationale for government intervention is to coordinate positive externalities that would not result from individual household choices. The estimated existence of strong network externalities suggests such a coordinating role does exist, as market forces alone may not provide the optimal levels of service. Consumers are more likely to demand residential access if there are more people to interact with or ways to use the technology. In turn, suppliers are more likely to provide infrastructure if there are more users. This is particularly true for high-speed access due to the expenses involved in providing infrastructure and the multitude of on-line experiences available to high-speed users. In this light the best policies to reach households with lower access rates (for the purposes of this study, those in rural areas) should focus on inducing demand, potentially by subsidizing access and promoting community networks. Further research may need to identify the "tipping point" where the impact of such subsidies is largest.

The minimal contribution of differences in DCT infrastructure between rural and urban areas does not mean that future policies should completely forsake promoting infrastructure in rural areas. It simply implies that other factors – namely, differences in levels of income and network externalities – are potentially more important in determining high-speed access rates and need to be included in the policy portfolio.

References

Ben-Akiva, M. and S. Lerman. 1985. *Discrete Choice Analysis: Theory and Application to Travel Demand.* Cambridge, MA: MIT Press.

Cooper, M and G. Kimmelman. 1999. "The Digital Divide Confronts the Telecommunications Act of 1996." Consumer Federation of America: Washington D.C.

Drabenstott, M. 2001. "New Policies for a New Rural America." *International Regional Science Review*. 24, 1:3-15.

Federal Communications Commission – Industry Analysis and Technology Division. 2003. *High Speed Services for Internet Access: Status as of June 30, 2003*. Available at http://www.fcc.gov/wcb/iatd/comp.html

Forestier, E., J. Grace, and C. Kenney. 2002. "Can information and communication technologies be pro-poor?" *Telecommunications Policy*. 26: 623-646.

Graham, S. and A. Aurigi. 1997. "Virtual Cities, Social Polarization, and the Crisis in Urban Public Space." *Journal of Urban Technology* 4:19-52.

Grubesic, T. and A. Murray. 2004. "Waiting for Broadband: Local Competition and the Spatial Distribution of Advanced Telecommunication Services in the United States." *Growth and Change*. 35: 2, 139-165.

Hausman, J. and D. McFadden. 1984. "Specification Tests for the Multinomial Logit Model." *Econometrica*. 52,5: 1219 – 1240.

Hensher, D. and W. Greene. 2000. "Specification and Estimation of the Nested Logit Model: Alternative Normalizations." Mimeo, New York University.

Horrigan, J.B. 2001. *Online Communities: Networks that Nurture Long-Distance Relationships and Local Ties*. Pew Internet & American Life Project. http://pewinternet.org/

Horrigan, J.B. 2005. *Broadband Adoption at Home in the United States: Growing but Slowing*. Pew Internet & American Life Project. http://pewinternet.org/

Kruger, L. 2005. "Broadband Internet Access and the Digital Divide: Federal Assistance Programs." *Congressional Research Service – The Library of Congress*.

Leighton, W.A. 2001. "Broadband Deployment and the Digital Divide." Cato Policy Analysis No. 410. August 7.

Malecki, E.J. 2003. "Digital Development in rural areas: potentials and pitfalls." *Journal of Rural Studies* 19: 201-214.

McConnaughey, J., and W. Lader. 1998. *Falling Through the Net II: New Data on the Digital Divide.* National Telecommunications and Information Administration, http://www.ntia.doc.gov/ntiahome/net2/falling.html

McFadden, D. 1973. "Conditional Logit Analysis of Qualitative Choice Behavior," in P. Zarembka, ed., *Frontiers in Econometrics*. Academic Press: New York

McFadden, D. 1981. Econometric Models of Probabilistic Choice. In *Structural Analysis of Discrete Data and Econometric Applications*, eds. C.F. Manski and D.L. McFadden, 198-272. Cambridge, MA: MIT Press.

Mills, B.F. and B. Whitacre. 2003. "Understanding the Non-Metropolitan – Metropolitan Digital Divide." *Growth and Change*. 34,2: 219-243.

National Telecommunications and Information Administration and Economics Statistics Administration. 2002. *How Americans Are Expanding Their Use of the Internet*. U.S. Department of Commerce: Washington, D.C.

Nielson, H.S. 1998. "Discrimination and Detailed Decomposition in a Logit Model." *Economics Letters*. 61: 115-120.

Rose, R. 2003. *Oxford Internet Survey Results.* The Oxford Internet Institute: The University of Oxford, UK.

Townsend, A. 2001. "The Internet and the Rise of the New Network Cities, 1969 - 1999." *Environment and Planning B: Planning and Design*, 28: 39-58.

Train, K. 1986. Qualitative Choice Analysis. Cambridge, MA: MIT Press.

Figure 1. The Shifting Rural - Urban Digital Divide

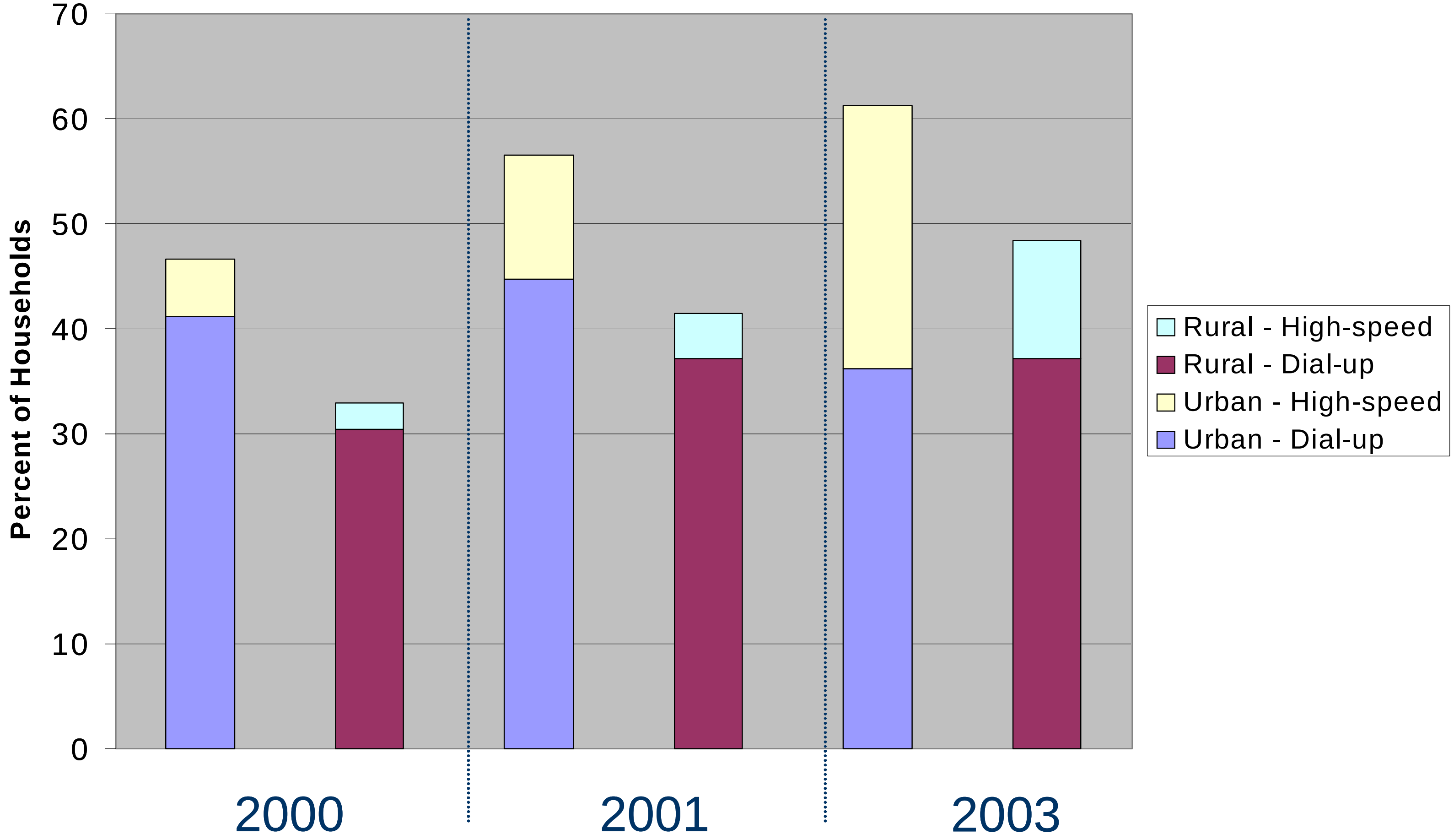

Figure 2. Nested Logit Tree Structure

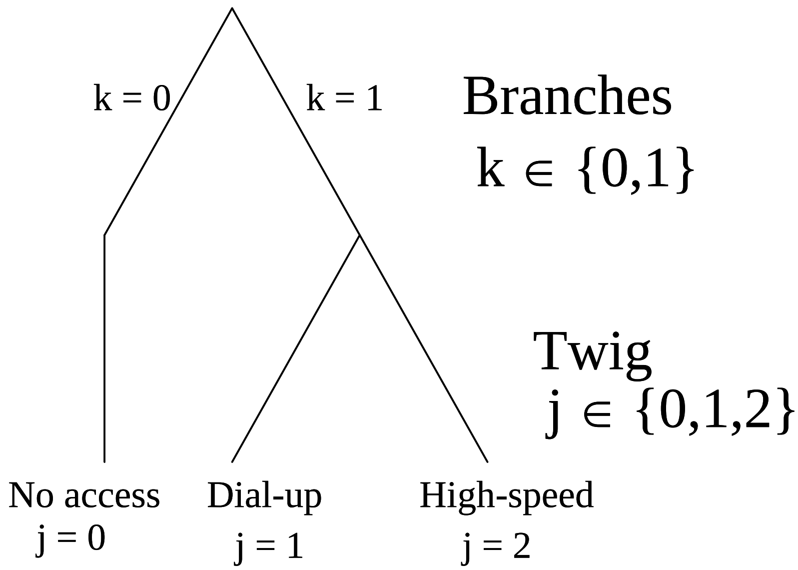

Table 1. Household Characteristics by Type of Internet Access

	No Access			Dial-up Access			High-Speed Access		
	2000	2001	2003	2000	2001	2003	2000	2001	2003
Income									
< $25,000	0.463	0.510	0.510	0.124	0.136	0.162	0.089	0.101	0.113
$25,001 - $50,000	0.425	0.421	0.423	0.322	0.339	0.368	0.265	0.247	0.250
> $50,001	0.214	0.179	0.170	0.595	0.574	0.522	0.675	0.681	0.669
Education									
No High School	0.233	0.253	0.257	0.037	0.049	0.054	0.034	0.030	0.031
High School	0.354	0.365	0.373	0.208	0.230	0.251	0.158	0.170	0.171
Some College	0.242	0.242	0.235	0.312	0.316	0.321	0.292	0.304	0.290
College or More	0.171	0.141	0.135	0.444	0.404	0.375	0.515	0.496	0.508
Race / Ethnicity									
White	0.797	0.793	0.780	0.884	0.873	0.865	0.888	0.870	0.859
Black	0.166	0.174	0.169	0.066	0.079	0.082	0.060	0.066	0.067
Other	0.037	0.033	0.051	0.050	0.048	0.053	0.052	0.064	0.074
Hispanic	0.118	0.126	0.149	0.050	0.058	0.073	0.045	0.051	0.062
HH Composition									
Married	0.450	0.401	0.394	0.678	0.667	0.641	0.670	0.660	0.660
Male	0.511	0.487	0.489	0.610	0.582	0.559	0.648	0.623	0.603
Age of Head	50.5	51.7	51.3	44.1	44.7	46.3	42.9	42.9	43.6
# Children	0.477	0.470	0.467	0.475	0.772	0.711	0.487	0.774	0.761
Employment									
Employed	0.600	0.549	0.529	0.805	0.793	0.744	0.825	0.801	0.797
Net at work	0.122	0.137	0.117	0.292	0.415	0.349	0.379	0.505	0.464

Sources: CPS Computer and Internet Use Supplements, 2000, 2001, and 2003.

Table 2. Percent of Rural / Urban Population with DCT Infrastructure Capacity

	2000	2001	2003
Cable			
Rural	4.66	5.47	44.10
Urban	25.08	27.68	75.75
DSL			
Rural	3.43	6.39	29.55
Urban	21.61	32.05	42.39

Sources: Cable Television Factbook, NECA Tariff #4 Data for 2000, 2001, and 2003.

This table assumes that if the infrastructure exists within a rural or urban county (or city), the population of that county (or city) has infrastructure capacity.

Table 3. Nested Logit Results (2003)

Variables	Urban				Rural			
	None		Highspeed		None		Highspeed	
constant	1.0559	**	-1.1814		0.0771		-0.7472	
hs	-0.6386	***	0.0526		0.0503		0.0050	
scoll	-1.3375	***	0.2028		0.1515		0.1731	
coll	-1.6842	***	0.3871	*	0.1335		-0.0376	
collplus	-1.8546	***	0.4027	**	0.1853		0.1080	
faminc1	0.2913		-0.3959		-0.3608		1.0742	
faminc2	0.4053		-0.4137		-0.3092		0.5577	
faminc3	0.2085		-0.4363		-0.3117		0.8844	
faminc4	0.2256		-0.5061		-0.4576		1.0108	
faminc5	0.0957		-0.4796		-0.4391		1.0317	
faminc6	-0.1136		-0.3570		-0.3463		0.6927	
faminc7	-0.1795		-0.2086		-0.4451		0.4246	
faminc8	-0.3407	***	-0.3615		-0.4537		0.7753	
faminc9	-0.4997	***	-0.5148		-0.6360		1.3911	
faminc10	-0.8418	***	-0.2525		-0.2627		0.6280	
faminc11	-0.9836	***	-0.1142		-0.5125		0.6383	
faminc12	-1.3348	***	-0.0872		-0.1925		0.8989	
faminc13	-1.7958	***	0.3647	**	-0.0634		0.6222	
netatwork	-0.5698	***	0.1357	**	-0.0558		0.0088	*
black	0.7308	***	-0.1901	*	-0.1170		0.3095	
othrace	0.1435		0.0680		0.0162		0.6222	
hisp	0.7381	***	-0.1386	*	-0.2782		-0.0619	
peage	-0.0538	**	-0.0043	*	-0.0149		-0.0187	
age2	0.0008		-0.0001		0.0002		0.0003	
sex	-0.0882		0.1855		0.1726		-0.2229	
married	-0.5024	**	-0.0349		-0.0991		-0.1952	
chld1	-0.2558	***	-0.0279		-0.0107		0.3900	
chld2	-0.3010	***	-0.0305		-0.0167		0.3049	
chld3	-0.1757	**	-0.1397		0.0225		0.4133	
chld4	-0.2211		-0.2889		0.5778		0.2635	
chld5	-0.1249		-0.2058		-0.0894		-0.2093	
retired	-0.1223	***	-0.0789		-0.3006		0.3487	
rate	2.7352	***	2.2806	***	0.5027	*	2.8191	**
dslaccess	-0.1544		0.2099		0.0402		-0.1538	
cableaccess	-0.2525		0.4210		0.3713		-0.5937	
IV - no	1							
IV - yes	0.8920	***						
Log-likelihood	-17632.0							

Note: *, ***, and *** indicate statistically significant differences from zero at the p = 0.10, 0.05, and 0.01 levels, respectively. For the inclusive value (IV), they indicate a statistically significant difference from one.

Table 4. Decomposition of Nested Logit Specification

Specification	$X_i^U = X_i^R$ Explanatory Variables	Variables Added	$(\hat{P}_{uj} - \hat{P}_{rj})$ $(\hat{P}_{uj} - \hat{P}_{rj}^0)$ Differences in Attributes	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$ Differences in Parameters
(1)	Constant term		0	rural intercept (δ)
(2)	(1) + Education Levels	X_E	X_E	rural intercept (δ)
(3)	(2) + Income Levels	X_I	$X_E + X_I$	rural intercept (δ)
(4)	(3) + Other Household Characteristics	X_O	$X_E + X_I + X_O$	rural intercept (δ)
(5)	(4) + Network Externalities	X_N	$X_E + X_I + X_O + X_N$	rural intercept (δ)
(6)	(5) + DCT Infrastructure	X_T	$X_E + X_I + X_O + X_N + X_T$	rural intercept (δ)

Hypotheses: $\delta(1) > \delta(2) > \delta(3) > \delta(4) > \delta(5) > \delta(6)$ for dial-up and high-speed access
Importance of X_T for high-speed access > Importance of X_T for dial-up access

Table 5. Nested Logit Decomposition Results

		2003			2001			2000	
		j = 0	j = 1	j = 2	j = 0	j = 1	j = 2	j = 0	j = 1	j = 2
Rates of Access		None	Dialup	Highspeed	None	Dialup	Highspeed	None	Dialup	Highspeed
Urban	$\hat{P}_{uj}$	0.3877	0.3623	0.2500	0.4343	0.4475	0.1181	0.5324	0.4142	0.0533
Rural	$\hat{P}_{rj}$	0.5161	0.3718	0.1122	0.5706	0.3864	0.0430	0.6706	0.3058	0.0236
Delta	$(\hat{P}_{uj} - \hat{P}_{rj})$	-0.1284	-0.0095	0.1378	-0.1363	0.0611	0.0751	-0.1382	0.1084	0.0298
Explanatory Variables										
Education										
	$\hat{P}_{rj}^0$	0.4593	0.3339	0.2068	0.5054	0.3972	0.0974	0.6262	0.3345	0.0432
% Explained	$(\hat{P}_{uj} - \hat{P}_{rj}^0)$	56%	-299%	31%	52%	82%	28%	68%	74%	34%
Remainder	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$	44%	399%	69%	48%	18%	72%	32%	26%	66%
Education + Income										
	$\hat{P}_{rj}^0$	0.4985	0.3194	0.1821	0.5510	0.3628	0.0862	0.6456	0.3165	0.0378
% Explained	$(\hat{P}_{uj} - \hat{P}_{rj}^0)$	86%	-452%	49%	86%	139%	43%	82%	90%	52%
Remainder	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$	14%	552%	51%	14%	-39%	57%	18%	10%	48%
Education + Income + Other HH Characteristics										
	$\hat{P}_{rj}^0$	0.4757	0.3372	0.1871	0.5249	0.3874	0.0877	0.6210	0.3408	0.0382
% Explained	$(\hat{P}_{uj} - \hat{P}_{rj}^0)$	69%	-264%	46%	66%	98%	40%	64%	68%	51%
Remainder	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$	31%	364%	54%	34%	2%	60%	36%	32%	49%
Education + Income + Other HH Characteristics + Network Externalities										
	$\hat{P}_{rj}^0$	0.5174	0.3379	0.1447	0.5715	0.3604	0.0681	0.6798	0.2940	0.0216
% Explained	$(\hat{P}_{uj} - \hat{P}_{rj}^0)$	101%	-257%	76%	101%	143%	67%	107%	111%	107%
Remainder	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$	-1%	357%	24%	-1%	-43%	33%	-7%	-11%	-7%
Education + Income + Other HH Characteristics + Network Externalities + DCT Infrastructure										
	$\hat{P}_{rj}^0$	0.5316	0.3401	0.1284	0.5731	0.3585	0.0682	0.6855	0.2862	0.0283
% Explained	$(\hat{P}_{uj} - \hat{P}_{rj}^0)$	112%	-234%	88%	102%	146%	66%	111%	118%	84%
Remainder	$(\hat{P}_{rj}^0 - \hat{P}_{rj})$	-12%	334%	12%	-2%	-46%	34%	-11%	-18%	16%

Note: Percentages indicate the contribution of the regressed group of variables to the rural - urban gap for each type of access

Table 6. Nested Logit Decomposition Results (Order Reversed)

		2003			2001			2000	
	j = 0	j = 1	j = 2	j = 0	j = 1	j = 2	j = 0	j = 1	j = 2
Rates of Access	None	Dialup	Highspeed	None	Dialup	Highspeed	None	Dialup	Highspeed
Urban $\hat{P}_{uj}$	0.3877	0.3623	0.2500	0.4343	0.4475	0.1181	0.5324	0.4142	0.0533
Rural $\hat{P}_{rj}$	0.5161	0.3718	0.1122	0.5706	0.3864	0.0430	0.6706	0.3058	0.0236
Delta $(\hat{P}_{uj} - \hat{P}_{rj})$	-0.1284	-0.0095	0.1378	-0.1363	0.0611	0.0751	-0.1382	0.1084	0.0298
Explanatory Variables									
DCT Infrastructure									
$\hat{P}_{rj}^0$	0.3985	0.3999	0.2417	0.4405	0.4447	0.1148	0.5434	0.4058	0.0508
% Explained $(\hat{P}_{uj} - \hat{P}_{rj}^0)$	8%	396%	6%	5%	5%	4%	8%	8%	8%
Remainder $(\hat{P}_{rj}^0 - \hat{P}_{rj})$	92%	-296%	94%	95%	95%	96%	92%	92%	92%
DCT Infrastructure + Network Externalities									
$\hat{P}_{rj}^0$	0.4585	0.3331	0.1875	0.4850	0.4018	0.0752	0.6004	0.3459	0.0428
% Explained $(\hat{P}_{uj} - \hat{P}_{rj}^0)$	55%	-307%	45%	37%	75%	57%	49%	63%	35%
Remainder $(\hat{P}_{rj}^0 - \hat{P}_{rj})$	45%	407%	55%	63%	25%	43%	51%	37%	65%
DCT Infrastructure + Network Externalities + Other HH Characteristics									
$\hat{P}_{rj}^0$	0.4492	0.3405	0.1957	0.4805	0.4106	0.0852	0.5924	0.3511	0.0435
% Explained $(\hat{P}_{uj} - \hat{P}_{rj}^0)$	48%	-229%	39%	34%	60%	44%	43%	58%	33%
Remainder $(\hat{P}_{rj}^0 - \hat{P}_{rj})$	52%	329%	61%	66%	40%	56%	57%	42%	67%
DCT Infrastructure + Network Externalities + Other HH Characteristics + Income									
$\hat{P}_{rj}^0$	0.5014	0.3383	0.1502	0.5685	0.3785	0.0724	0.6739	0.2988	0.0285
% Explained $(\hat{P}_{uj} - \hat{P}_{rj}^0)$	89%	-253%	72%	98%	113%	61%	102%	106%	83%
Remainder $(\hat{P}_{rj}^0 - \hat{P}_{rj})$	11%	353%	28%	2%	-13%	39%	-2%	-6%	17%
DCT Infrastructure + Network Externalities + Other HH Characteristics + Income + Education									
$\hat{P}_{rj}^0$	0.5316	0.3401	0.1284	0.5731	0.3585	0.0682	0.6855	0.2862	0.0283
% Explained $(\hat{P}_{uj} - \hat{P}_{rj}^0)$	112%	-234%	88%	102%	146%	66%	111%	118%	84%
Remainder $(\hat{P}_{rj}^0 - \hat{P}_{rj})$	-12%	334%	12%	-2%	-46%	34%	-11%	-18%	16%

Note: Percentages indicate the contribution of the regressed group of variables to the rural - urban gap for each type of access

Table 7. Nested Logit Decomposition Results (Single Explanatory Variables)

		2003			2001			2000	
		j = 0	j = 1	j = 2	j = 0	j = 1	j = 2	j = 0	j = 1	j = 2
Rates of Access		None	Dialup	Highspeed	None	Dialup	Highspeed	None	Dialup	Highspeed
Urban	$\hat{P}_{uj}$	0.3877	0.3623	0.2500	0.4343	0.4475	0.1181	0.5324	0.4142	0.0533
Rural	$\hat{P}_{rj}$	0.5161	0.3718	0.1122	0.5706	0.3864	0.0430	0.6706	0.3058	0.0236
Delta	$(\hat{P}_{uj} - \hat{P}_{rj})$	-0.1284	-0.0095	0.1378	-0.1363	0.0611	0.0751	-0.1382	0.1084	0.0298
Explanatory Variables										
Education										
	$\hat{P}^0_{rj}$	0.4593	0.3339	0.2068	0.5054	0.3972	0.0974	0.6262	0.3345	0.0432
% Explained	$(\hat{P}_{uj} - \hat{P}^0_{rj})$	56%	-299%	31%	52%	82%	28%	68%	74%	34%
Remainder	$(\hat{P}^0_{rj} - \hat{P}_{rj})$	44%	399%	69%	48%	18%	72%	32%	26%	66%
Income										
	$\hat{P}^0_{rj}$	0.4792	0.3271	0.1937	0.5337	0.3764	0.0899	0.6031	0.3536	0.0432
% Explained	$(\hat{P}_{uj} - \hat{P}^0_{rj})$	71%	-371%	41%	73%	116%	38%	51%	56%	34%
Remainder	$(\hat{P}^0_{rj} - \hat{P}_{rj})$	29%	471%	59%	27%	-16%	62%	49%	44%	66%
Other HH Characteristics										
	$\hat{P}^0_{rj}$	0.3999	0.3642	0.2359	0.4502	0.4384	0.1113	0.5370	0.4123	0.0507
% Explained	$(\hat{P}_{uj} - \hat{P}^0_{rj})$	10%	20%	10%	12%	15%	9%	3%	2%	9%
Remainder	$(\hat{P}^0_{rj} - \hat{P}_{rj})$	90%	80%	90%	88%	85%	91%	97%	98%	91%
Network Externalities										
	$\hat{P}^0_{rj}$	0.4987	0.3213	0.1589	0.5598	0.3810	0.0751	0.6638	0.3055	0.0306
% Explained	$(\hat{P}_{uj} - \hat{P}^0_{rj})$	86%	-431%	66%	92%	109%	57%	95%	100%	76%
Remainder	$(\hat{P}^0_{rj} - \hat{P}_{rj})$	14%	531%	34%	8%	-9%	43%	5%	0%	24%
DCT Infrastructure										
	$\hat{P}^0_{rj}$	0.3985	0.3999	0.2417	0.4405	0.4447	0.1148	0.5434	0.4058	0.0508
% Explained	$(\hat{P}_{uj} - \hat{P}^0_{rj})$	8%	396%	6%	5%	5%	4%	8%	8%	8%
Remainder	$(\hat{P}^0_{rj} - \hat{P}_{rj})$	92%	-296%	94%	95%	95%	96%	92%	92%	92%

Note: Percentages indicate the contribution of the regressed group of variables to the rural - urban gap for each type of access

Appendix A.1 – Nested Logit Results (2000)

Variables	Urban				Rural			
	None		Highspeed		None		Highspeed	
constant	0.1260	***	-1.9091	***	0.5125		-0.6490	*
hs	-0.5362	***	-0.3194		-0.2175		0.6751	
scoll	-1.1582	***	-0.1760		-0.4571		0.8483	
coll	-1.4914	***	0.0697		-0.4524		0.5560	
collplus	-1.6087	***	0.1718	**	-0.4938		1.0592	
faminc1	0.2509		-0.0881		0.4216		-3.0757	
faminc2	0.2470		-0.1239		0.1711		-1.7583	
faminc3	0.1378		-0.2198		0.3059		-0.1288	
faminc4	-0.1648		-0.0878		0.0903		-1.3618	
faminc5	-0.0154		-0.6346		-0.2994		0.5055	
faminc6	-0.1920		-0.1627		0.0355		-0.2920	
faminc7	-0.5420	**	0.1353		0.2438		-0.8961	
faminc8	-0.7451	***	0.1630		0.1296		-0.9369	
faminc9	-0.6096	***	-0.2381		-0.0758		0.0505	
faminc10	-0.9662	***	0.0334		-0.0389		-0.1034	
faminc11	-1.1606	***	0.1810		0.1348		-0.8307	
faminc12	-1.4247	***	0.1661	**	0.1841		-0.6850	
faminc13	-1.9408	***	0.4329	***	0.1434		-0.3838	
netatwork	-0.1984	***	0.2505	**	0.2269		-0.0660	
black	0.9197	***	-0.2478	*	-0.1509		0.1654	
othrace	0.1407		-0.1198		0.5257		-1.2931	
hisp	0.7761	***	-0.1058	**	0.0749		-0.0633	
peage	-0.0329	**	-0.0145		-0.0179		-0.0248	
age2	0.0006		0.0001		0.0001		0.0004	
sex	-0.0525		0.1002	*	0.0288		0.3372	
married	-0.3799	**	-0.1381		-0.1113		-0.3665	
chld1	0.0410		0.1461		-0.0055		-0.3612	
chld2	-0.0260		0.1127		0.0678		-0.0338	
chld3	0.1391		0.0641		-0.0833		-0.2163	
chld4	-0.2051		-0.0784		-0.2254		0.4692	
chld5	-0.0633		0.3247		0.7138		-4.9407	
retired	-0.0907	***	0.1535		0.2295		-0.3023	
rate	3.0846	***	5.1862	**	0.5410	*	6.2007	
dslaccess	-0.1811		0.1400		0.1388		0.3283	
cableaccess	0.0556		-0.1913		-0.7822	*	0.9272	
IV - no	1							
IV - yes	0.9302	**						
Log-likelihood:	-22,905							

Note: *, **, and *** indicate statistically significant differences from zero at the *p* = 0.10, 0.05, and 0.01 levels, respectively. For the inclusive value (IV), they indicate a statistically significant difference from one.

Appendix A.2 – Nested Logit Results (2001)

Variables	Urban				Rural			
	None		Highspeed		None		Highspeed	
constant	0.9714	***	-1.1705	**	0.7362		-1.5876	*
hs	-0.6216	***	0.0907		0.0040		0.0657	
scoll	-1.1609	***	0.2458		-0.0080		-0.1385	
coll	-1.4678	***	0.3243		0.1291		-0.0090	
collplus	-1.5454	***	0.2218	**	-0.1759		0.0162	
faminc1	0.2609		-0.6960		0.0352		-1.1593	
faminc2	0.3295		-0.2356		-0.4138		-0.7735	
faminc3	0.0644		-0.0669		-0.4968		0.2149	
faminc4	0.0886		-0.2932		-0.1041		0.6921	
faminc5	-0.0163		-0.5568		-0.0948		1.1272	
faminc6	-0.1948		-0.5249		-0.2424		0.1533	
faminc7	-0.3813	**	-0.4621		-0.1588		0.7051	
faminc8	-0.6412	***	-0.3996		-0.1982		0.6744	
faminc9	-0.6943	***	-0.4100		0.0102		0.5392	
faminc10	-0.8996	***	-0.2938		-0.1582		0.3182	
faminc11	-1.1025	***	-0.3602		-0.1485		0.8044	
faminc12	-1.3692	***	-0.1564		-0.0726		0.8517	
faminc13	-1.8157	***	0.1291	**	0.0106		0.5704	
netatwork	-0.4794	***	0.1548	**	-0.1144		-0.1120	
black	0.7903	***	-0.1878	**	-0.3079		0.2319	
othrace	-0.0875		0.0345		0.4239		0.5828	
hisp	0.7048	***	-0.1202	*	-0.1332		0.4554	
peage	-0.0377	**	-0.0202		-0.0247		-0.0172	
age2	0.0006		0.0001		0.0002		0.0003	
sex	0.0077		0.1770		0.0116		-0.1502	
married	-0.5325	**	-0.1286		-0.1983		0.0135	
chld1	-0.1893		-0.0081		-0.1385		0.2683	
chld2	-0.3210		0.0050		-0.1383		-0.3462	
chld3	-0.2902		0.0575		0.0789		-0.9515	
chld4	-0.1242		0.0452		-0.1546		-0.2112	
chld5	-0.2163		-0.0392		0.4633		-0.1191	
retired	-0.0449	***	0.1479		-0.1235		-0.3828	
rate	2.3405	***	3.4180	**	0.5711	**	8.2573	
dslaccess	-0.0665		0.1578		-0.2219		-0.4152	
cableaccess	0.1164		-0.2998		-0.1022		-0.6213	
IV - no	1							
IV - yes	0.8504	***						
Log-likelihood:	-29,876							

Note: *, **, and *** indicate statistically significant differences from zero at the *p* = 0.10, 0.05, and 0.01 levels, respectively. For the inclusive value (IV), they indicate a statistically significant difference from one.